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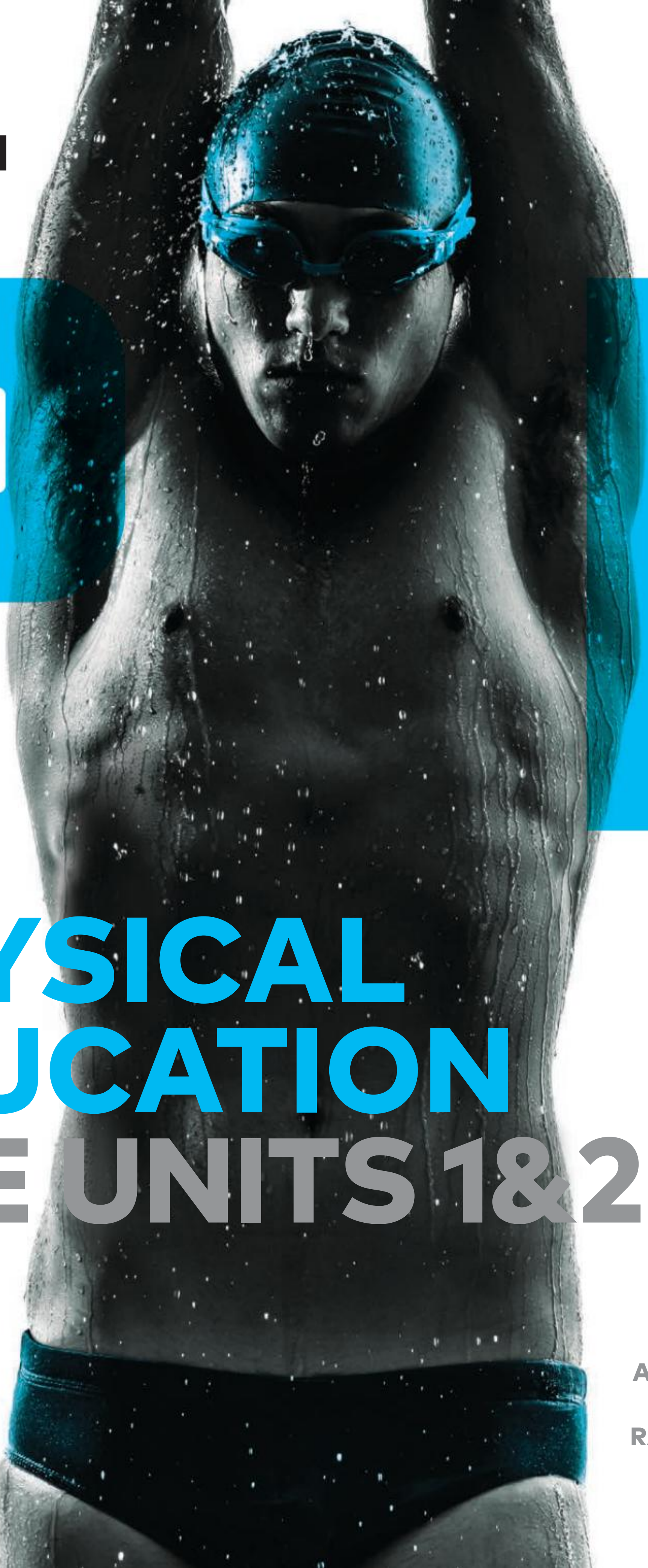
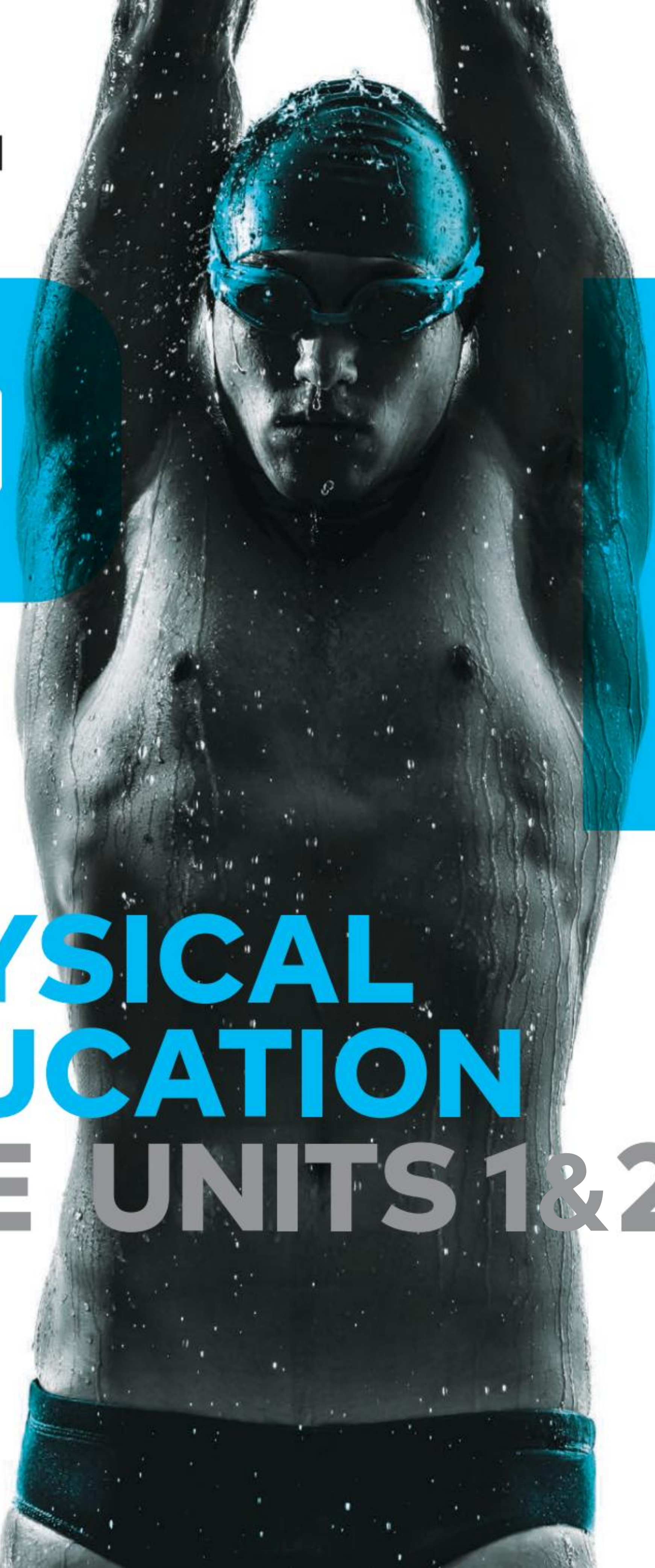


PHYSICAL EDUCATION VCE UNITS 1&2

EDITION 2

AMANDA TELFORD
ROB MALPELI
RACHAEL WHITTLE
PAUL SEERY
MARK CORRIE

NELSON



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PHYSICAL EDUCATION VCE UNITS 1&2

2ND EDITION

NELSON
CENGAGE Learning

Nelson Physical Education VCE Units 1 & 2
2nd Edition
Amanda Telford
Rob Malpeli
Rachael Whittle
Paul Seery
Mark Corrie

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Whittle, Rachael, author.
Seery, Paul, author.
Corrie, Mark, author.
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Cengage Learning Australia
Level 7, 80 Dorcas Street
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Cengage Learning New Zealand
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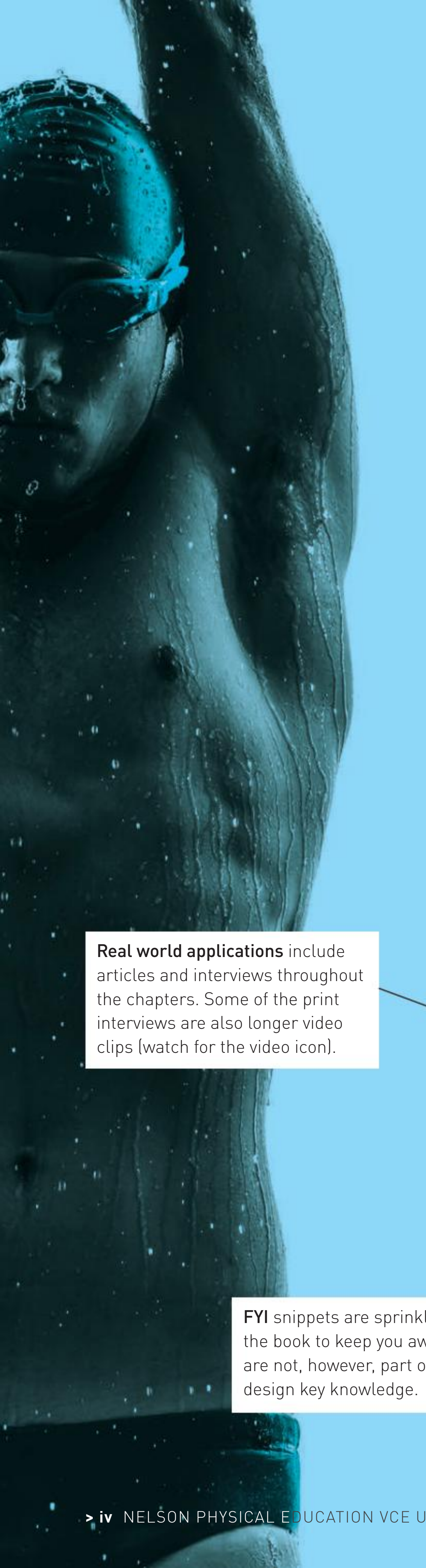
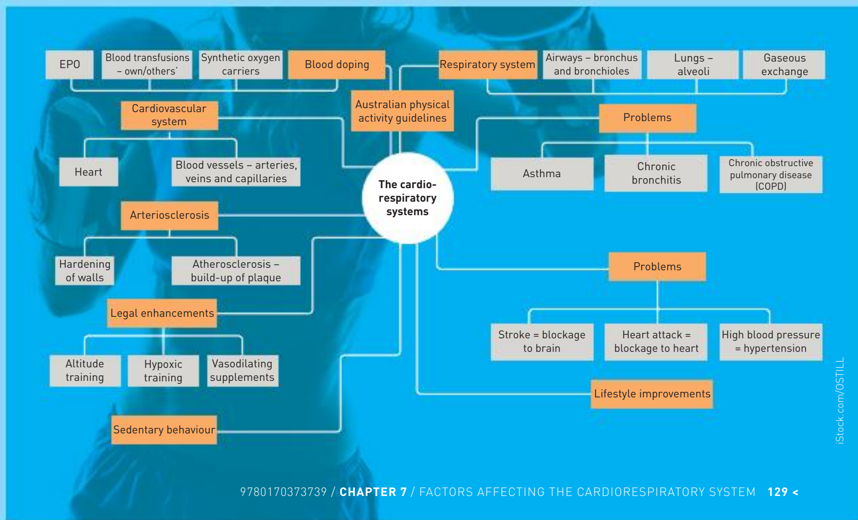


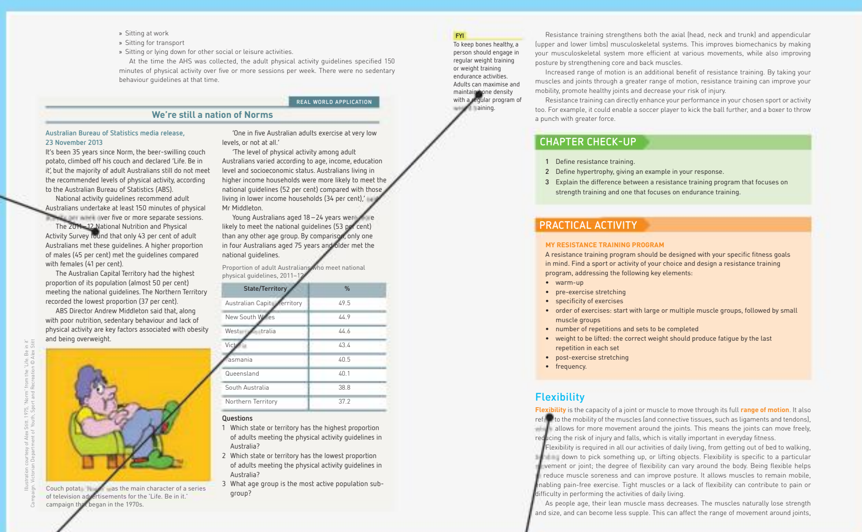
ABOUT THIS BOOK

This book has been completely rewritten to match the new study design, so we have taken the opportunity to include new research in the relevant areas. We have revised the content and features to provide a better, clearer, more user-friendly book.

Area of study pages list chapters. All VCAA key knowledge and key skills are explicitly covered within them. Each chapter opens with a flow chart providing an at-a-glance preview of what the chapter will cover.



IN EACH CHAPTER



» Sitting at work
» Sitting for transport
» Sitting or lying down for other social or leisure activities.

At the time the AHS was collected, the adult physical activity guidelines specified 150 minutes of physical activity over five or more sessions per week. There were no sedentary behaviour guidelines at that time.

REAL WORLD APPLICATION

We're still a nation of Norms

Australian Bureau of Statistics media release, 23 November 2013

It's been 35 years since Norm, the beer-swilling couch potato, climbed off his couch and declared 'Life. Be in it', but the majority of adult Australians still do not meet the recommended levels of physical activity, according to the Australian Bureau of Statistics (ABS).

National activity guidelines recommend adult Australians undertake at least 150 minutes of physical [illegible] over five or more separate sessions.

The 2011–12 National Nutrition and Physical Activity Survey found that only 43 per cent of adult Australians met these guidelines. A higher proportion of males (45 per cent) met the guidelines compared with females (41 per cent).

The Australian Capital Territory had the highest proportion of its population (almost 50 per cent) meeting the national guidelines. The Northern Territory recorded the lowest proportion (37 per cent).

ABS Director Andrew Middleton said that, along with poor nutrition, sedentary behaviour and lack of physical activity are key factors associated with obesity and being overweight.

Illustration courtesy of Alex Stitt. 1975, 'Norm' from the 'Life. Be in it' Campaign. Victorian Department of Youth, Sport and Recreation © Alex Stitt

Couch potat[illegible] was the main character of a series of television advertisements for the 'Life. Be in it.' campaign that began in the 1970s.

'One in five Australian adults exercise at very low levels, or not at all.'

'The level of physical activity among adult Australians varied according to age, income, education level and socioeconomic status. Australians living in higher income households were more likely to meet the national guidelines (52 per cent) compared with those living in lower income households (34 per cent),' [illegible] Mr Middleton.

Young Australians aged 18–24 years wer[illegible]e likely to meet the national guidelines (53 per cent) than any other age group. By comparison, only one in four Australians aged 75 years and older met the national guidelines.

Proportion of adult Australians who meet national physical guidelines, 2011–12

State/Territory	%
Australian Capital Territory	49.5
New South Wales	44.9
Western Australia	44.6
Victoria	43.4
Tasmania	40.5
Queensland	40.1
South Australia	38.8
Northern Territory	37.2

Questions

1 Which state or territory has the highest proportion of adults meeting the physical activity guidelines in Australia?
2 Which state or territory has the lowest proportion of adults meeting the physical activity guidelines in Australia?
3 What age group is the most active population sub-group?

FYI

To keep bones healthy, a person should engage in regular weight training or weight training endurance activities. Adults can maximise and maintain bone density with a regular program of [illegible]aining.

Resistance training strengthens both the axial (head, neck and trunk) and appendicular (upper and lower limbs) musculoskeletal systems. This improves biomechanics by making your musculoskeletal system more efficient at various movements, while also improving posture by strengthening core and back muscles.

Increased range of motion is an additional benefit of resistance training. By taking your muscles and joints through a greater range of motion, resistance training can improve your mobility, promote healthy joints and decrease your risk of injury.

Resistance training can directly enhance your performance in your chosen sport or activity too. For example, it could enable a soccer player to kick the ball further, and a boxer to throw a punch with greater force.

CHAPTER CHECK-UP

1 Define resistance training.
2 Define hypertrophy, giving an example in your response.
3 Explain the difference between a resistance training program that focuses on strength training and one that focuses on endurance training.

PRACTICAL ACTIVITY

MY RESISTANCE TRAINING PROGRAM

A resistance training program should be designed with your specific fitness goals in mind. Find a sport or activity of your choice and design a resistance training program, addressing the following key elements:

- warm-up
- pre-exercise stretching
- specificity of exercises
- order of exercises: start with large or multiple muscle groups, followed by small muscle groups
- number of repetitions and sets to be completed
- weight to be lifted: the correct weight should produce fatigue by the last repetition in each set
- post-exercise stretching
- frequency.

Flexibility

Flexibility is the capacity of a joint or muscle to move through its full **range of motion**. It also ref[illegible] to the mobility of the muscles (and connective tissues, such as ligaments and tendons), [illegible] allows for more movement around the joints. This means the joints can move freely, reducing the risk of injury and falls, which is vitally important in everyday fitness.

Flexibility is required in all our activities of daily living, from getting out of bed to walking, [illegible] down to pick something up, or lifting objects. Flexibility is specific to a particular [illegible]vement or joint; the degree of flexibility can vary around the body. Being flexible helps [illegible] reduce muscle soreness and can improve posture. It allows muscles to remain mobile, enabling pain-free exercise. Tight muscles or a lack of flexibility can contribute to pain or difficulty in performing the activities of daily living.

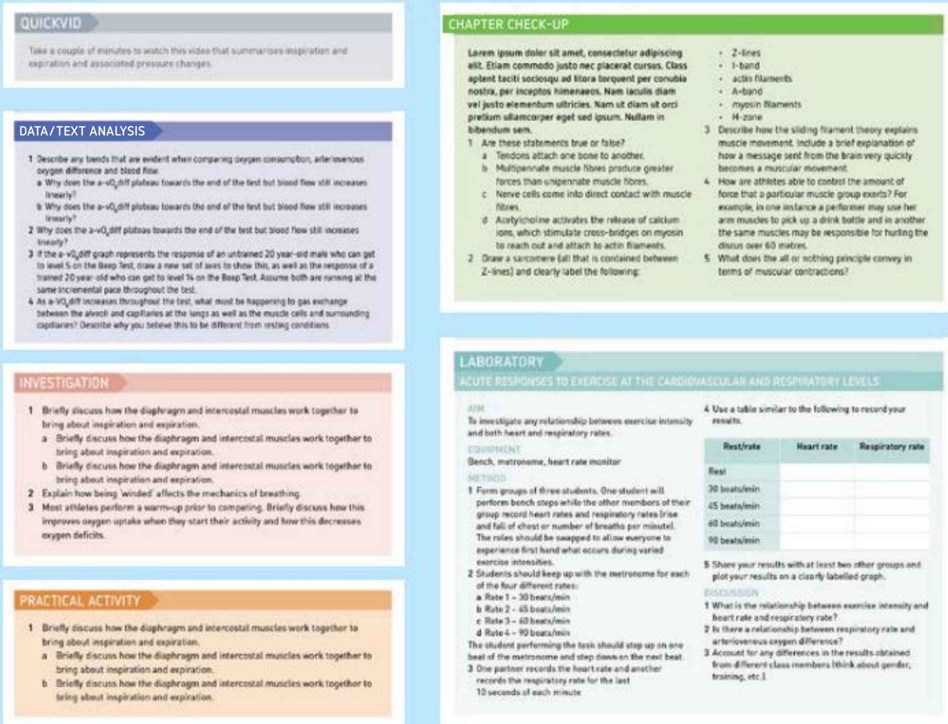
As people age, their lean muscle mass decreases. The muscles naturally lose strength and size, and can become less supple. This can affect the range of movement around joints,

Real world applications include articles and interviews throughout the chapters. Some of the print interviews are also longer video clips (watch for the video icon).

FYI snippets are sprinkled through the book to keep you awake! They are not, however, part of the study design key knowledge.

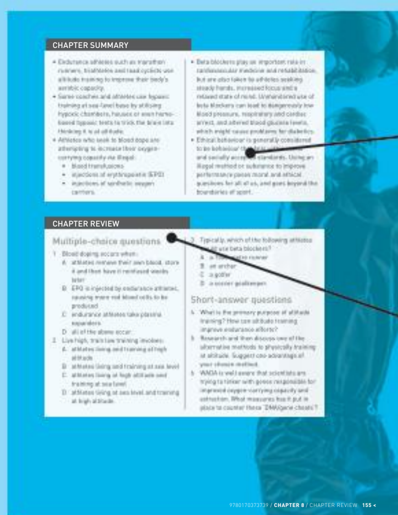
Rollover definitions work with the NelsonNetBook. Otherwise, go to the Glossary pages at the end of the printed book (pp. 356–359).

There are several types of activities within the chapters: Chapter check-up, Laboratory, QuickVid, Data/Text analysis, Investigation and Practical activity. These activities help you develop key skills, think about the content topics, or summarise and consolidate the material you have just completed. They are supplemented by the *Nelson Physical Education VCE Units 1&2 Peak Performance* workbook activities.



There are no direct weblinks printed in the book, as URLs change often. Instead, there is a single weblink (http://vcepe12.nelsonnet.com.au) to a free-access website that will give you direct access to all the weblinks. A web icon will alert you to web-based activities and video clips.

Weblink



Each chapter concludes with a dot-point summary of the relevant key knowledge covered.

Chapter revision questions are exam-style, with multiple-choice, short-answer and investigation questions. Answers are in the back of this book, where relevant.

ON THE NELSONNET WEBSITE

The NelsonNet student website has:

- short video clips of interviews
- some templates (scaffolds) of forms, tables and questionnaires for you to complete online or print out
- a few skillsheets and fact sheets

Video Fact sheet Skillsheet Scaffold

Complex concepts are explained by the authors in short video clips, also located on your student website.

Visit http://nelsonnet.com.au and enter your login code from the back of this book to access the website.

We hope you have fun using and learning from this book!

ABOUT THE AUTHORS

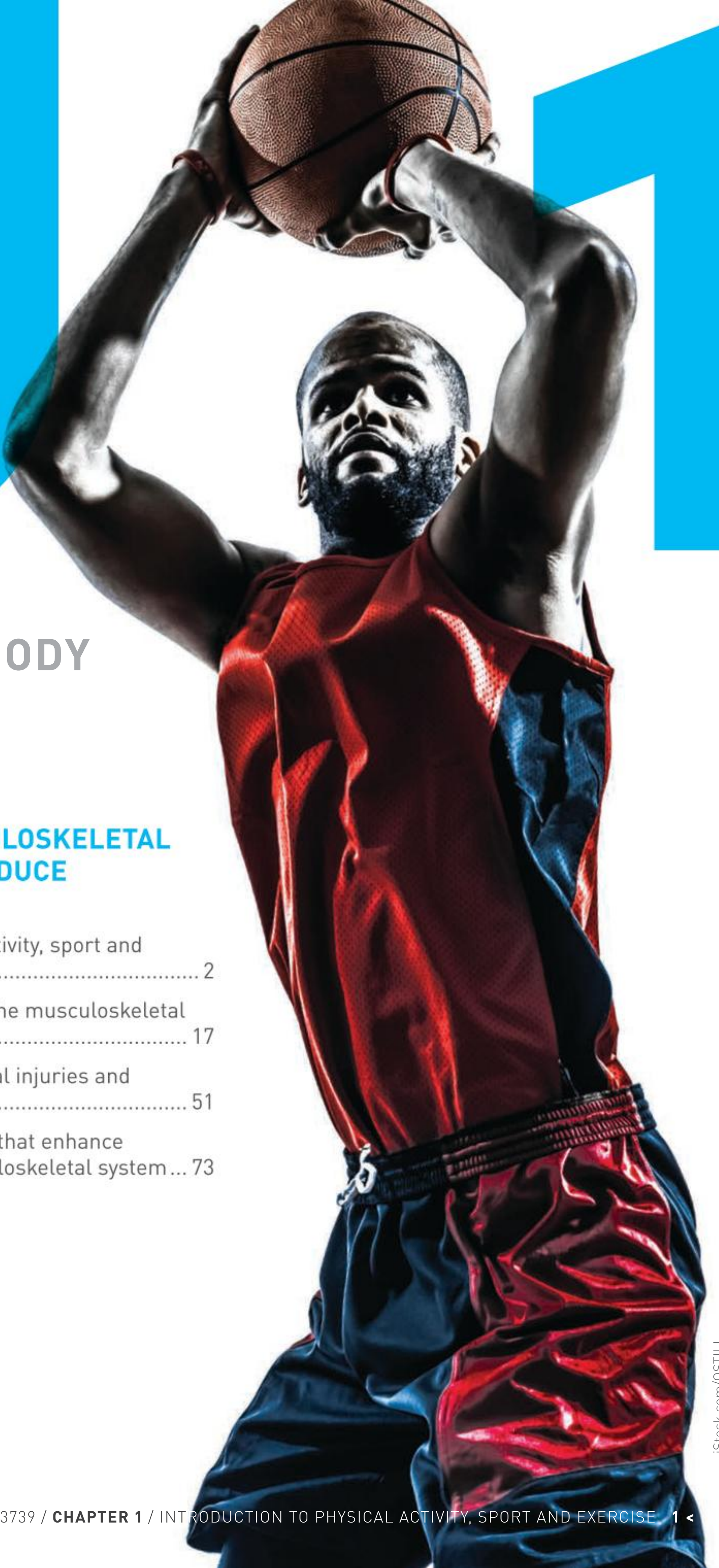
Dr Amanda Telford (PhD) is an Associate Professor in teacher education. She coordinates a Health and Physical Education degree course in Melbourne and lectures in pedagogy, curriculum design and physical activity behaviour. Amanda was involved in the development of the physical activity and sedentary behaviour guidelines for young people nationally.

Robert Malpeli teaches at the Knox School, Victoria. He has been a leading light in senior physical education for more than 25 years. With Amanda Telford, he runs a physical education teacher network in Victoria that supports both teachers and students at professional development sessions and seminars.

Rachael Whittle is an experienced senior-secondary physical education teacher. She has worked extensively with the Victorian Curriculum and Assessment Authority (VCAA) on the development of senior-secondary physical education curriculum and assessment. Rachael has delivered dynamic professional learning to teachers nationally and internationally and teaches Physical Education undergraduate degree students at RMIT University. She is currently undertaking her doctoral studies at RMIT University.

Paul Seery is currently VCE and Special Programs manager at Bendigo Senior Secondary College. He is a presenter for the Australian Council for Health, Physical Education and Recreation (ACHPER) and has been involved with VCAA. He has also worked in the sports fitness industry, designing and implementing elite sports programs.

Mark Corrie has taught VCE Physical Education for the past 17 years. He also runs one of the largest physical education teacher networks in Victoria, aimed at sharing resources with teachers across the state. He has been a VCAA Physical Education exam assessor for the past 16 years. Mark is a respected presenter at numerous conferences for both teachers and students throughout the state.



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UNIT 1

THE HUMAN BODY IN MOTION

AREA OF STUDY 1

HOW DOES THE MUSCULOSKELETAL SYSTEM WORK TO PRODUCE MOVEMENT?

CHAPTER 1

INTRODUCTION TO PHYSICAL ACTIVITY, SPORT AND EXERCISE

Key knowledge

- the concepts of physical activity, sport and exercise
- social, cultural and environmental enablers and barriers to movement such as family, peers, socioeconomic status, level of education, cultural values, geographic location and access to facilities

Key skills

- define and participate in a range of physical activities, sports and exercise
- describe the social, cultural and environmental influences on physical movement

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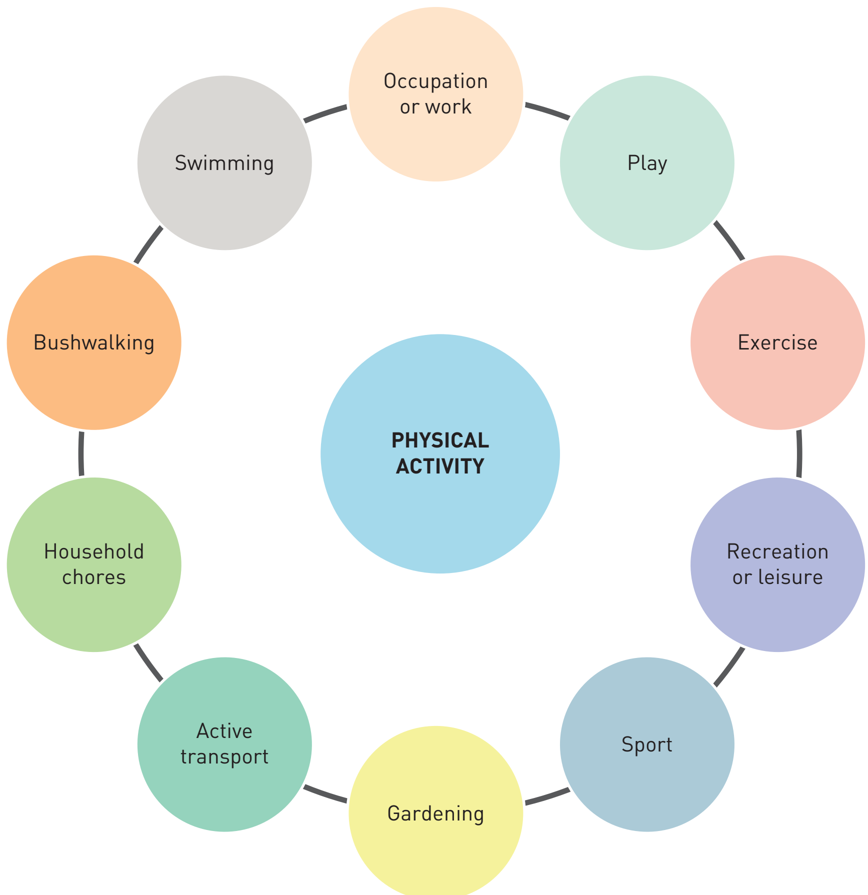
> The study of VCE physical education enables students to integrate a contemporary understanding of the theoretical underpinnings of influences on performance and participation in physical activity with practical application. Through engagement in physical activities, VCE physical education will allow students to develop the knowledge and skills required to critically evaluate influences that affect their own and others' performance and participation in physical activity. This study equips students with the appropriate knowledge and skills required to plan, develop and maintain their involvement in physical activity, sport and exercise across their lifespan and to understand the physical, social, emotional and cognitive health benefits associated with being active. The study also prepares students for employment and/or further study at the tertiary level or in vocational education and training settings in fields such as exercise and sport science, health science, education, recreation, sport development and coaching, health promotion and related careers.
>
> Source: VCAA VCE Physical Education Study Design 2017–2021

While undertaking VCE physical education, you will be looking at physical activity and its various components or parts. Units 1 and 2 introduce a number of different concepts, such as the musculoskeletal and cardiorespiratory systems, as well as participation in physical activity, all within the context of physical activity, sport and exercise.

The terms 'physical activity', 'exercise' and 'sport' are often used interchangeably. They all refer to bodily movement that expends energy, but exercise and sport are components of physical activity, just as aerobic capacity, agility, speed, flexibility and a whole host of other components make up a person's physical fitness.



The relationship between physical activity, sport and exercise

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Physical activity can occur in a number of ways – scooting to the shops, playing competitive softball on the weekend or playing beach cricket with family and friends.

Physical activity is commonly described according to the following four dimensions:

1 **frequency** – the number of events of physical activity during a specific time period
2 **intensity** – physiological effort associated with participating in a special type of physical activity
3 **duration** – time of participation in a single bout of physical activity
4 **type** – the sort of physical activity that is being done.

These are sometimes referred to by the acronym FITT, which stands for frequency, intensity, time (duration) and type. Three of the dimensions of physical activity (intensity, frequency and duration) are fundamental because their assessments make it possible to calculate the energy expenditure associated with physical activity.

Students undertaking physical education studies will engage in exercise and sport – two common sub-components of physical activity that are both structured and planned. However, some physical activity is unstructured and unplanned. This type of activity is commonly referred to as incidental physical activity.

CHAPTER CHECK-UP

1 How could you encourage more students to use active transport as a means of getting to school two days per week?

2 List three different ways you could assess the intensity of movement when someone is
   a bushwalking
   b playing netball
   c doing a gym workout.

3 a What are the differences between sport, exercise and play?
   b What do sport, exercise and play all have in common?

In 2012 the Australian Bureau of Statistics found that physical activity levels of adults (aged 15+) were related to a number of environmental and socioeconomic conditions.

- Men had higher participation rates for sport and physical recreation than women.
- Adults living in the lowest income households were more likely to be sedentary or to exercise at low levels.
- Employed adults were more active than unemployed adults.
- People living in cities were likely to be more physically active than those living in rural areas.
- Almost half of employed adults worked in a job environment with low levels of physical activity or incidental physical activity.
- Women spent more hours per day sitting at work than men.
- People with dependent children were less likely to meet the recommended physical activity guidelines than those without children.
- Being physically inactive can lead to becoming overweight and obese, which can increase the risk of developing a number of chronic health conditions. People who were sedentary or exercised at low levels were more likely to have heart disease, stroke and vascular disease, hypertension, type 2 diabetes and arthritis than those who exercised at moderate or high levels.

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Having dependent children doesn't necessarily mean physical activity levels need to decrease. Being active with others, as well as providing social benefits, is more likely to result in regular physical activity.

ENABLERS AND BARRIERS TO MOVEMENT AND PHYSICAL ACTIVITY

If you take a quick survey of your classmates regarding the physical activities they participate in, their preferences and the reasons for these would probably differ from those of their parents. There is a range of factors that influence people to participate in physical activities – these are known as **enablers**. Conversely, the factors that stop or inhibit people's participation in activities are known as **barriers**. These will be investigated in greater detail in chapter 12.

The two factors that have the greatest influence on physical activity, sports and exercise participation are access to supportive facilities, and time. These factors can be both enablers and barriers. The following factors also influence people's decisions to take up, and continue, physical activity.

Family and peers

Socialising agents such as family, peers, coaches and teachers can all greatly influence participation in physical activities.

Parents and carers can help their children be physically active in numerous ways. They can set a positive example by being regularly physically active themselves, and also by involving the whole family in physical activities. This can happen by playing sport together, or by engaging in recreational and play-based activities, depending on the age of their children. Once children become young adults, this support can also come in the form of driving them to games and cheering for them on the sidelines.

Parents and carers can also encourage students of an appropriate age to consider active transport to school, such as walking, scooting or cycling. Setting time limits on sedentary activities such as playing computer games, spending time on social media and watching

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Positive peer interactions promote physical activity.

television can also help encourage physical activity and adherence to the Australian physical activity and sedentary behaviour guidelines (see chapter 10).

Family members can become actively involved in other ways, too. Many parents encourage participation in sport by organising and supporting training schedules, converting part of their home into a training space, or by providing financial assistance when required.

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Peer role modelling of sedentary behaviour can lead to decreased participation in physical activity.

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Alamy Stock Photo / Derek Trask

It is vital that students receive equal opportunities and encouragement to pursue sports that they enjoy, regardless of their gender.

CHAPTER CHECK-UP

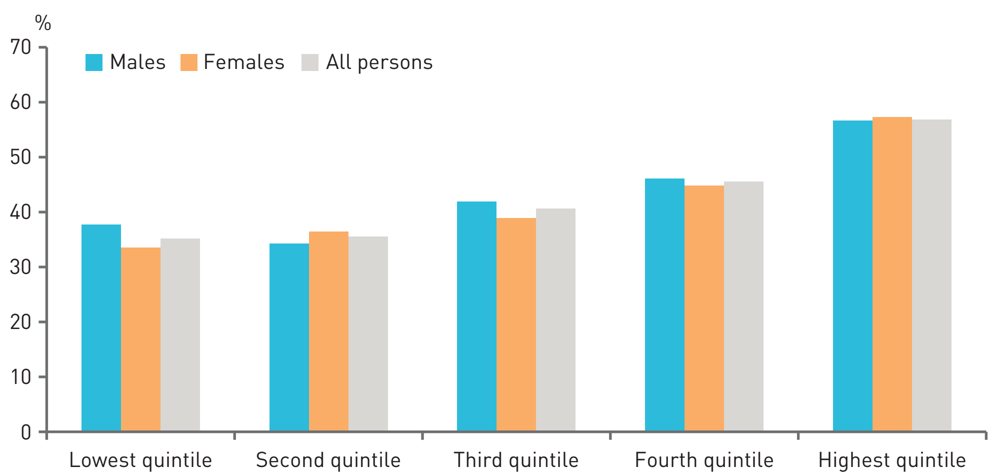
1. Discuss how having dependent children might contribute to lowered levels of physical activity.
2. Some family settings do not encourage participation in physical activity, and some may even provide significant barriers to it. Provide two examples of barriers to physical activity that may be present in a family setting.
3. Discuss two ways a peer group can positively influence participation in physical activity.
4. How can physical education teachers contribute to barriers to physical activity?
5. Not having enough time is often cited as a reason for not being physically active. Imagine that you know a 15-year-old who plays two musical instruments, is SRC middle-school rep and has just been awarded the leading role in the school's drama production. She is concerned that she is 'too busy' to exercise. Suggest two ways she could create time for exercise.

As children become young adults and move from primary to secondary school, their peers will increasingly influence whether they are physically active or inactive. Research indicates that some parents believe that sports are more suited to boys than girls, and encourage stereotypical participation in sport and physical activity according to gender. For example, some parents may encourage their daughters to take up gymnastics and dance but their sons to take up football and karate.

Teachers, and PE teachers in particular, can counter these skewed perceptions by providing equal opportunities and encouragement to both males and females. Although this is slowly changing, some activities still offer one gender more opportunities than the other. A boy who loves netball may struggle to find a team to train and play with, while a girl trying to play rugby may encounter similar difficulties, particularly in their mid to late teens.

Socioeconomic status

People living in lower income households are less likely to meet the national physical activity guidelines. In 2011–12, just 35 per cent of Australians in the lowest income households were sufficiently active for health. The proportion of fit adult Australians generally increased with

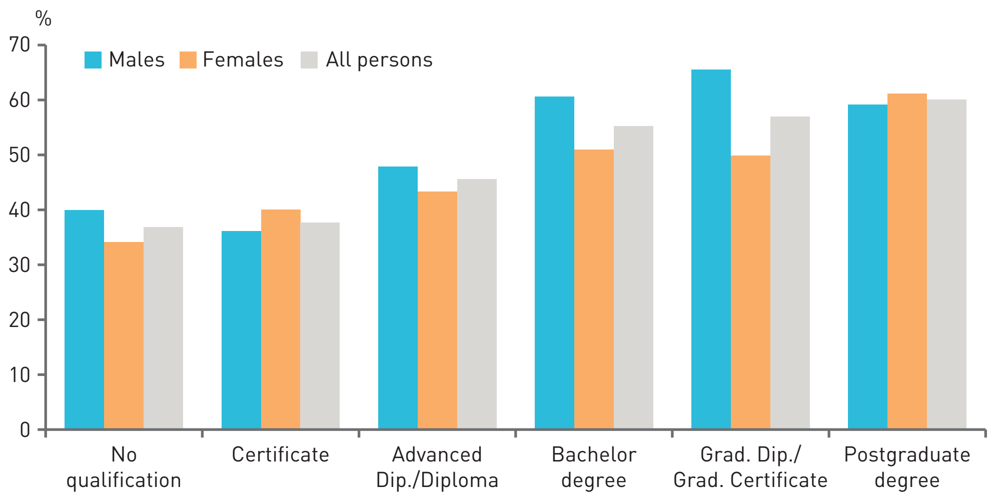


Proportion of adult Australians classed as sufficiently active, by household income, 2011–12

Source: Australian Bureau of Statistics, 2013, *Perspectives on Sport*, cat. No. 4156.0.55.001, viewed 6 June 2016 income, with 57 per cent of people in the highest income households sufficiently active for health. The low rates of activity in lower income households may be due, in part, to limited financial resources, greater child-minding responsibilities, higher levels of disability, higher levels of psychological distress, or long hours in manual work, all of which affect people's capacity for participation.

Level of education

The most recent Australian survey has found that higher education levels are associated with increased physical activity. Adults with a tertiary qualification were more likely to meet the physical activity guidelines than those with no post-school qualifications (46 per cent compared with 34 per cent), and were less likely to be sedentary or to exercise at low levels.



Proportion of Australian adults classed as sufficiently active, by highest non-school qualification, 2011–12

Source: Australian Bureau of Statistics, 2013, *Perspectives on Sport*, cat. No. 4156.0.55.001, viewed 6 June 2016

People with higher levels of education may be more informed about the health consequences of certain lifestyle behaviours, leading them to exercise more often and more intensely.

As well as leading to a greater awareness of the health benefits associated with regular physical activity, a higher level of education is closely linked to higher income, earning capacity and socioeconomic status.

Age and sex

Age also affects the likelihood of a person being sufficiently active for health. In 2011–12, Australians aged 18 to 24 years were more likely to meet the national guidelines than any other age group (53 per cent). The proportion of the active population declined with age, with only about 25 per cent of Australians aged 75+ years being sufficiently active. In the 18 to 24 age group, 59 per cent of males and 48 per cent of females were sufficiently active, reflecting a trend that can be seen across all age groups.

Cultural values

Research suggests that a person's culture shapes their attitudes towards and involvement in physical activity. For example, some cultures value physical activity and movement obtained via sport, leisure and play, whereas others regard physical labour and household chores as a better way to engage in physical activity.

In some cultures, family and community responsibilities take precedence over recreational activity. Taking time to exercise can be seen as selfish. In others, clothing requirements, such as women being required to wear skirts or a hijab, or men to wear a turban, might restrict movement, and thus limit involvement in physical activity.

Religious beliefs and holidays can affect an individual's ability to participate in scheduled sporting programs and competitions. For example, many Muslim men and women pray at regular times throughout the day. A scheduled physical activity program may not be able to accommodate this requirement (Caperchione et al., 2009).

People who are new to Australia may not speak English, and so may struggle to understand programs and activity guides, or follow exercise instruction. Not all cultural groups are aware of the benefits of physical activity, so a lack of translated material and multimedia campaigns aimed at these groups can be a barrier. Additionally, the steps required in order to join physical activity pursuits, such as joining clubs, completing registration forms and providing personal information, might be particularly problematic for people from a non-English speaking background (NESB).

Some people feel more comfortable interacting with individuals of a similar background and identity. This can either be a motivator or a barrier to physical activity, depending on the facility and the organisation. Individuals may be afraid of encountering prejudice and discrimination due to ethnicity, race or cultural heritage. For example, there have been instances of racist abuse against black players in some sports, most notably in football.

Geographic location and environmental factors

People living in rural areas are often perceived as being more active than those in metropolitan areas, due to the physical nature of work commonly done in rural areas, such as agriculture, forestry and fishing. However, reduced access to and availability of sporting and public transport facilities in rural areas may create barriers to participating in recreational physical activity. The active nature of a person's job may also have an effect on how much physical activity they do outside of work.

After adjusting for age, a higher proportion of men living in inner regional (41 per cent) or outer regional and remote areas of Australia (47 per cent) did no exercise in the week prior to interview, compared with those living in major cities (36 per cent). Men in outer regional and remote areas of

Newspix / Norm Oorloff

Australia were also more likely to be sedentary or to exercise at low levels than those in major cities (72 per cent compared with 68 per cent). (Australian Institute of Health and Welfare, 2014) This may be influenced by the amount of physical activity they do at work. The exercise levels of women living both within and outside major cities were similar.

Being outside can provide opportunities for enjoyable physical activity. However, the natural environment can also be a barrier to physical activity, with factors such as weather and air quality sometimes creating unsafe conditions.

Activities such as camping and hiking are popular ways to exercise outdoors. Some people enjoy walking in natural settings as the sunlight and fresh air can improve their physical and mental states. However, the natural environment can also be uncomfortable and sometimes unsafe for people to be active in. For example, extreme heat or cold may lead to hyperthermia or hypothermia, respectively, and air or water quality can be too poor or polluted to be active in. These factors can provide significant barriers to being physically active.

CHAPTER CHECK-UP

1 Belonging to a cultural group can either be an enabler or a barrier to physical activity. Copy and complete the following table to provide two examples of each that are different from the reasons given on pages 9 and 10.

Cultural enablers	Cultural barriers

2 Rural areas in Australia have a reputation for having great 'sporting communities', despite researchers having found that people living in rural areas have lower levels of physical activity participation. Discuss why this might be the case.

3 Provide two examples of how the natural environment might not be suitable for physical activity at a particular time.

4 In Singapore, most new schools have air-conditioned gymnasiums. Why would schools go to this great expense?

Alamy Stock Photo / Martyn Goddard

Natural settings where local councils install community facilities attract people and encourage them to be physically active.

The built environment refers to things that have been built by people, as opposed to occurring naturally – for example, paths, roads, schools and recreation facilities (pools, playing fields, gymnasiums), as well as town planning and neighbourhood design. Traffic calming measures such as roundabouts, speed humps or other means of slowing traffic make it safer for people to use active transportation such as walking, cycling and skating. Well-lit, well-maintained footpaths and separate bike lanes also encourage active transportation.

Safety

Unsafe neighbourhoods provide barriers to physical activity for both males and females. People who feel that their neighbourhood is unsafe are less willing to walk outside, especially at night. Neighbourhood safety can be challenged by the presence of drugs, crime and violence. Neighbourhoods can also be unsafe due to poor lighting, pollution or poor design. Community leaders and representatives need to be aware of these issues in order to combat them and provide safe places for people to be physically active outdoors in their local area.

Social support

Social support has long been considered a key determinant in reinforcing physical activity. Sources of this type of support can be in the form of someone with whom to exercise, or someone who provides encouragement and praise for being active. People who feel socially isolated may be less confident about participating in physical activity and less aware of the programs that are available. When family or friends do not support an individual's attempts to become physically active, it is harder to stay involved, and participants are more likely to drop out. When an individual's social connections change (for example, kids grow up, friends move away, careers change direction), this transition can affect social connections and lead to decreased levels of physical activity.

REAL WORLD APPLICATION

Physical activity: getting children involved

Getting children involved in lots of fun physical activity keeps them active and healthy. It's easy when you help them find activities that they enjoy – and that you can do as part of everyday family life.

How to get children involved in physical activity

Helping children find activities that they like is one of the keys to keeping them active.

Dancing, skipping, running, playing with a ball or flying a kite – it doesn't matter what the activity is as long as they like it.

Physical activity: variety and fun

You can help your child explore lots of different activities to find something they enjoy.

For example, children who like balancing might enjoy climbing, cycling, playgrounds, dance or gymnastics. Others who like hand–eye coordination tasks might enjoy ball games in the park, tenpin bowling, Frisbee or sports such as cricket or tennis.

Plenty of variety in your child's mix of sports, games and activities will also keep him or her excited about moving. And when your child tries out different activities, they can pick up new skills, stay interested and challenged, and get enough physical activity in their days.

It is also good for your child's health and development to do physical activity that varies in intensity, including moderate and vigorous activity.

Tips for encouraging active children

- Be active yourself and your child is more likely to follow your lead.
- Give your child praise and encouragement if an activity is proving hard for them.
- Try to make some time to have fun playing actively with your child. It's great to find something you both enjoy doing.
- Encourage your child to play outside.

>

- Go with your child when they try an organised sport or group lesson – for example, swimming or dancing.
- Get the family going – organise family activities like camping, bushwalking and outdoor games.
- Involve your child in daily chores around the house such as gardening, washing the car and cleaning.
- Keep an activities box at home and in the car with balls, bats, kite, beach bucket and spade so that you're always prepared.
- Balls, bikes and scooters make great gifts, and encourage physical activity and opportunities to play outdoors.

Young children are rarely intensely active for long periods, but will often have bursts of activity for a few minutes or less. This is healthy, and your children will be more likely to keep doing it if you encourage them.

Source: Raising Children Network

Activity

The advice above from the Raising Children Network on encouraging children to be active provides us with insights into social, cultural and environmental considerations around the promotion of movement and physical activity, as well as the barriers that need to be overcome.

Draw a grid similar to the one below. Decide whether each recommendation/bullet point in the article above is an enabler or barrier linked to family, peers, access to facilities, access to equipment, geographic location, socioeconomic status etc., and list it in the table below.

Some enablers and barriers have already been inserted to start you off.

	Family	Peers	Access to facilities	Access to equipment	Geographic location	Socioeconomic status
Enablers	» Having active parents as role models		» Having playing fields, playgrounds, basketball/netball courts at school		» Living close to the beach, park, playing field	
Barriers	» Parents who don't like walking and drive their children to school			» Not having frisbees, kites, balls etc.	» Not living close to bike paths	» Not being able to afford dance/ swimming lessons

Walking

One of the easiest ways to incorporate activity into your child's routine is to take regular walks together.

You can walk to school, child care or kindergarten. Look for parks along the way. Active transport, such as walking, cycling or using a scooter, encourages children to get around on their own safely in your neighbourhood. You can even start when your child is a baby. Young babies can go on outings in a sling, carrier or pram.

Walking to school every day has many benefits for you, your children and your community. These benefits include:

» keeping you and your children feeling happy and well
» giving your children opportunities to learn and practise road rules and road safety
» making your children aware of their neighbourhood
» giving you and your children the chance to talk and spend time together
» meeting neighbours along the route, and chatting with other parents at the school gate
» helping children feel good about where they live.

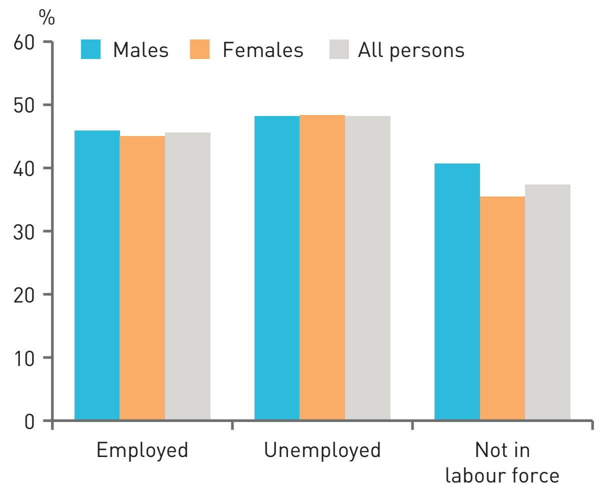
You can increase the range of your walks by following nature trails in parks, and by taking trips to interesting locations.

FYI

Dogs are considered a form of social support because they can increase a person's confidence and decrease their fear of walking alone. People who own a dog walk an average of 15 minutes a week more than non–dog owners.

Employment status

There is no statistical evidence to suggest that employed people are more likely to meet the Australian physical activity guidelines than unemployed Australians. In 2011–12 a similar proportion of employed Australians (45 per cent) and unemployed Australians (48 per cent) were classed as being sufficiently active. However, both employed and unemployed people were more likely to meet the guidelines than those not in the labour force (retirees and those who no longer work, do not intend to work in the future, are permanently unable to work or have never worked). Adults who were employed were less likely to be sedentary or exercise at low levels (54.6 per cent) than those who were not in the labour force (62.7 per cent). Around 37 per cent of Australians not in the labour force were classed as sufficiently active for health. Of those not in the labour force, a higher proportion of males (41 per cent) than females (35 per cent) were classed as sufficiently active for health (Australian Bureau of Statistics).



Proportion of adult Australians classed as sufficiently active, by work status

Source: ABS, 2013, *Perspectives on Sport*, cat. No. 4156.0.55.001

Mass media promoting physical activity

Mass media also plays a key role in the promotion of physical activity. It does this in a number of ways, such as:

» increasing awareness of how people can become involved in physical activity
» increasing awareness of physical activity as a public health issue
» providing information about the health and non-health benefits associated with regular physical activity
» providing information about the consequences of inactivity
» increasing interest in physical activity participation and raising awareness of community-based programs
» motivating individuals to take action towards increasing their physical activity.

CHAPTER SUMMARY

- Exercise and sport are components of physical activity, which involves bodily movement resulting in energy expenditure.
- Participation in physical activity is influenced by many factors. Some of these are known as 'enablers' – things that promote and encourage participation in movement/physical activity. Others are known as 'barriers', because they block or impede participation in physical activity.
- FITT is an acronym describing the four dimensions commonly monitored when considering physical activity. FITT stands for frequency, intensity, time and type of activity.
- Incidental physical activity can occur during work, play and walking to and from work/school. Structured activities include dancing, organised/competitive sport and bushwalking.
- Socialising agents such as family, peers, coaches and teachers greatly influence participation in movement-based and physical activities.
- There is a relationship between lower socioeconomic status and reduced participation in physical activity.
- Recent Australian research has found that higher education levels are associated with increased physical activity. People with higher levels of education may be more informed of the health consequences of certain lifestyle behaviours, leading them to exercise more often.
- Some cultures value physical activity and movement obtained via sport, leisure and play whereas others regard physical labour and household chores as a better way to engage in physical activity.
- People living in rural areas are often perceived as being more active than those living in metropolitan areas, due to the physical nature of work commonly done in rural areas, such as agriculture, forestry and fishing. However, reduced access to and availability of sporting and public transport facilities in rural areas may create barriers to people participating in recreational physical activity.
- Unsafe neighbourhoods provide barriers to physical activity. People who feel their neighbourhoods are unsafe are less willing to walk outside, especially at night.
- People who feel socially isolated may feel less confident about participating in physical activity and may not be aware of the programs that are available.

CHAPTER REVIEW

Multiple-choice questions

1 The natural environment can be a nice place to be active, unless it is:
   A overcrowded
   B far away
   C polluted
   D of historical significance.

2 Some immigrants may display low levels of physical activity because they might not:
   A like the activities available to them in Australia
   B have a driver's licence, and so might have restricted access to facilities
   C be aware of opportunities to be physically active, due to language barriers
   D want to change their existing patterns of exercise and physical activity participation.

3 Factors that influence the ability to participate in physical activity outdoors include:
   A natural environments
   B built environments
   C the weather
   D all of the above.

Short-answer questions

4 Rather than rewarding their children with electronic games, parents today are being encouraged to consider providing sporting goods (balls, racquets, bikes) as rewards. Discuss why this practice doesn't guarantee an increase in children's physical activity levels.

5 Mass media campaigns, such as TV commercials, seek to increase levels of physical activity among the population, targeting thousands of people. List two advantages these campaigns have over information brochures, which might be mailed to 5000 households. How might the brochures actually have a greater influence in getting more people physically active than mass media campaigns?

6 People with higher levels of education tend to be more physically active than those with lower levels. Discuss two reasons why this might be the case.

7 Just as racism, sexism and classism are all forms of prejudice, disability can also be met with negative attitudes and false stereotypes. People with impairments often have lower levels of participation in physical activity than non-impaired people. Suggest three reasons why this might be the case.

8 Schools are great settings in which to encourage participation in physical activity. Discuss three reasons why schools are able to do this more effectively than the workplace or the general community.

CHAPTER 2

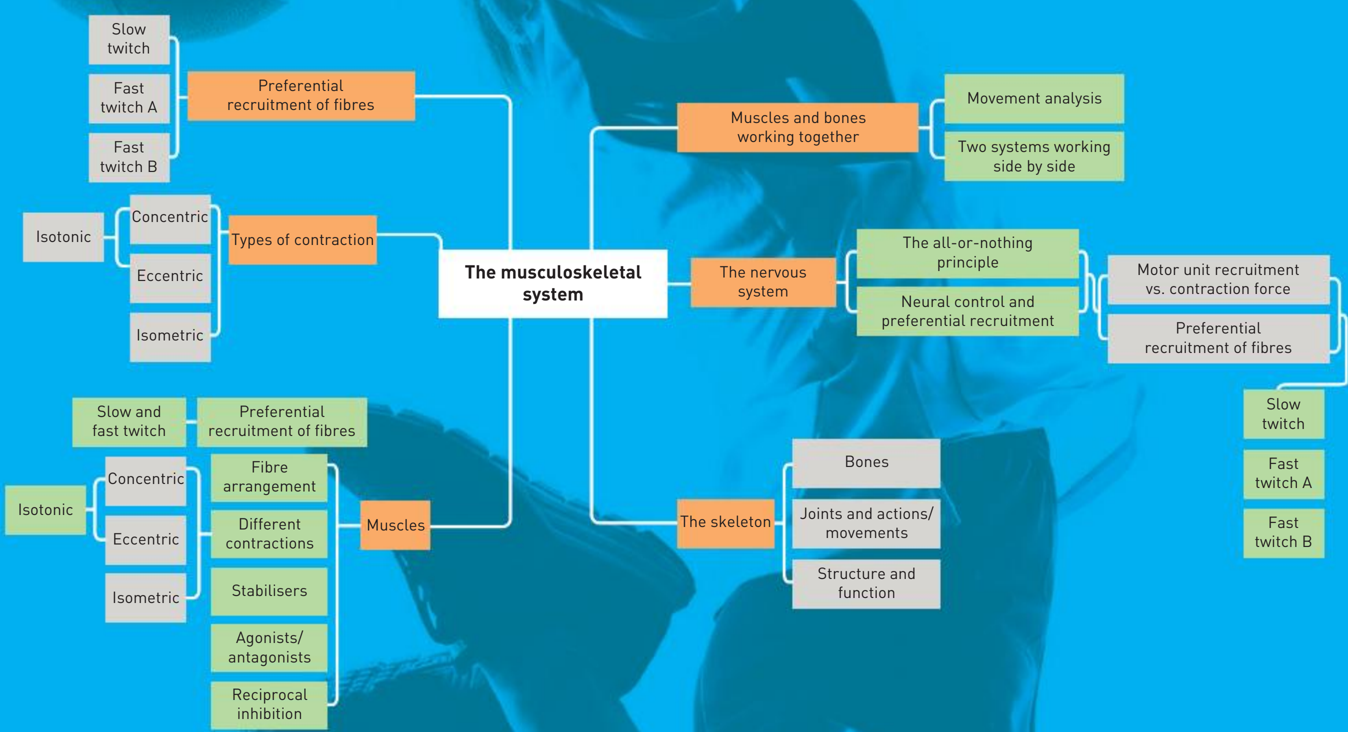
STRUCTURE AND FUNCTION OF THE MUSCULOSKELETAL SYSTEM

Key knowledge

- the structure and function of the skeletal system including bones of the human body, classification of joints and joint actions
- the major muscles of the human body
- characteristics and functions of muscle fibres, including fibre arrangement and type (fast twitch and slow twitch)
- types of muscular actions (isoinertial, isometric and isokinetic)
- agonists, antagonists and stabilisers, and the concept of reciprocal inhibition
- control of muscles, including the recruitment (size principle) and activation (all or nothing principle) of motor units in relation to force production
- interactions of muscles and bones to produce movement in physical activity, sport and exercise

Key skills

- use and apply correct terminology to the working of the musculoskeletal system in producing human movement
- perform, observe and analyse a variety of movements used in physical activity, sport and exercise to explain the interaction between bones, muscles, joints and joint actions responsible for movement
- describe the role of agonists, antagonists and stabilisers in movement
- describe the relationship between motor unit recruitment, activation and force production



When studying physical education, a basic understanding of anatomy and physiology is vital. This chapter considers anatomical concepts relating to the body's basic structure. It then looks at physiological concepts, which focus on how the human body works and functions, and how its many systems are interrelated.

The musculoskeletal system consists of the skeletal system, which is made up of the bones and joints, and the skeletal (voluntary) muscle system. The bones provide the levers for the muscles to act upon. As well as the bones and skeletal muscles, the musculoskeletal system includes:

» ligaments, which connect bones to other bones
» cartilage, which provides a protective 'shock-absorbing' gel between joints
» tendons, which connect muscles to bones.

These three tissues work together with the skeleton, which performs the following important functions:

» protection of vital internal organs such as the brain (skull), spinal cord (vertebral column) and lungs (ribs)
» support, allowing upright posture to be attained and maintained, as well as suitable attachment sites for muscles
» storage of fuels, fats and minerals
» leverage, allowing movements to occur
» mineral balance/homeostasis
» blood cell production (haematopoiesis).

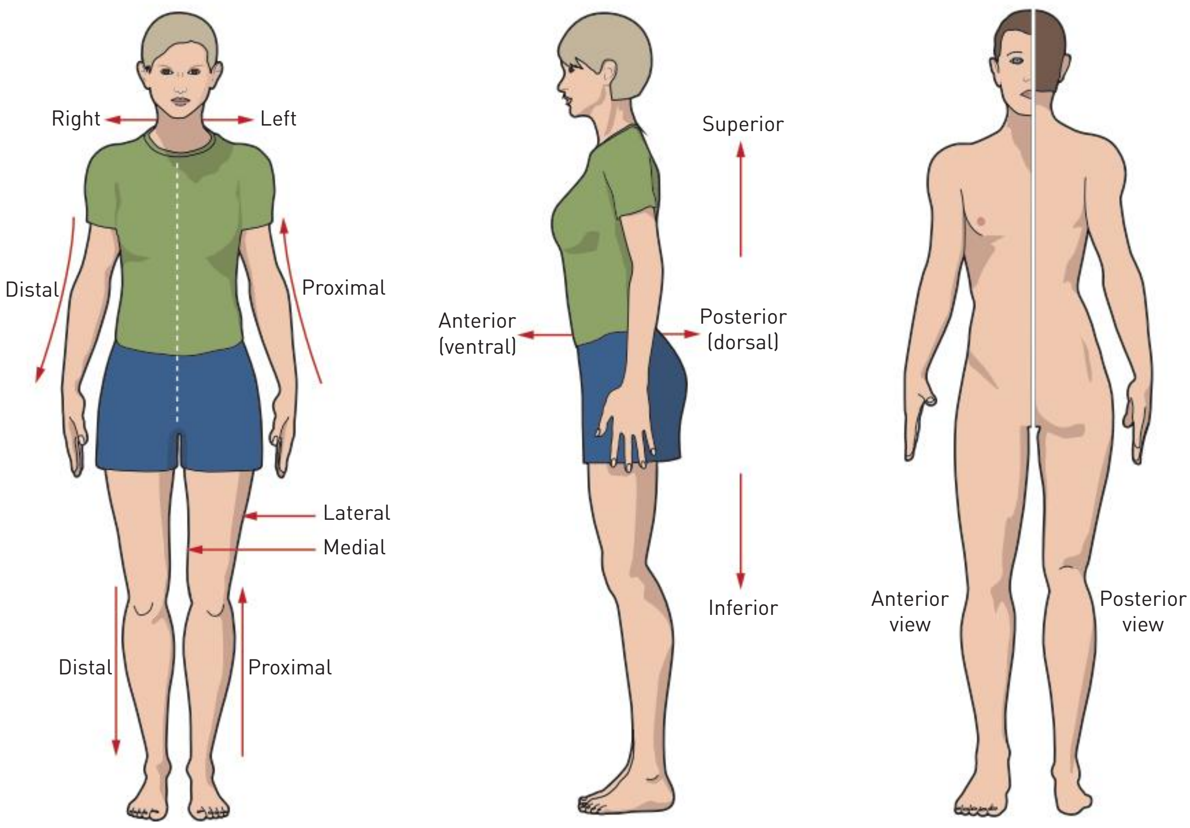
ANATOMICAL TERMS

To understand how the parts of the musculoskeletal system work together, it is important to become familiar with terms of direction and body planes. Anatomical terms are used to explain the location of body parts, usually in relation to others. For example, the shoulder is superior to the hip and the knee is inferior to the hip. Table 2.1 summarises some of the most commonly used anatomical terms.

TABLE 2.1 Definitions of commonly used anatomical terms

Anatomical term	Definition	Example
Superior	Closer to the head than another part	The shoulder joint is superior to the elbow joint.
Inferior	Closer to the feet than another part	The knee joint is inferior to the hip joint.
Anterior/ventral	Towards the front of the body	The pectorals are anterior to the latissimus dorsi.
Posterior/dorsal	Towards the back of the body	The hamstrings are posterior to the quadriceps.
Medial	Towards the imaginary midline of the body	The nose is medial to the ears.
Lateral	Away from the imaginary midline of the body	The ears are lateral to the eyes.
Proximal	A body part closer to its attachment point	The elbow is **proximal** to the wrist because it is closer to the shoulder joint – the attachment point.

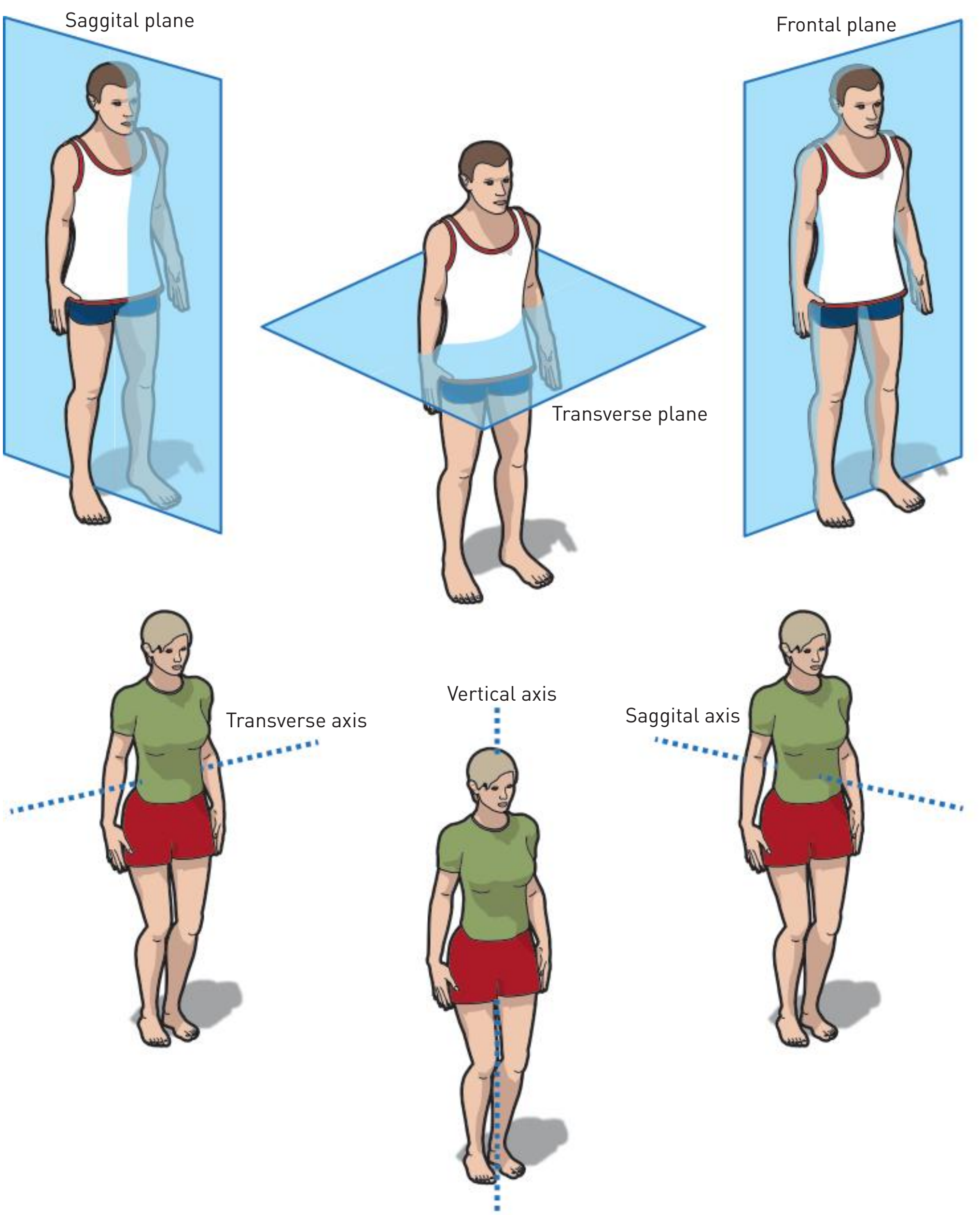
Anatomical term	Definition	Example
Distal	A body part further away from the point of attachment than another	The wrist is **distal** to the forearm flexors.
Left	Towards the left side of the body	Your right if looking at the anterior view.
Right	Towards the right side of the body	Your left if looking at the anterior view.
Superficial	A body part closer to the surface of the body than another	When you sweat, your veins dilate and become more superficial.
Deep	A body part that is internal or further from the surface of the body than another	Hypothermia leads to vasoconstriction and the veins become more deeply positioned.
Palmar	The palm side of the hand	When the radius and the ulna of the forearm are crossed, the palmar part of the hand faces downwards.
Plantar	The sole side of the foot	When the heel strikes the ground and you push off your toes as you walk or run, you are using the plantar side of your feet.



Basic anatomical positions

When the skeletal and muscular systems work together, our bodies are capable of moving in many different ways. It is useful to imagine the body and its segments having flat surfaces or planes running through them. These surfaces are known as **planes of movement**, and they divide the body up in three ways.

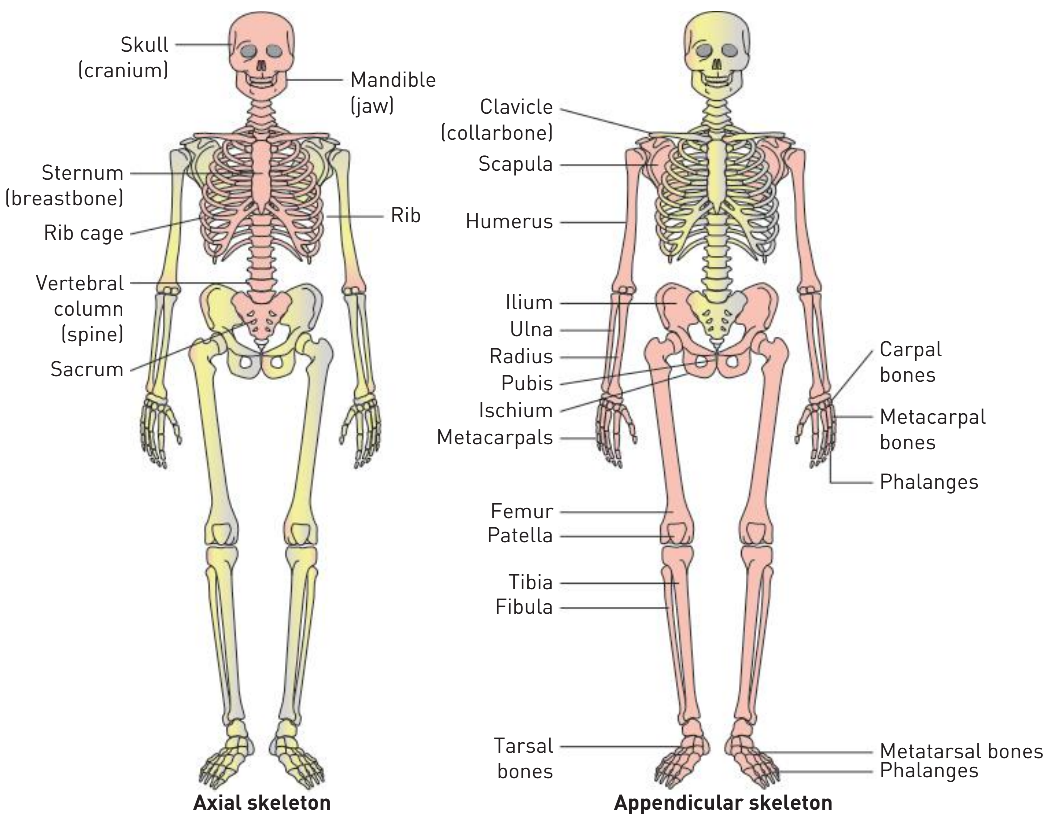
» **Median/sagittal plane** – divides the body into left and right sections.
» **Horizontal/transverse plane** – divides the body into superior and inferior sections.
» **Frontal/coronal plane** – divides the body into anterior and posterior sections.



Body planes

BONES OF THE HUMAN BODY

The skeleton is made up of 206 bones and can be divided into two distinct sections – the axial and appendicular skeletons. The diagram on page 21 shows the differences between these two sections, and reveals the major bones responsible for movement (it's unlikely you will need to familiarise yourself with every bone in the body!). The axial section provides the main support for the body and includes the skull, vertebral column and rib cage. The appendicular section is made up of the limb bones and their 'girdles', which connect onto the axial skeleton.



The axial and appendicular sections of the skeleton (shown in pink)

FYI

The appendicular skeleton has 126 bones; the axial skeleton has 80 bones.

The vertebral column

The vertebral column is involved in more than 95 per cent of the movements you make. It comprises 33 bones – 24 are unfused or separate and nine are fused together to make up the sacrum and coccyx. The five main sections of the vertebral column are summarised below.

The cervical vertebrae

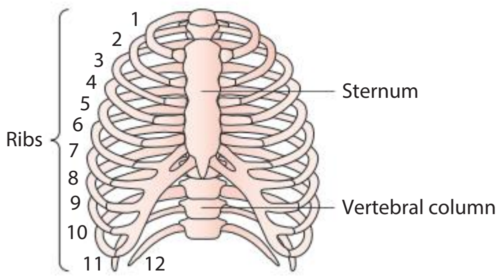
These seven unfused bones essentially make up the neck and are responsible for supporting the head. The top two bones – the atlas and axis – allow your head to move up and down and side to side, so that you can nod yes or shake no.

The thoracic vertebrae

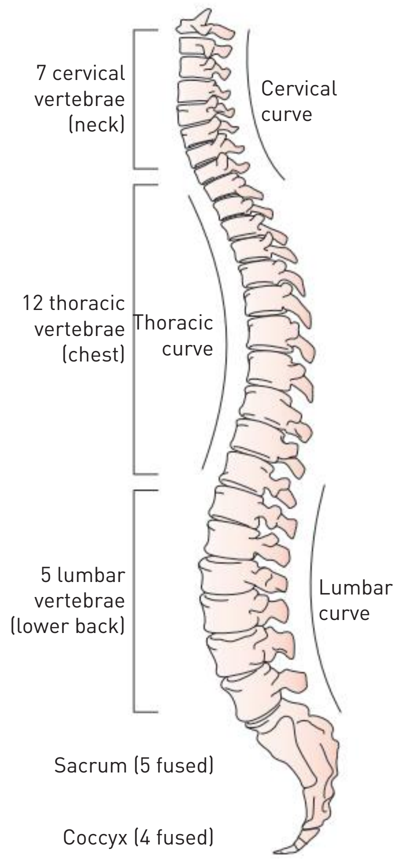
These 12 unfused bones connect the rib cage to the spinal column and form a protective shield for the heart and lungs. The first seven pairs of ribs attach directly to the sternum to reinforce this shield, and each rib is attached to the others via intercostal muscles, which assist the body to breathe in and out.

The lumbar vertebrae

These five unfused bones are the largest of the vertebrae and have a high weight-carrying capacity. They also provide a large attachment site for powerful muscles to pull on.



The ribs and attachment to the vertebral column (posterior) and sternum (anterior)



The five sections of the vertebral column

The sacrum

The five fused sacral vertebrae are connected to form the sacrum, which fuses to the pelvis. Together they distribute the weight of the upper body.

The coccyx

The coccyx is sometimes referred to as the 'tail bone', and comprises four fused bones that form the base of the vertebral column. Its main function is to provide a site for muscle attachment to allow a multitude of movements to occur.

Weblink

QUICKVID

Take two minutes to view this great clip, which provides a simple overview of skeletal structure and function. You can link to it directly via http://vcepe12.nelsonnet.com.au.

JOINTS

Muscles are attached to bones; when the muscles contract, they pull on the bones and movement occurs. Where two or more bones meet, they form a joint. This can remain quite rigid and immovable, as in the skull, but most joints are free-moving to allow a wide range of movement and actions. Joints are classified into three main categories according to the amount of movement they allow (see Table 2.2).

TABLE 2.2 Joints and their movement

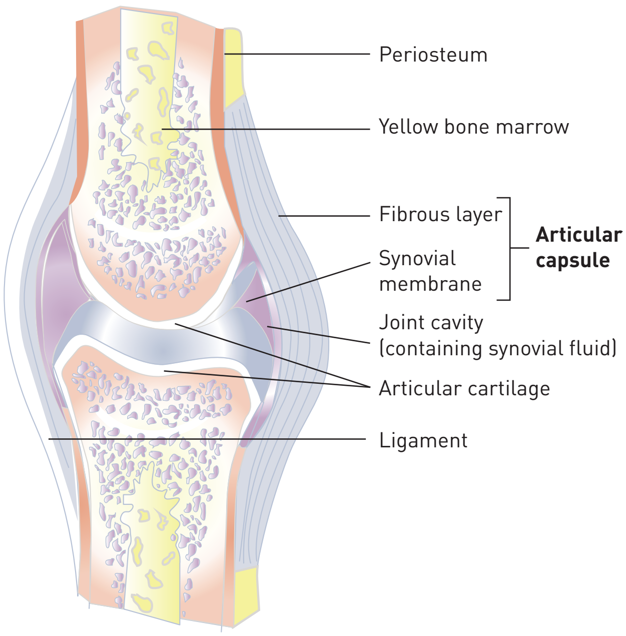
Type of joint	Amount of movement	Examples
Fixed or fibrous	None	Skull, pelvis, radioulnar and tibiofibular joints
Cartilaginous	Slight	Ribs attaching to sternum, lumbar vertebrae
Synovial	Free	Hip and knee joints, cervical and thoracic vertebrae

Synovial joints

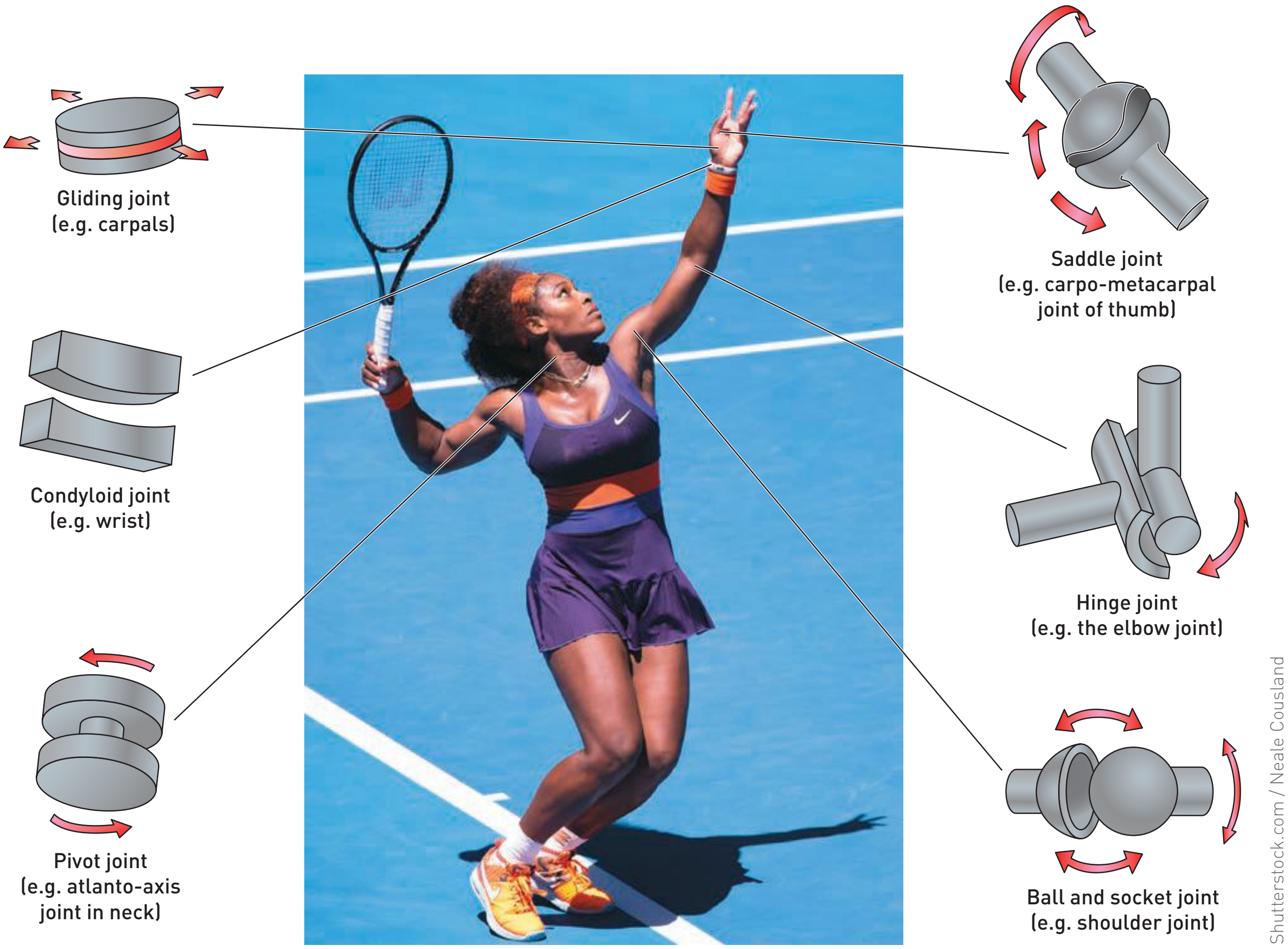
There are more synovial joints in the body than any other kind of joint. They allow the greatest amount of movement. All synovial joints have a synovial capsule, made up of collagenous material, surrounding the entire joint. A synovial membrane on the inner layer of the capsule secretes a lubricating fluid known as synovial fluid, and the hyaline cartilage completes the joint and provides padding at the ends of the **articulating** bones (see next page).

Types of synovial joints

There are six types of synovial joints, which are classified according to their shape and the type of movement they allow. They are summarised in the diagram on the next page and in Table 2.3.



A typical synovial joint



Examples of the six synovial joints

TABLE 2.3 The six synovial joints: basic structure and examples of the movement they allow

Type of joint	Basic structure	Movement at joint	Examples
Pivot	A **uniaxial** joint that only allows rotation	Rotation of one bone around another	Atlas and axis (top vertebrae)
Gliding	Occurs where flat bones glide past each other, usually in a **biaxial** manner	Gliding movements	Carpals/tarsals
Ball and socket	Occurs where a rounded bone head articulates with a cup-shaped cavity	Flexion, extension, adduction, abduction, internal and external rotation	Shoulder, hip
Hinge	A uniaxial joint	Flexion, extension	Knee, elbow
Saddle	Occurs where concave and convex bone surfaces align; generally biaxial	Flexion, extension, adduction, abduction, circumduction	Carpo-metacarpal joint of thumb
Condyloid	Very similar to a hinge joint but also allows slight rotation; hence, is biaxial	Flexion, extension, adduction, abduction, circumduction	Wrist

Weblink

QUICKVID

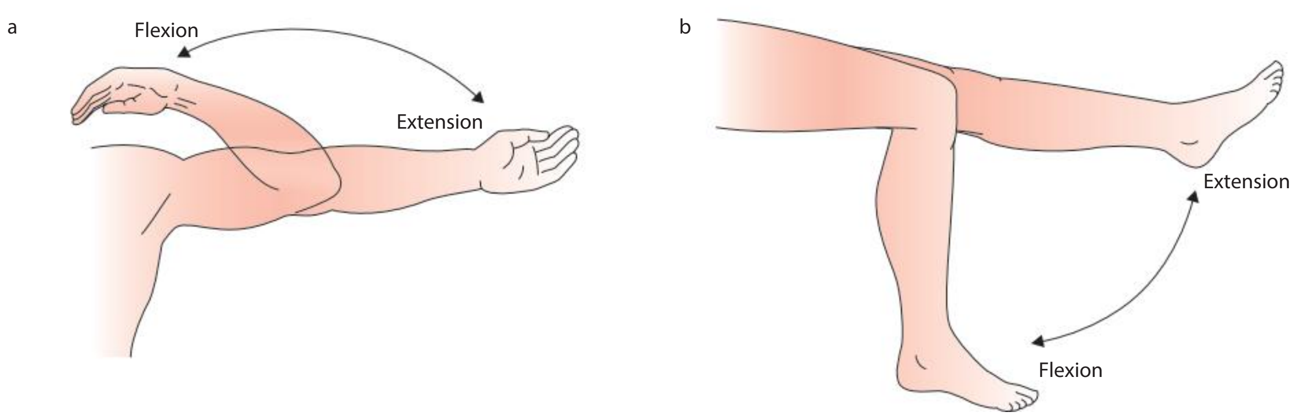
This two-minute clip reinforces the six different types of synovial joints and their associated movements. Link to it directly via http://vcepe12.nelsonnet.com.au.

Types of joint movements

When muscles receive messages from the brain, they contract to pull on bones, which act as levers, and movement occurs. The role muscles and nerves play will be discussed later in this chapter. First, consider the types of movements that are possible at the various synovial joints.

Flexion

The angle between articulating bones is decreased and flexion occurs in the median plane about a horizontal axis. Muscles responsible for flexion are called flexors.



Flexion and extension at the elbow and knee joints

Extension

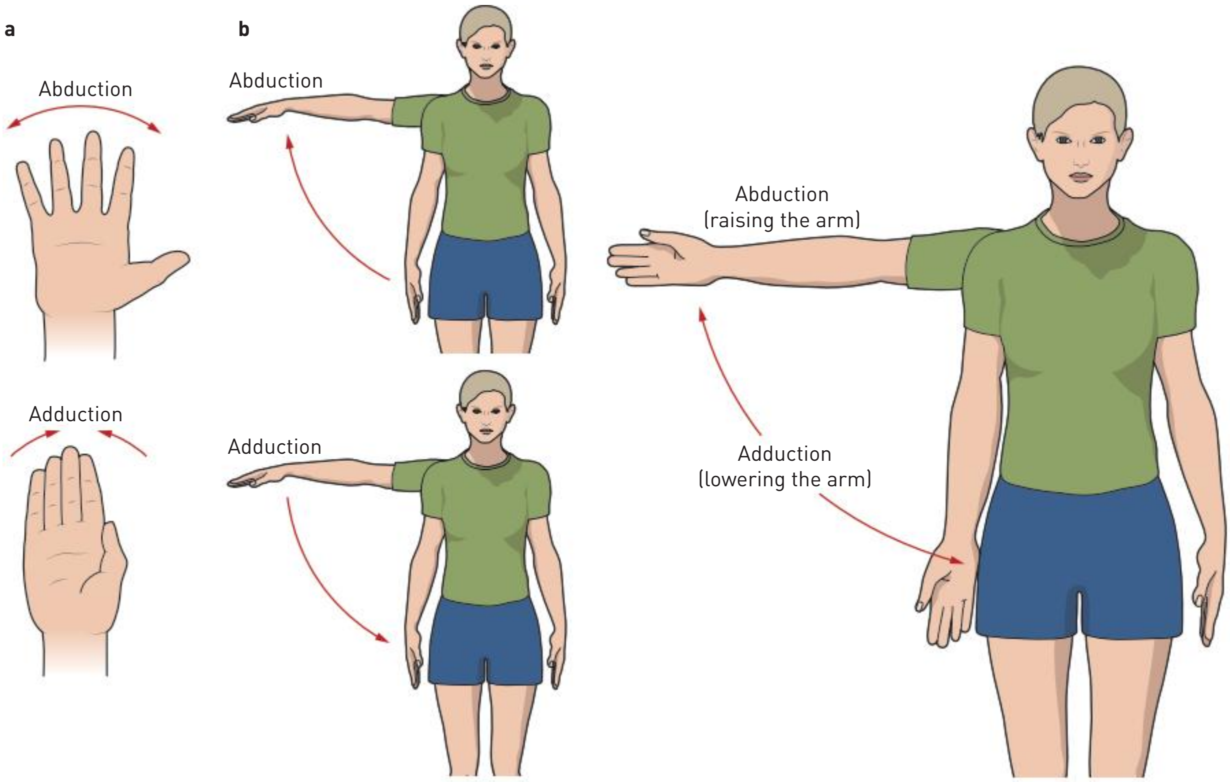
The angle of the joint is increased and extension occurs in the median plane about a horizontal axis. Muscles responsible for extension are known as extensors.

Abduction

This is movement of a body part away from an imaginary midline of the body. It can occur in the frontal or horizontal planes.

Adduction

This is movement of a body part towards an imaginary midline of the body. It can occur in the frontal or horizontal planes.



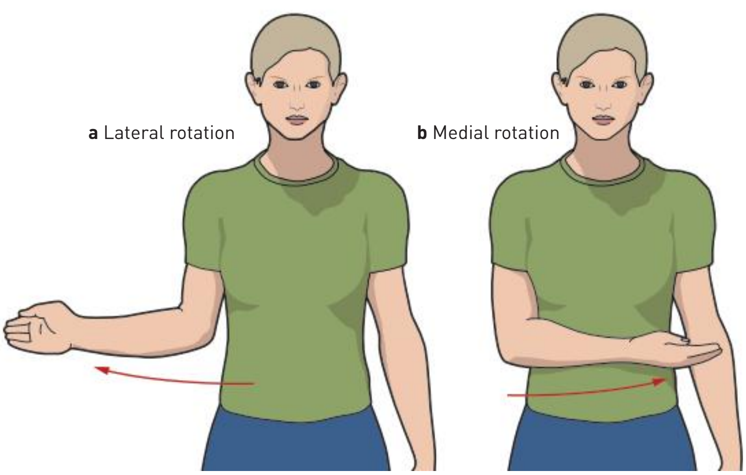
Abduction and adduction with the fingers and arms

Rotation

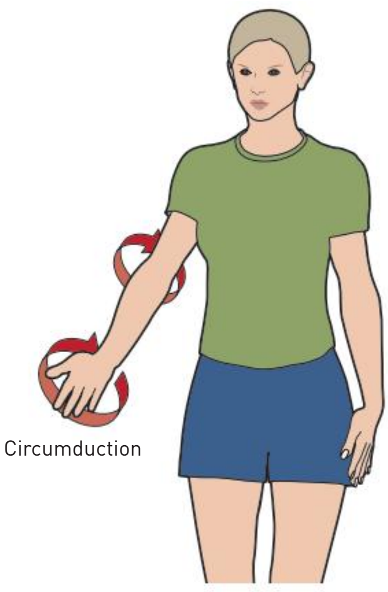
Rotation occurs when a bone turns on its own axis within a joint. Rotation towards the body's midline is known as medial or internal rotation; rotation away from the midline is known as lateral or external rotation.

Circumduction

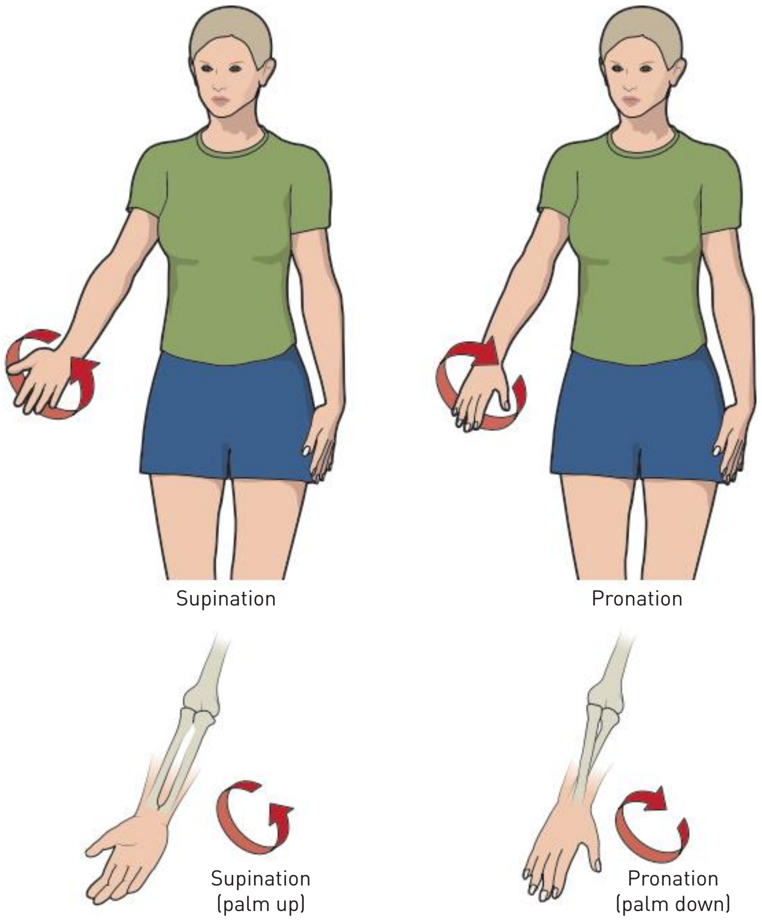
Circumduction occurs when a limb moves in a circular fashion and is generally only possible at ball and socket joints because flexion, extension, abduction and adduction are required. This occurs in the median and frontal planes.



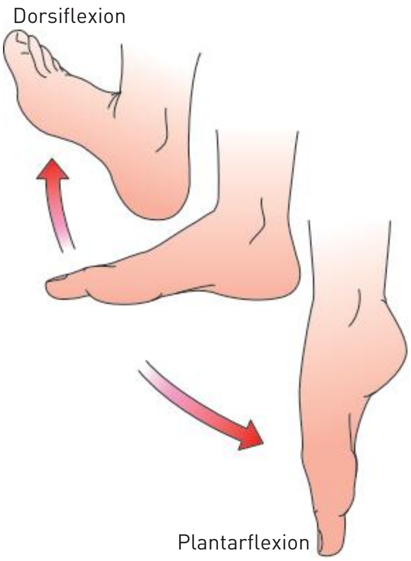
(a) Lateral and (b) medial rotation of the arm



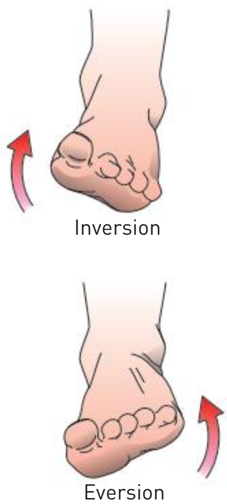
Circumduction involves the circular movement of a limb.



Pronation and supination of the hand. Notice what happens to the radius and ulna bones for each movement.



Dorsiflexion and plantarflexion at the ankle



Inversion and eversion of the ankle

Supination

Supination occurs when the forearm is rotated, turning the hand from palm down to palm up, so that the radius and ulna lie parallel to each other and are uncrossed.

Pronation

Pronation occurs when the forearm is rotated while the palm of the hand faces downwards. When this occurs, the radius and the ulna are crossed over each other.

Dorsiflexion

Dorsiflexion occurs at the ankle when the toes are pointing towards the tibia and are generally higher than the heel. This occurs in the median plane about a horizontal axis.

Plantarflexion

Plantarflexion occurs at the ankle when the toes are pointed downwards and the heel is raised. This occurs in the median plane about a horizontal axis.

Inversion

Inversion occurs when the sole of the foot is turned inwards towards the imaginary midline of the body. This occurs is in the frontal plane.

Eversion

Eversion occurs when the sole of the foot is turned outwards from the imaginary midline of the body. This occurs is in the frontal plane.

QUICKVID

Have a look at these simple visuals that will help you better understand the anatomical joint movements. Link via http://vcepe12.nelsonnet.com.au.

Weblink

CHAPTER CHECK-UP

1 Why are bones, such as those in the cranium, connected by fibrous joints rather than being large, single bones?
2 Why is the shoulder joint more likely to dislocate than the hip joint?
3 Discuss what would happen to a football player if they had an artificial ball and socket joint inserted to replace a badly damaged knee joint.
4 Which bones are more likely to be injured when playing a contact sport such as Australian Rules football: those of the axial or the appendicular skeleton? Briefly explain the reason for your selection.
5 Torn cartilages are common when synovial joints are forced to move beyond their normal range of motion. These are easily repaired via a procedure known as arthroscopy. Research what this involves and discuss how a 'small tear' can be fixed. You may also wish to view this short clip to help you gain a better understanding of the joint repair process. Link via http://vcepe12.nelsonnet.com.au.

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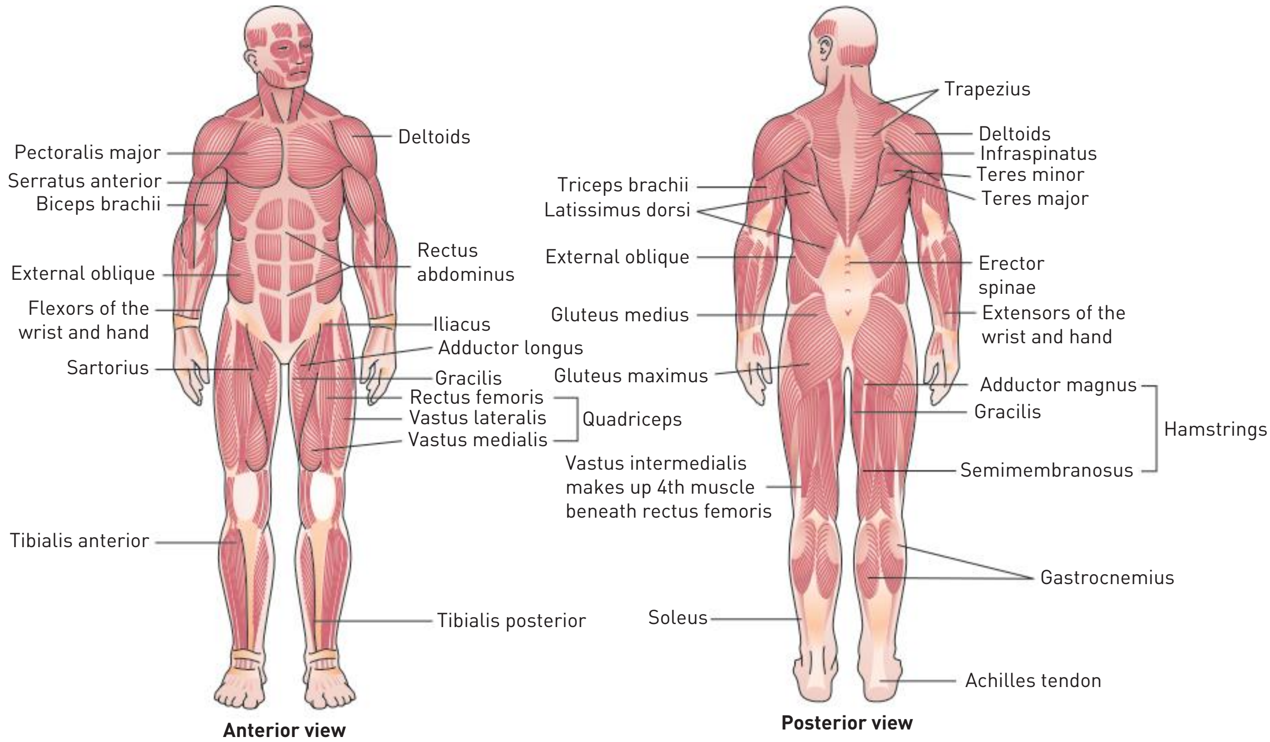
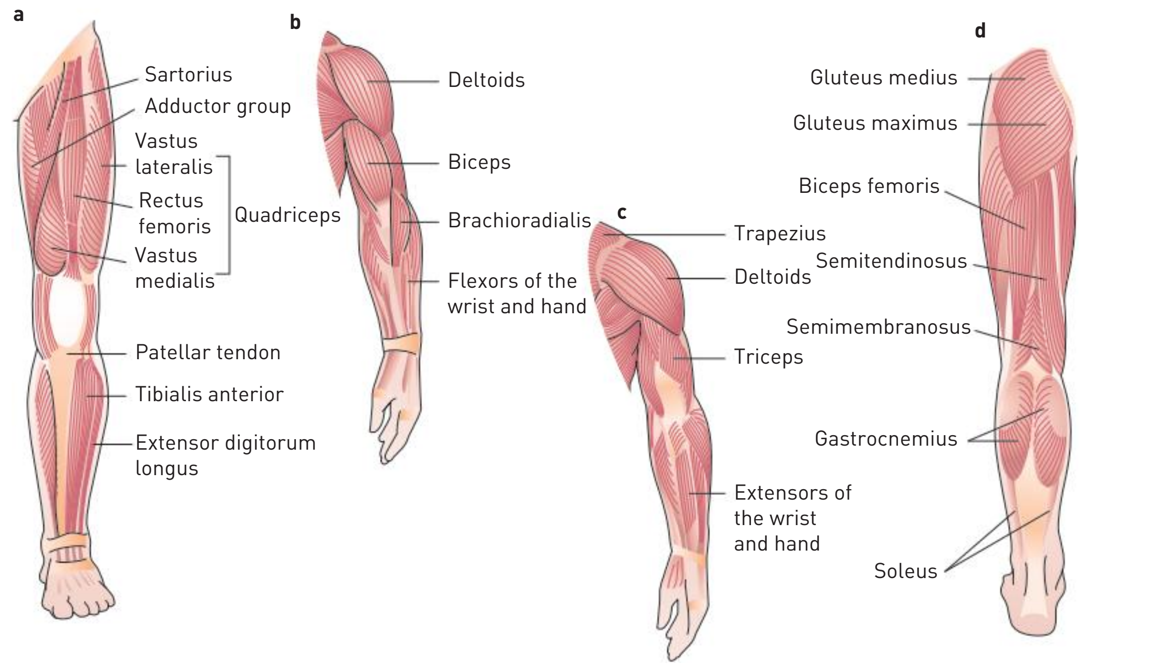
MUSCLES

Everyday movements such as running, jumping, swimming and swinging a bat to hit a ball are made possible by muscles exerting force on bones through tendons. There are more than 660 skeletal muscles in the body; by working together, they produce a wide range of movements. Each muscle is only capable of two actions: **contraction** and **relaxation**. The anterior and posterior views on the next page show some of the major muscles responsible for movement.



Anterior and posterior view of superficial skeletal muscles

Greater detail can be seen in the diagrams of the arms and legs below.



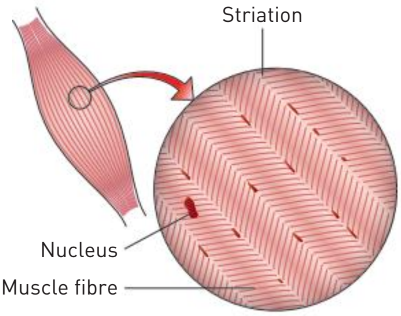
Anterior (a, b) and posterior (c, d) views of superficial skeletal muscles of the legs and arms

Types of muscles

There are three types of muscle tissue in your body: skeletal, smooth and cardiac.

Skeletal muscles

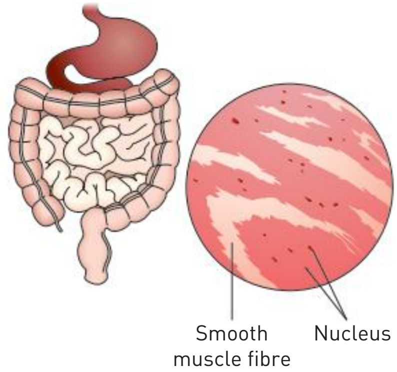
These external muscles are attached to the bones that make up the skeleton. They are under your direct control and so they are known as voluntary muscles. They are made up of striped/striated cells.



Skeletal muscle is striped or voluntary muscle.

Smooth muscles

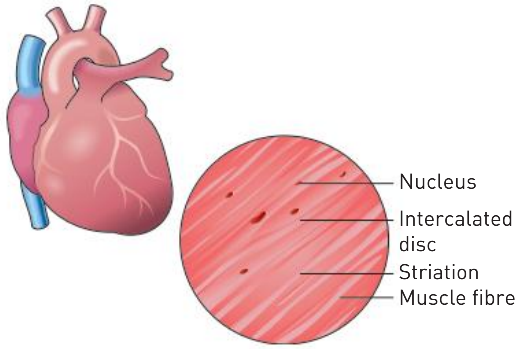
Smooth muscles are found in blood vessels and walls of the intestine. They are known as involuntary muscles, because you have no control over them. Smooth muscles are made up of spindle cells.



Smooth muscles are involuntary and are made up of spindle cells.

Cardiac muscles

Cardiac muscles make up the walls of the heart. They are involuntary and have a striped appearance.



Cardiac (heart) muscle is striped and involuntary.

Other muscle functions

All skeletal movements result from muscles pulling on bones. Muscles also provide us with support and allow us to maintain an upright posture. Many muscles found in the legs and torso contract statically, or **isometrically**, for extended periods of time (also known as muscle tone) to enable us to stay upright. Another important function of muscles is their ability to produce heat when energy is produced from foods and other stored fuels, allowing muscle contractions to occur. Skeletal muscles can also contract involuntarily when it is very cold in order to release heat and maintain a stable core temperature – this is experienced as shivering.

Muscle attachment

Muscles are attached to bones by tendons, which are generally situated at the end of the **muscle belly**. Tendons are made up of connective tissue and can cross joints to provide additional support to specific sites. **Ligaments** attach one bone to another bone, and these too provide strength around a joint. To move a bone, a muscle must cross over a joint. One end of the muscle is attached to a bone on one side of a joint, while the other end is attached to another bone on the other side of the joint.

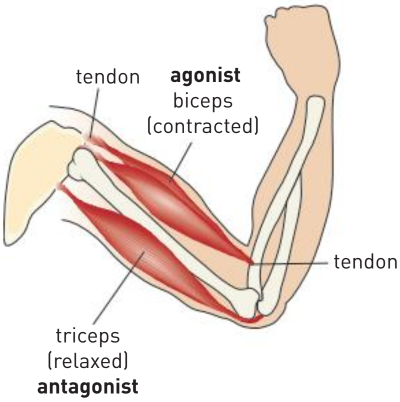
The points of attachment for each muscle are known as the **origin** and **insertion** points. The origin is the site where a muscle is attached to a stable bone, which the muscle can pull against. In most cases, this is a flat bone, which provides a large surface area for a muscle to attach to and pull against. The insertion occurs where the muscle attaches to a bone that is pulled by the action of the muscle. For example, the origin of the biceps is the scapula and its insertion point is on the radius (across the elbow joint).

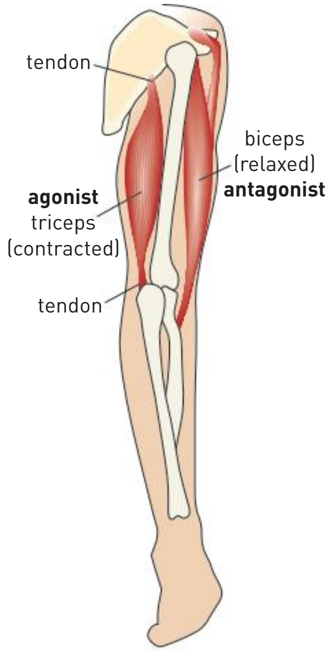
FYI

You use 17 muscles when you smile and 43 muscles when you frown. Keep smiling!

Agonists, antagonists and stabilisers

Muscles never work in isolation – they always work as a team to bring about successful movements. Consider a biceps curl, which involves elbow flexion. The biceps brachii contracts and is responsible for flexing the elbow; because it causes the movement, the biceps brachii is known as the prime mover or **agonist**. But to allow the biceps to contract, the triceps muscle must lengthen. Therefore, the triceps is known as the **antagonist** because its actions are the opposite to that of the biceps (agonist).





The agonist and antagonist relationship with elbow flexion (left) and extension

The roles of muscles change depending on the type of muscular action required. During elbow extension, the triceps becomes the prime mover or agonist, while the biceps lengthens, becoming the antagonist. **Reciprocal inhibition** is the term used to explain how muscles work in 'teams' to allow efficient movements to occur; it essentially describes how one muscle contracts and its opposite relaxes to allow ease of movement and reduce the risk of muscle tears.

Weblink

QUICKVID

Here's a short clip that will clearly explain the agonist and antagonist relationship that exists between the biceps and triceps in the arm. Link via http://vcepe12.nelsonnet.com.au.

FYI

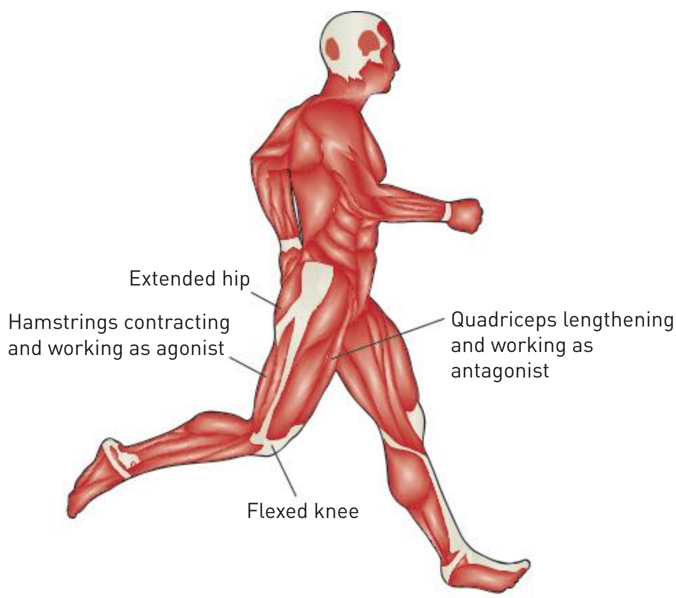
'Core stability' refers to exercises that strengthen all the muscles responsible for stabilising the spine, pelvis and shoulder regions. Many people mistakenly see core stability as only relating to the abdominal and lower back areas.

If muscles that act in opposition to each other are stimulated at the same time and contract, a serious muscle tear can result. This is common in Australian Rules football when the powerful quadriceps and weaker hamstrings contract at the same time due to neural misfiring. When this happens, the weaker muscles 'tear' and are injured. Ordinarily, the hamstrings will act as the agonist and contract, causing the knee to flex, while the quadriceps relax as the antagonist to allow ease of movement. When the leg needs to be straightened and the knee is extended (as when kicking a ball), the quadriceps become the prime movers, or agonists, while the hamstrings relax and this time become the antagonists.

Fixator muscles or **stabilisers** are also involved in contractions by holding or stabilising a body part, making it immobile while another body part is moving. The sustained stabilising contraction is isometric in most cases. In most activities, proximal joints are stabilised by muscle contractions during movement of more distal joints – this is called proximal stabilisation. For an isolated movement to occur at a joint, the muscles that control the proximal joints must stabilise them so no motion occurs there. The antagonists for each motion at the proximal joint co-contract, or contract against each other, to prevent motion.

Examples

1. The quadriceps may stabilise the knee in an extended position to permit plantarflexion of the ankle when calf raises are performed.
2. During elbow flexion the trapezius contracts to stabilise the scapula, locking it in place to provide a strong, rigid base for the biceps to pull on.



The agonist and antagonist relationship between the hamstrings and the quadriceps

QUICKVID

Take a couple of minutes to view this clip of how muscles perform isometric contractions so others can use them as a base of support to generate even stronger movement. Link via http://vcepe12.nelsonnet.com.au.

Weblink

LABORATORY REPORT

IDENTIFYING MUSCLES

Complete one of the following tasks.

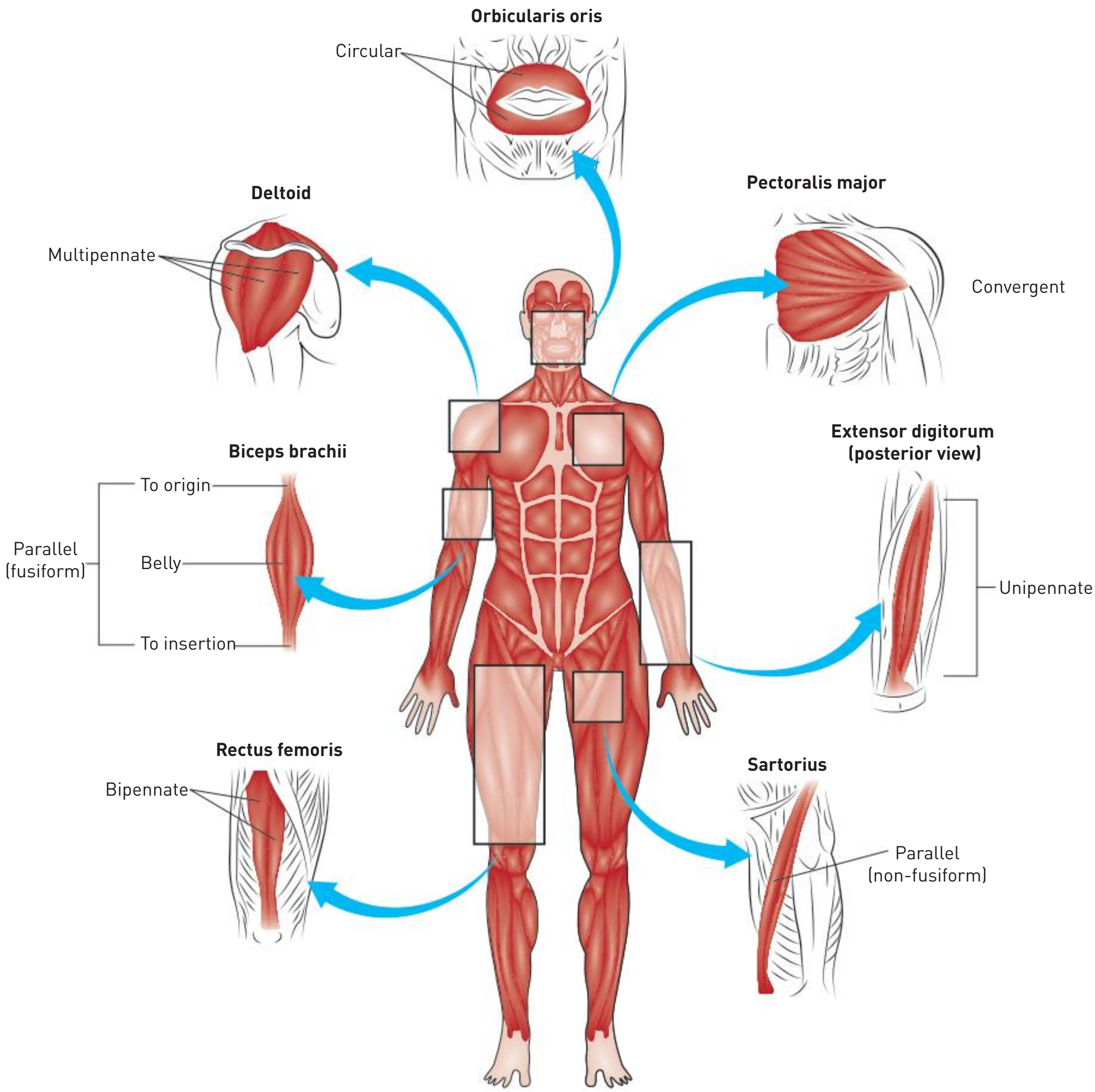
1. Work in groups of three. Write the names of 10 anterior and 10 posterior muscles on sticky labels. Two group members of the same sex are to work together and place the labels on one partner's body. The third group member acts as a 'judge'. For each correct placement (as determined by the third student), score one point.
2. Work in pairs. Obtain a body-building magazine or a photo of a body builder posing from the anterior and posterior views. Point to a muscle and state its correct name while your partner checks your accuracy. Continue for as long as you keep naming muscles correctly. Once you make an error, your partner starts naming other muscles and you check their accuracy.
3. Work in pairs. One partner thinks of a muscle and then describes it by an anatomical term (such as inferior, lateral etc.), without naming the muscle. The other partner guesses the correct muscle.

MUSCLE FIBRES (fascicles)

All skeletal muscle is made up of **fascicles** (bundles of muscle fibres), but fascicle arrangements vary considerably, resulting in muscles with different shapes and functional capabilities. Fascicle arrangements are a major contributor to muscle force and speed. Other factors, such as fibre type, lever systems and load, will be discussed in other chapters.

There are five different muscle shapes within our body:

» circular
» convergent
» parallel
» pennate
» fusiform.



The five different muscle shapes and fibre arrangements in the human body

Fibre arrangement

Circular

The fascicular pattern is circular, with the fibres arranged in concentric rings. Muscles with this arrangement surround external body openings, which they close by contracting. The general term used for these kinds of muscles is 'sphincter'. Examples include the orbicularis muscles that surround the mouth and eyes.

Convergent

A convergent muscle has a broad origin, and its fascicles converge towards a single tendon of insertion. Such a muscle is triangular or fan-shaped, like the pectoralis major muscle of the anterior thorax.

Parallel

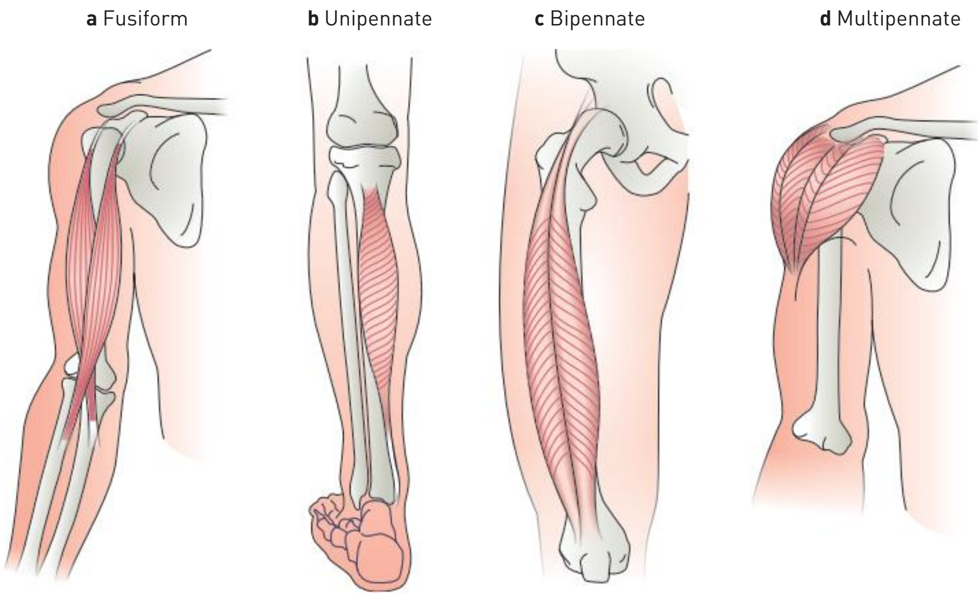
In a parallel arrangement, the length of the fascicles runs parallel to the long axis of the muscle. These muscles are either straplike, like the sartorius muscle of the thigh, or spindle-shaped with an extended belly, like the biceps brachii muscle of the arm. However, some scientists classify spindle-shaped muscles into a separate class, as **fusiform** muscles.

Pennate

In a **pennate** pattern, the fibres are short and they attach obliquely to a central tendon that runs the length of the muscle. Pennate muscles come in three forms:

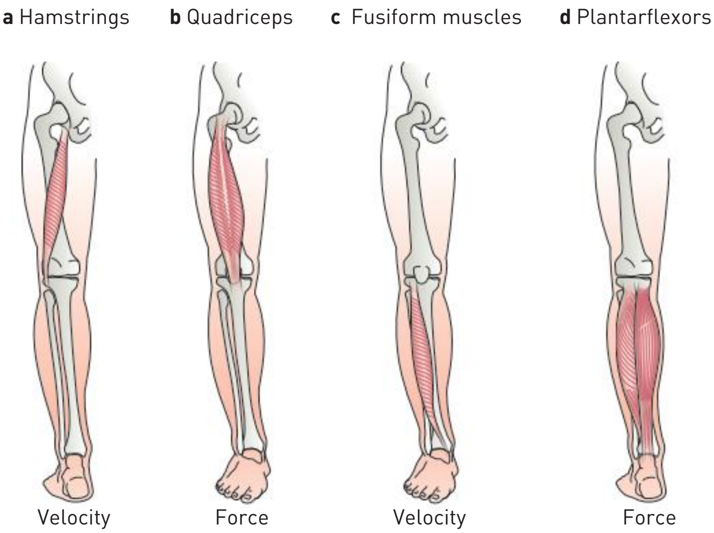
» **unipennate**, in which the fascicles insert into only one side of the tendon, as in the semimembranosis of the leg.
» **bipennate**, in which the fascicles insert into the tendon from opposite sides so the muscle 'grain' resembles a feather. The rectus femoris of the quadriceps is bipennate.
» **multipennate**, which looks like many feathers side by side, with all their quills inserted into one large tendon. The deltoid muscle, which forms the roundness of the shoulder, is multipennate.

Pennation allows considerably more fibres to be packed into a muscle; so the amount of force that can be generated also increases by a proportional amount. Muscle length and speed of contraction affect the ability of fusiform and pennate muscles to develop force. To investigate this, consider the 'opposite' muscles of the upper and lower leg. The quadriceps and plantarflexors are able to develop high forces because of their low fibre length (FL) to muscle length (ML) ratios, relatively large cross-sectional area and short fibres. The hamstrings and dorsiflexors are utilised for speed due to their high fibre length to muscle length ratios and long fibres.



Muscle fibres in skeletal muscles, from left: fusiform (biceps), unipennate (calf), bipennate (quadriceps), multipennate (deltoid)

The arrangement of a muscle's fascicles determines its range of motion and its power. Because skeletal muscle fibres may shorten to about 70 per cent of their resting length when they contract, the longer the muscle fibres are, and the more nearly parallel they are to a muscle's long axis, the more the muscle can shorten. Muscles with parallel fascicle arrangements shorten the most, but are not usually very powerful. Muscle power depends more on the total number of muscle fibres in the muscle. The greater the number of muscle fibres, the greater the power. The thicker bipennate and multipennate muscles, which pack the most fibres, shorten very little but are extremely powerful.



Hamstrings and dorsiflexors are utilised for speed; quadriceps and plantarflexors are utilised for force.

Fusiform muscles

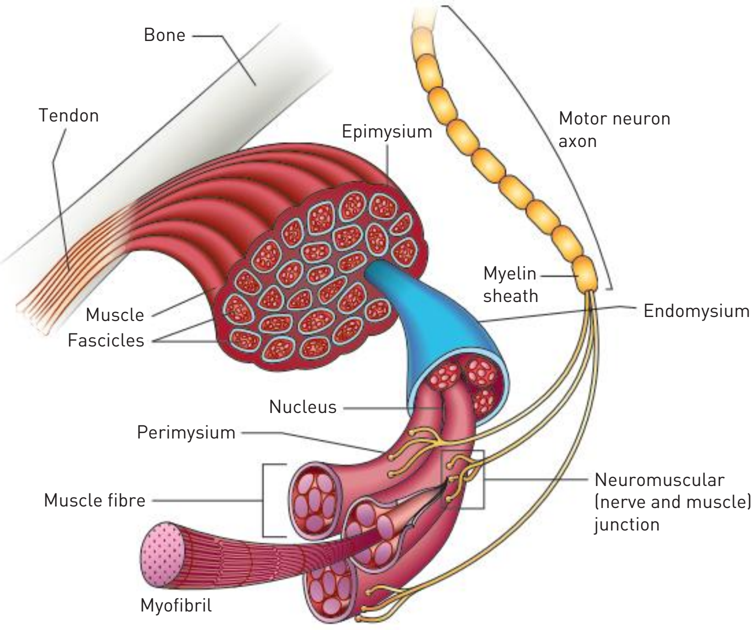
Fusiform muscles are sometimes included in the parallel muscle group, but are more spindle-shaped, with a muscle belly that is wider than the origin and insertion. Fusiform muscle fibres, such as those of the biceps muscle in the arm, run in the same direction as the tendon, or longitudinally. There are few fusiform muscles. They produce low force but can shorten over a large range.

Because fusiform muscles have longer fibres, they cannot generate the high forces that pennate muscles can with their shorter fibres and greater cross-sectional area. However, fusiform muscles can generate greater contractile velocities.

CHAPTER CHECK-UP

1 List three examples of fusiform muscles.
2 Why are pennate muscles able to generate greater force than fusiform muscles?
3 If muscles need to contract rapidly, should the muscle length to fibre length ratio be high or low? Give reasons for your answer.
4 Sportspeople sometimes overstretch or injure their ligaments.
   a How could this affect a sportsperson?
   b How is a ligament different from a tendon?
   c Why do ligaments take longer to repair and heal than tendons?

In summary, pennate muscles can contract forcefully and develop high amounts of strength. These muscles are able to generate greater force over longer periods of time than fusiform muscles. Fusiform muscles, however, can contract rapidly and develop greater power.



Inside a muscle belly

The microscopic structure of muscles

The brain sends messages to muscles via nerves called motor neurons. Muscles contract and apply forces to bones via the tendons that connect them. When a muscle contracts, it pulls the bones closer to each other, making movements such as jumping, running and swimming possible. These structures combine to form the **neuromusculoskeletal** system.

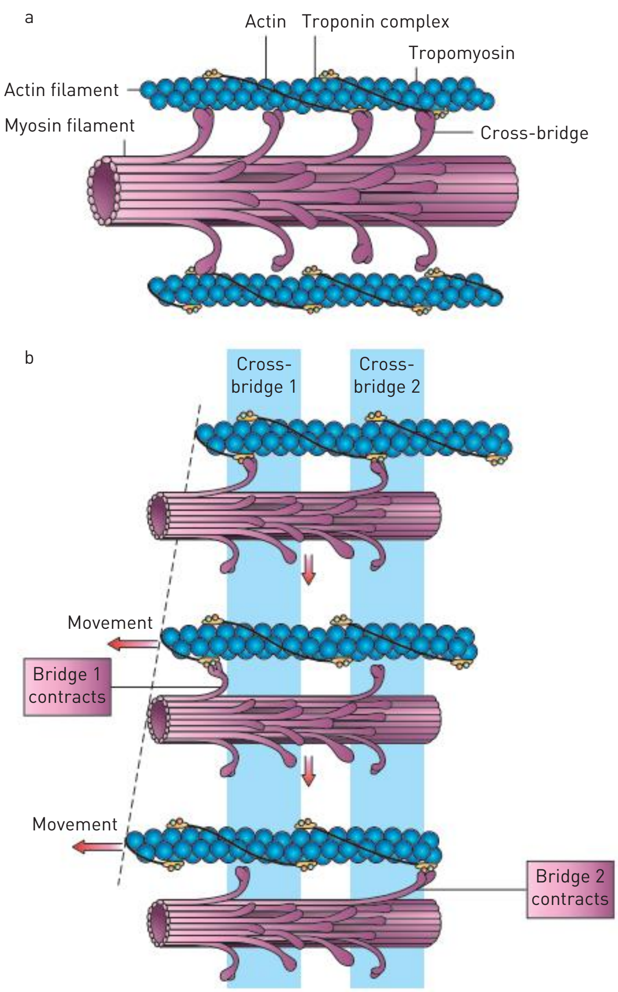
The muscle belly consists of thousands of muscle fibres known as fascicles, which run side by side along the length of the muscle (see diagram). Each of these fibres is encased in connective tissue known as perimysium, which assists in keeping the fascicles together. The fascicles are in turn surrounded by endomysium. All of this is encased by a connective tissue called the epimysium. Near the end of the muscle, the epimysium thickens and eventually becomes the tendon.

Muscle fibres are made up of **myofibrils**, which are similar to the many wires within a telephone cable. These have many units, known as **sarcomeres**, which are arranged end to end for their entire length, separated by dark lines called Z-lines. The myofibrils are further divided into myofilaments – a thick filament (**myosin**) and a thin filament (**actin**) which attach to the Z-line. It is the overlap of these two myofilaments that gives muscle its striped appearance.

Each muscle cell/fibre is surrounded by the cell membrane (sarcolemma), which encases a gelatin-like substance (sarcoplasm), which in turn surrounds the actin and myosin filaments. The sarcoplasm contains:

- **mitochondria** – the 'powerhouses' where oxygen combines with other substances to produce energy
- myoglobin – similar to haemoglobin and responsible for the transport of oxygen from the blood to the mitochondria
- fat, glycogen, phosphocreatine (PC) and adenosine triphosphate (ATP) for energy production
- **enzymes** for energy production and muscle growth.

Actin and myosin filaments take up different parts of the length of a sarcomere. The light section, which only contains the thin actin filaments, is the **I-band**. The darker section where the actin and myosin overlap is known as the **A-band**. In the middle of the A-band is a very small section where only the thick myosin filaments occur – this is the **H-zone**.



Structural arrangement of actin and myosin filaments in a sarcomere

Thousands of these sarcomeres may exist along the length of a myofibril, all separated by Z-lines (see diagram of microscopic muscle structure, page 41).

Connecting the nerves, muscles and bones

Open and closed kinetic chains

Your nerves, muscles and bones combine to form a **kinetic chain**. Imagine your body as a collection of bony parts (segments) linked by a series of joints. The bones are like the links in the chain and the joints are the places where the links join together.

Your nerves, muscles and bones work together to produce movements. For example, a biceps curl doesn't only involve your biceps muscle – the muscles and nerves of your arm and shoulder all work together to achieve elbow flexion.

The kinetic chain can be open or closed, depending on the type of exercise being done. Open kinetic chain exercises are usually not weight-bearing, and allow your limb to move freely, with resistance applied at the end – for example, leg curls and triceps extensions. Closed kinetic chain exercises involve the movement of multiple joints, and are weight-bearing. Closed kinetic chain exercises include squats and push-ups.

MUSCLE CONTROL

FYI

In a closed kinetic chain exercise, the foot or hand is in contact with the floor. In an open chain exercise, it is not. For example, a squat, where the feet press against the floor, is a closed-chain kinetic exercise. Using a leg-curl machine, where the lower leg swings freely, is an open chain exercise.

Many complex processes are involved in seemingly simple tasks, such as hitting a hockey ball or passing a netball. Although these movements occur automatically and with great speed, they are not simple tasks. The brain is responsible for initiating all actions, and the spinal cord carries all of its messages. Messages are sent as electrical impulses via motor neurons (nerve cells), which in turn stimulate muscular contraction and hence movement. Nerve cells or neurons all contain:

» a cell body
» dendrites (receptors from other neurons or sense organs)
» an axon (conducts impulses away from the cell body).

Sensory neurons conduct impulses (messages) from the sense receptors to the brain; motor neurons carry impulses from the brain and central nervous system to muscles and ultimately bring about movement. Many nerve cells extend the length of a myofibril in the same way that many sarcomeres do. They are placed 'end to end' from the brain to the many thousands of points throughout the body. The brain must monitor and receive messages from all these points in order to respond to a stimulus. Neurons that are 'linked' are known as neural chains.

One motor neuron only stimulates a small portion of the muscle, not the whole muscle. The **motor neuron** and the muscle fibres it stimulates are together known as the motor unit. One motor neuron may be responsible for stimulating one or two muscle fibres when precision is required; in other parts of the body a motor neuron may stimulate thousands of muscle fibres where gross movements occur. The first might occur in the eye or fingers and the gross movement could be that of the quadriceps when kicking a soccer ball.

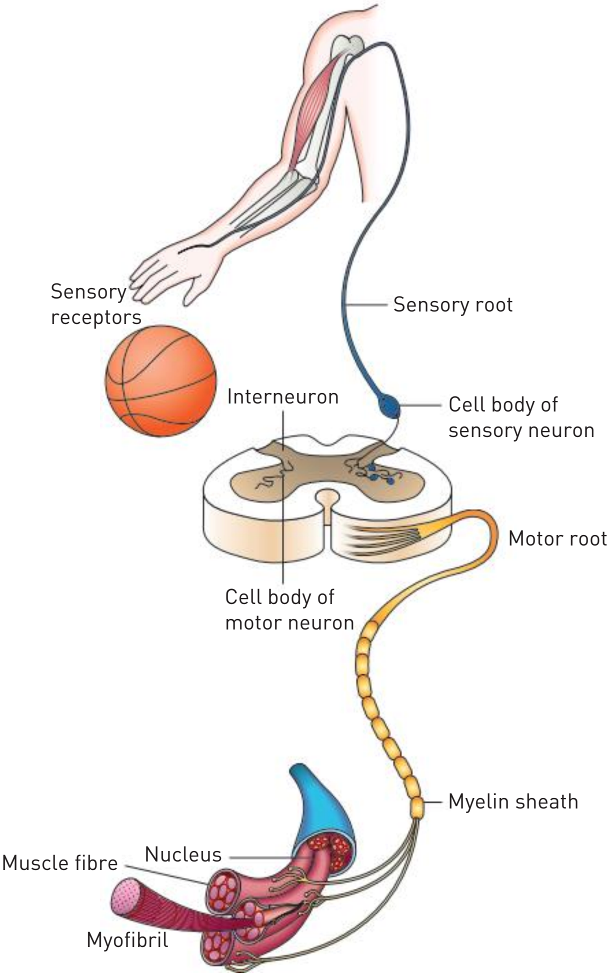
Nerves 'connect' to muscles at **synapses** on the individual myofibrils, known as neuromuscular junctions (see diagram on page 35) in a similar manner to a cord plugged into an electric kettle. However, there is no direct contact. When the signal or action potential reaches the 'end of the neural line', it causes the release of chemicals known as neurotransmitters (**acetylcholine**) that travel across the synapse between the neurons and continue the action potential in the next neuron. This is repeated until the action potential rapidly and eventually travels across the synapse to stimulate muscle cells into action.

Acetylcholine diffuses across the synaptic cleft and binds to the acetylcholine receptors that occur on the motor end plate. The receptors also double up as ion channels, and when bound by acetylcholine, they open, allowing sodium ions to flow in and potassium ions to flow out of the muscle cells. Because of electrolyte concentration differences across the plasma membrane, more sodium moves in than potassium out, producing a local depolarisation of the motor end plate known as an end-plate potential.

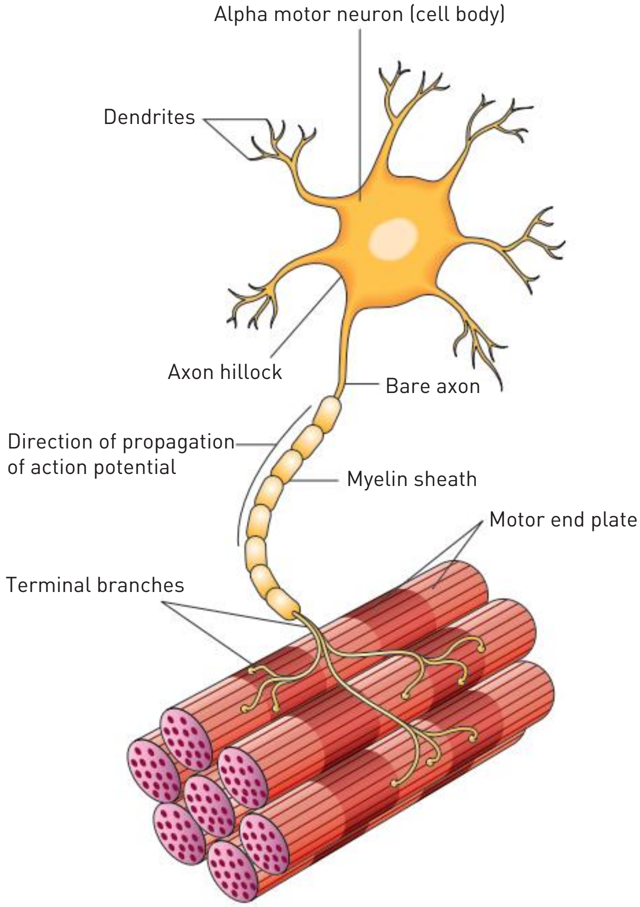
This depolarisation spreads across the surface of the muscle fibre into transverse tubules, causing the release of calcium from the sarcoplasmic reticulum, resulting in muscle contraction and movement. Acetylcholine's action ends when the enzyme **acetylcholinesterase** breaks it down and becomes inactive. The muscles then relax.

FYI

Acetylcholine is a neurotransmitter synthesised in the human body from dietary choline (found in many foods, including meat, dairy products, eggs and grains) and acetyl coenzyme A.



Nerve impulses are transmitted from the brain to the muscles via the spinal cord.



A motor unit

The all or nothing principle

Do all impulses from the brain result in movement or muscular contraction? Muscular movement is subject to the all or nothing principle. When the electrical impulse reaches a certain **threshold**, all of the fibres of that motor unit will contract at the same time and as forcefully as possible. However, until this threshold is reached or surpassed, none of the fibres will contract. Once the impulse surpasses the threshold, the ATP stored in the muscle fibre is split, with the resultant energy release allowing muscular contraction to occur. The quantity of ATP stored in the muscle fibres is relatively small; hence the body must supply the muscles with more ATP in order for it to continue to work and for the muscles to contract. Recall that the body is equipped with three

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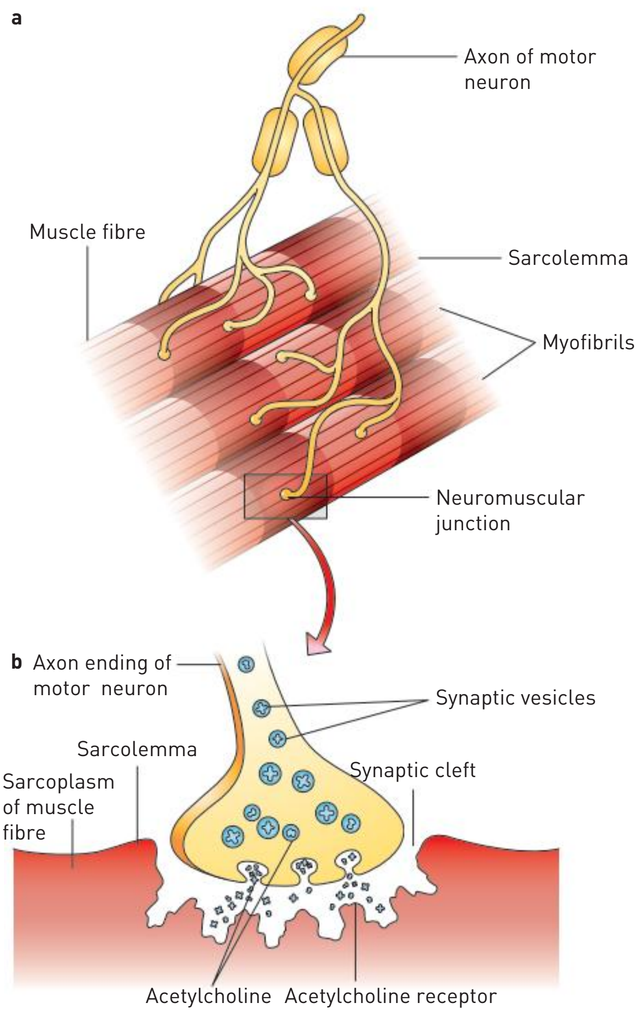
Gross movements, such as kicking a ball, require more motor neurons than precise movements, such as throwing a dart.



Enlarged detailed view of the neuromuscular junction

energy systems (ATP-PC, anaerobic glycolysis and aerobic) to ensure that the supply of ATP is maintained.

Regulation of force

How do you vary the intensity of muscular contractions? Not all muscle fibres contract every time there is a signal to do so. The number of fibres recruited to contract is governed by the strength of the nerve impulses coming from the brain. The force of a muscle contraction can be increased by boosting the frequency of action potentials to an individual fibre. This can range from the force generated by a single twitch to the force of **maximum tetanic tension**.

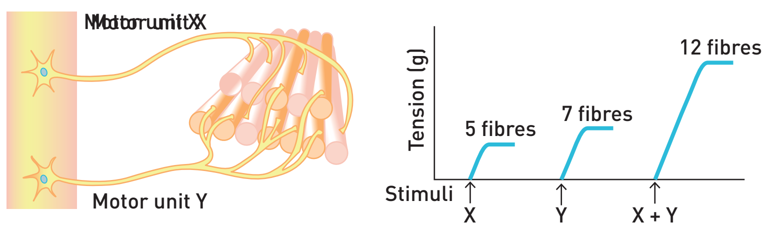
The force generated by a fibre only accounts for a fraction of the whole range of force that a muscle can generate. The whole muscle can generate greater force by increasing the number of individual fibres that contract, in a process called recruitment.

Muscle fibre recruitment (size principle)

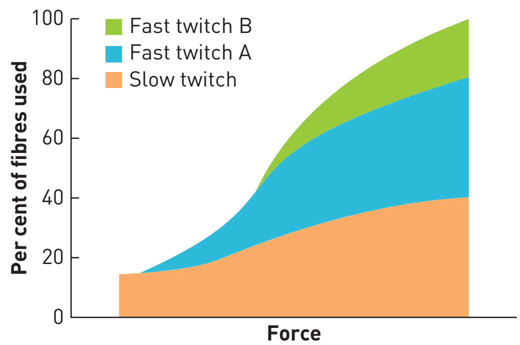
The nervous system controls muscle forces by varying the number of active motor units it stimulates. Recruitment is the term used to describe the number of active motor units stimulated by the brain. Motor units themselves vary in the number of fibres they stimulate and in the type of fibres they stimulate within each muscle. The diagram on the next page shows that stimulation of motor unit 'X' results in five fibres contracting, but stimulation of motor unit 'Y' results in seven fibres contracting. When both are stimulated, the 12 fibres contract together.

This enables fine movements to be controlled by the smaller increments of force generated by the smaller motor units. When greater force is required, the larger increments come from the larger motor units. The gradual recruitment of larger motor units is because larger motor units have larger motor neurons, which require more stimulation to fire. In the graph at right you see that as the action potential frequency increases, motor neurons become active in order of increasing size. The force generated also increases, as larger motor units with increasing numbers of associated fibres are recruited.

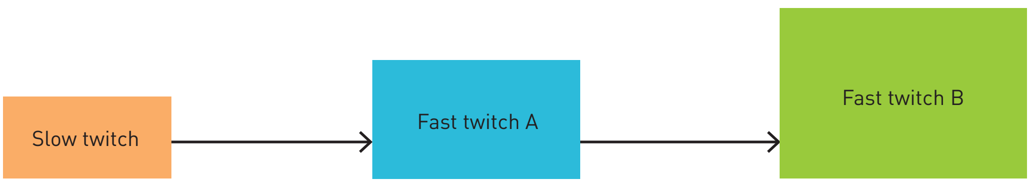
Athletes exert different forces during performances and different numbers of motor units are recruited within a muscle. For example, a cricket player hitting a six would be using most, maybe all, of the motor units in his or her arms. For a task requiring minimal strength, such as blocking a ball in cricket, only a moderate number of muscle fibres will be activated. The greater the frequency of electrical stimulation at the myofibrils, the greater the force generated by muscles.



More motor unit activation/stimulation results in greater force production.



The recruitment of fibres increases as muscular force increases.



Progressive orderly recruitment of muscle fibres during contraction with increasing force

The intensity of the task will determine which muscle fibre type is preferentially recruited for the task. Note the inverse relationship between twitch time and contraction time.

The body recruits fibres according to the activity demand; this is known as **preferential recruitment**. If an immediate and rapid response to a stimulus is required, then the **fast-twitch fibres**, which are quickest to respond, will be recruited first. **Slow-twitch fibres** are preferentially recruited if the event is of lower intensity.

QUICKVID

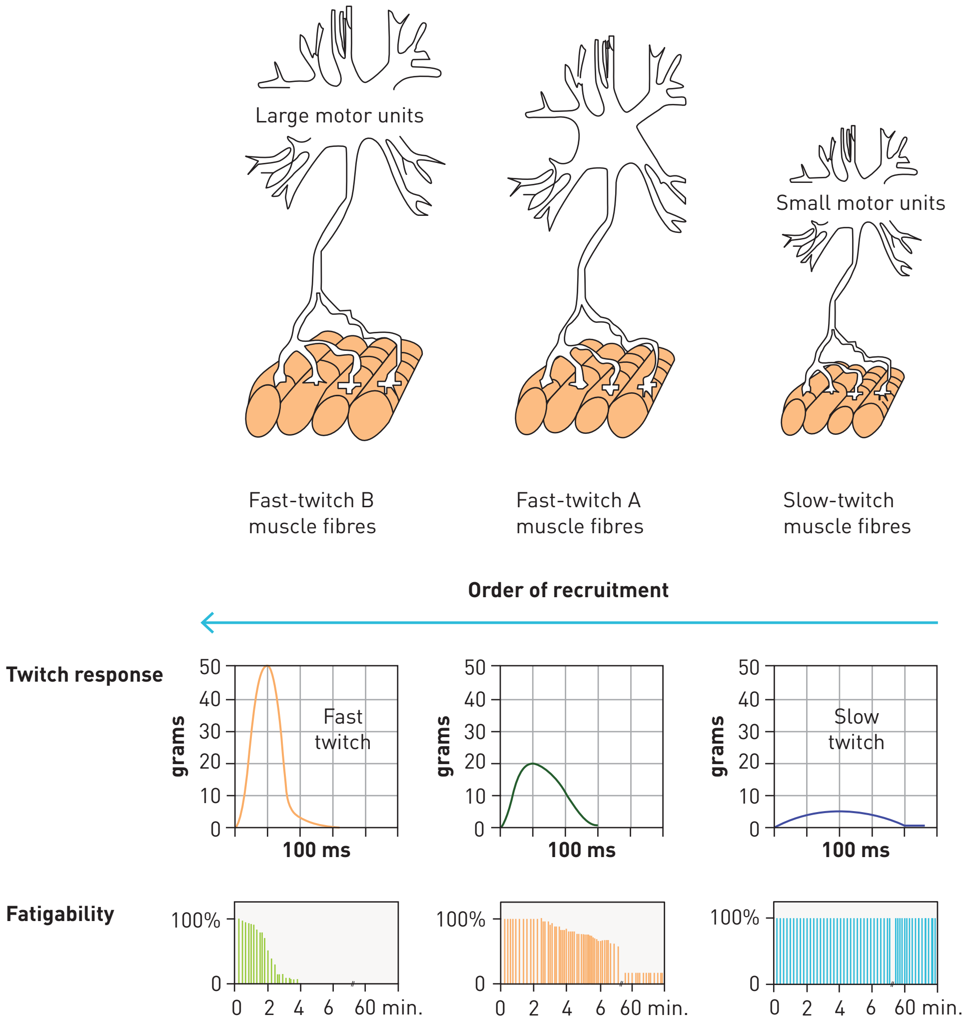
Slow- and fast-twitch fibres: check out this clip from the Australian Institute of Fitness via http://vcepe12.nelsonnet.com.au.

Weblink

QUICKVID

Watch the author explain preferential recruitment of muscle fibres and different characteristics of slow- and fast-twitch fibres. Log in to http://nelsonnet.com.au and navigate to chapter 2, page 39.

Video



The force of contraction increases as the larger motor units with increasing numbers of fibres are recruited.

How muscle actions occur

The sliding filament theory

This theory of how muscles contract involves the myofilaments sliding across each other – the actin slides over the myosin. The brain sends a message to muscles for contraction to occur. This is an electrical impulse that travels along axons and reaches muscles at the synapses of individual myofibrils at the neuromuscular junction. The acetylcholine activates the release of calcium ions (Ca^{2+}) stored within the sarcoplasmic reticulum – over the actin and myosin filaments. This then stimulates oar-like projections called **cross-bridges** on the myosin to reach out and attach to the actin filaments. The cross-bridges shorten and pull the actin filaments towards the centre and the muscle contracts. This happens thousands of times along the whole length of the muscle fibre and results in a shortening of the muscle's overall length.

Unless stimulated again, the cross-bridges relax as the calcium ions are drawn back into the sarcoplasmic reticulum, and the muscle returns to its original length. It is important to note that the length of the filaments does not change – the filaments simply slide over each other. When the actin filaments slide over the myosin filaments, the I-band and the H-zone will eventually disappear during a muscular contraction (isoinertial concentric contraction; see page 43). The A-band does not change because the myosin does not move. A muscle may shorten to 50–60 per cent of its resting length.

QUICKVID

A clear representation of the sliding filament theory to explain muscle movements. can be found in this video clip. Go to http://vcepe12.nelsonnet.com.au.

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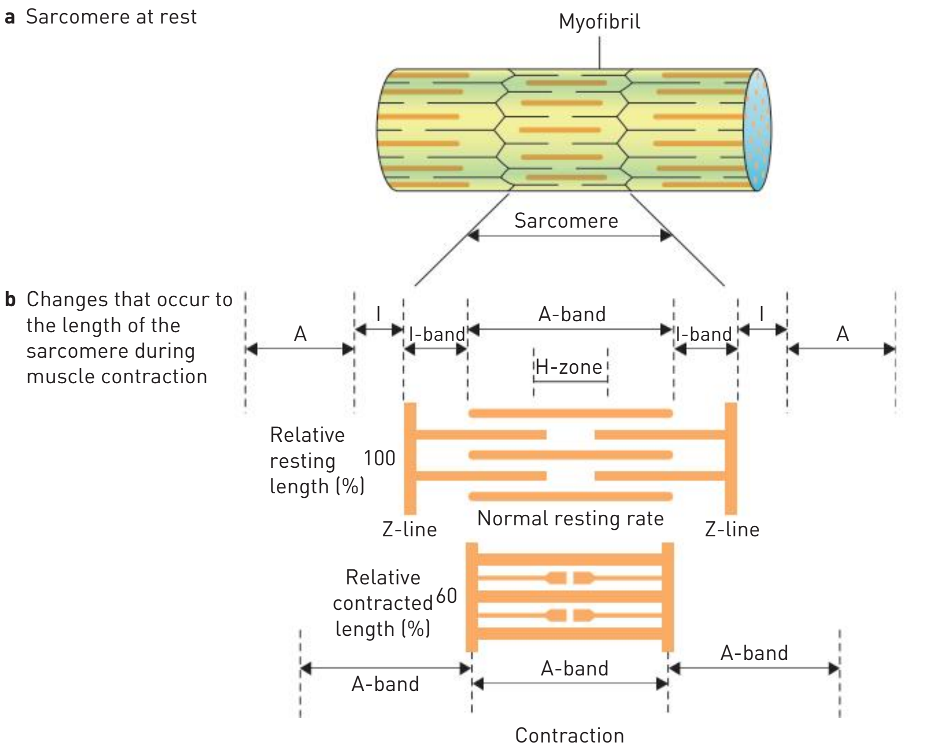


(a) Gross muscle structure: a sarcomere at rest; and (b) microscopic muscle structure: changes that occur to the length of the sarcomere during muscle contraction

Muscle action summary

In resting muscle:

» there are few or no electrical impulses reaching the muscle
» there are Ca^{2+} ions within the sarcoplasmic reticulum
» ATP is stored, not broken down.

During a contraction:

» nerve impulses travel along axons to the axon end plate
» acetylcholine travels across the synaptic cleft to the myofibril
» sarcoplasmic reticulum releases Ca^{2+}
» myosin cross-bridges attach to actin
» ATP is broken down and energy is released, causing cross-bridges to shorten
» actin is pulled and slides over myosin and the muscle shortens or contracts.

On relaxation:

» the nerve impulse stops
» Ca^{2+} ions are taken up by sarcoplasmic reticulum
» myosin cross-bridges are 'broken' down and actin returns to the resting state
» the muscle relaxes.

Even when a muscle is relaxed, some myosin cross-bridges remain in contact with actin, so the muscle is never truly relaxed, but remains toned. This allows contractions to occur rapidly and correct posture to be maintained.

To understand how force is created from a muscle contraction, imagine pulling a bucket up from a well with a rope:

» Grab the rope with both hands, arms extended.
» Loosen your grip with your left hand and maintain your grip with the right hand.
» With your right hand holding the rope, change your right arm's shape to shorten its reach and pull the rope and bucket towards you.
» Grab the rope with your extended left hand and release your right hand's grip.
» Change your left arm's shape to shorten it and pull the rope/bucket, returning your right arm to its original extended position so it can grab the rope again.
» Repeat alternating arms until you have pulled the bucket all the way up.

CHAPTER CHECK-UP

1 Are these statements true or false?
   a Tendons attach one bone to another.
   b Multipennate muscle fibres produce greater forces than unipennate muscle fibres.
   c Nerve cells come into direct contact with muscle fibres.
   d Acetylcholine activates the release of calcium ions, which stimulate cross-bridges on myosin to reach out and attach to actin filaments.
2 Draw a sarcomere (all that is contained between Z-lines) and clearly label the following:
   Z-lines
   I-band
   actin filaments
   A-band
   myosin filaments
   H-zone
3 Describe how the sliding filament theory explains muscle movement. Include a brief explanation of how a message sent from the brain very quickly becomes a muscular movement.
4 How are athletes able to control the amount of force that a particular muscle group exerts? For example, in one instance a performer may use her arm muscles to pick up a drink bottle and in another the same muscles may be responsible for hurling the discus over 60 metres.
5 What does the all or nothing principle convey in terms of muscular contractions?

TYPES OF MUSCLE ACTIONS

Isometric actions

Isometric exercise involves a muscle contraction against a force with no significant movement occurring. Tension is produced, but no joint movement or action takes place. Examples include pushing or pulling against an immovable object or holding a weight in a particular position. The main disadvantage associated with isometric contractions is that they result in elevated systolic blood pressure because muscles contract around blood vessels and restrict blood flow. This can place undue stress on the circulatory system because the heart needs to pump harder to force blood through these 'restricted' areas.

Isokinetic actions

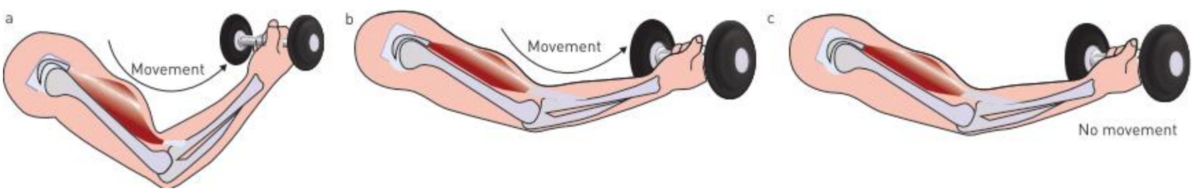
In an isokinetic contraction, the speed or velocity of movement is held constant regardless of the magnitude of force applied to the resistance. Typically this occurs with the use of specialised resistance machines such as Cybex, Biodex, Lido and Kin-Com, which use hydraulics to regulate the resistance, matching any increases in contraction speed. Any force applied results in an equal reaction force supplied by the machine. Isokinetic exercises are sometimes referred to as accommodating resistances. Because the machines work the muscle maximally throughout the entire range of motion, they tend to be favoured by many athletes. They develop the greatest improvements in both strength and endurance, leaving none of the 'weak spots' that are common to the isometric workouts exemplified by free weights.

Isoinertial actions

Isoinertial exercises maintain a constant inertia (mass). A weight is placed on an extremity (arm or leg) and this is put through the range of motion or pattern of movement the person is training for. This range of motion can change direction but the force on the extremity doesn't change. Isoinertial exercises strengthen the muscle being targeted as well as the synergist (helper) muscles. This type of exercise also helps strengthen ligaments and tendons throughout the range of motion. (These exercises are often confused with isometric exercises, which have a constant muscle force often involving a constant resistance, such as a free weight being moved through a range of motion.)

Concentric contraction

If the muscle shortens during an effort, a **concentric contraction** has occurred; for example, in the upward phase of a biceps curl, during elbow flexion. This is the most common type of contraction undertaken by most muscles. The action produced by a concentric contraction brings together or approximates the origin and insertion of the contracting muscle. In a concentric exercise, tension is developed and the muscle shortens to overcome an external force, such as a weight.



The three types of muscular activation: concentric (**a**), eccentric (**b**), and isometric (**c**).

Eccentric contraction

An eccentric muscle contraction is sometimes referred to as a lengthening contraction. If the muscle lengthens while tension is developed, an **eccentric muscular contraction** has occurred. This occurs in all gravity-resisting movements, such as lowering the barbell from the bent arm position during a biceps curl. The origin and insertion of the contracting muscle move further apart during the contraction. Eccentric exercise involves loading a muscle, causing a physical lengthening of the muscle as it attempts to control the load when lowering the weight. For example, as a person slowly lowers themselves into a chair, the quadriceps muscles must eccentrically contract to control the rate of descent, otherwise the person would fall into the chair.

Weblink

QUICKVID

This short video clip shows the three types of contraction: concentric, eccentric and isometric. Follow the link at http://vcepe12.nelsonnet.com.au.

PRACTICAL ACTIVITY

GAMES ANALYSIS

Students are required to participate in a team sport with classmates – this could be basketball, netball, soccer, hockey, European handball or some other sport. The purpose of this games analysis is to collect information on the variety of movements used in the sport in order to identify the bones, muscles, joints and joint actions used throughout the game.

The session should be filmed, and the footage then replayed so students can record what they see. This also allows relevant key knowledge to be pointed out to the class. Before starting, it is important that one player is identified as the one to focus on for data collection.

Essentially, the filming should allow members of the class to identify the numerous skills performed (these can be replayed in slow motion) and the various movement/locomotor patterns. When analysing the data collected, students must identify the various bones and joints involved with each movement, as well as the associated muscles responsible for movement.

The following tables may be useful; you can fill them in online or download them from the student website at http://www.nelsonnet.com.au, using your login code.

Scaffold

TABLE A Locomotor/movement patterns

Locomotion	Intensity	0–5 metres travelled (m)	6–10 m	11–15 m	16+ m	Total	Distance	% Total (Distance/Total)	Average (m)
Walk	Low								
Jog	Med/Low								
Shuffle	High								
Sprint	Very high								
Totals								100%	

NB: Enter skills most likely to be observed (see below for suggestions)

Scaffold

TABLE B Average number of repetitions of each skill

Skill	Frequency	Netball	Hockey	Volleyball	Tennis/Badminton
		Chest pass	Push	Serve overarm	Serve
		Overhead pass	Hit	Serve underarm	Forehand
		Catch	Flick	Dig	Backhand
		Rebound	Dribble < 5 m	Set	Volley
		Jump	Dribble > 5 m	Spike	Forehand winner
		Guard	Intercept	Leap forwards	Backhand winner
		Defend	Tackle on opposition	Leap sideways	Smash
		Leap forwards	Disposal	Dive	Lob
		Leap sideways	Corner	Jump	Change of direction
		Change of direction	Change of direction	Change of direction	
		Toss up	Lunge	Tip-off	
		Centre pass	Trap	Lunge	

Fibre types: fast- and slow-twitch

Muscles are made up of two different types of fibres:

» **Slow-twitch fibres** – these red fibres are best suited to aerobic endurance work such as a triathlon. They are also known as Type I fibres.

» **Fast-twitch fibres** – these white fibres are best suited to short-duration, high-intensity anaerobic work; for example, the bursts of power and speed required to sprint. They are also known as Type II fibres.

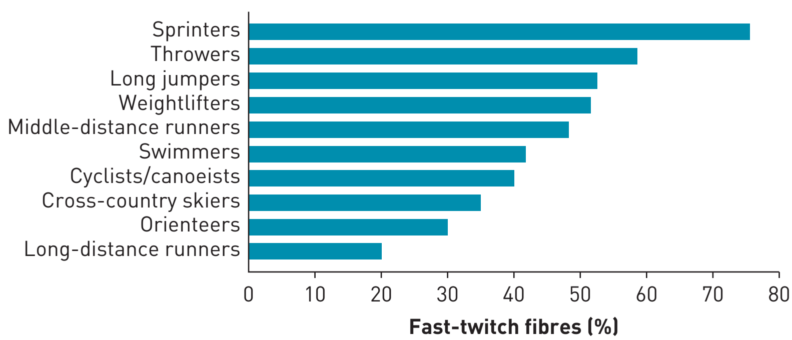
To discover your muscle fibre make-up it is possible to have a muscle **biopsy**. Biopsies are expensive, but they are commonly undertaken in many talent identification programs to determine whether an athlete has the right fibre type for a particular activity. Incorrect training based on predominant fibre type will result in minimal change.

Slow-twitch fibres contract slowly and are able to perform over extended periods of time, producing low forces. Fast-twitch fibres produce larger forces than slow-twitch fibres but tire much more rapidly. The proportion of slow-twitch and fast-twitch fibres varies from muscle to muscle and from person to person, although most people have roughly equal proportions of each. Athletes with a predominance of one fibre type over another will tend to succeed in events requiring that particular muscle fibre type. For example, an athlete with a predominance of fast-twitch fibres will perform best in sprint events, while an athlete with a majority of slow-twitch fibres will perform best in endurance events.

While the proportion of fast- and slow-twitch fibres is generally about equal in muscle groups, variations from one muscle, or group of muscles, can occur. The proportion of each fibre throughout your body tends to be genetically determined. Recent research indicates that genetics is much more important for sprint-type events than for endurance activities.

The soleus (lower leg) muscle contains about 30 per cent more slow-twitch fibres than other muscles in the leg, which makes it perfect for endurance performance. The triceps (upper arm), however, contains 25 per cent more fast-twitch fibres than other muscles in the arm, making it very powerful and fast. An athlete may also have a high proportion of slow-twitch fibres in the thigh muscles and a high proportion of fast-twitch fibres in the arms.

Fast-twitch fibres are better suited to anaerobic conditions where performers require speed, power and explosive efforts. These fibres tire quickly due to a rapid build-up of metabolic by-products that cause fatigue, and hence can only be used for a very short time. Slow-twitch fibres contract slowly and repeatedly and are best suited to aerobic conditions. They are slow to fatigue and are recruited for endurance-type activities, or where **submaximal** efforts occur repeatedly over a long period of time.



The percentage of fast-twitch fibres found in various types of athletes. Can you think of other examples?

Researchers have found that slow-twitch fibres cannot be converted to fast-twitch fibres. Fast-twitch fibres cannot become slow-twitch fibres, but some fast-twitch fibres can take on slow-twitch-fibre characteristics after aerobic and endurance training. Long-distance runner Ghirmay Ghebreslassie (2015 world marathon champion) would find it difficult to compete against a sprinter such as Usain Bolt in the 100 metres, but Bolt could possibly train to compete in a 1500 or 3000-metre race.

For this reason, fast-twitch fibres are further classified as:

» Type A – partially aerobic
» Type B – purely anaerobic.

TABLE 2.4 Characteristics of fast-twitch and slow-twitch fibres

Characteristic	Fast-twitch		Slow-twitch
	B	A	
Performance conditions	**Purely anaerobic**	**Partially aerobic**	**Aerobic**
Colour	White	White/red	Red
Oxidative enzymes	Low	Medium	High
Myoglobin content	Low	Medium	High
Glycolytic capacity	High	High	Low
Mitochondria density	Low	Medium	High
Capillary density	Low	Medium	High
Calcium capacity	High	Medium/low	Low
Myosin ATPase	High	High	Low
Phosphocreatine stores	High	Medium/low	Low
Triglyceride stores	Low	Medium/low	High
Fibre diameter	Large	Intermediate	Small
Contraction speed	High	Moderate	Slow
Force capacity	High	Intermediate	Low
Fatigue resistance	Low	Medium/low	High

Table 2.4 demonstrates that different types of muscle fibres have different characteristics. It can also be demonstrated that different athletes have the fibres that are best suited to the activities they perform. Athletes who have a high proportion of slow-twitch fibres include triathletes, marathon runners, long-distance cyclists, rowers and other performers who repeat the same activity over and over again over long periods of time. These athletes benefit from the following slow-twitch fibre characteristics:

» high capillary density – supplying large amounts of blood and oxygen to working muscles
» high mitochondrial density and oxidative enzymes – releasing large amounts of energy under aerobic conditions
» high **triglyceride** stores – preferred fuel under aerobic conditions (submaximal).

Fast-twitch fibres are found in athletes requiring speed and explosive power. These athletes benefit from:

» high phosphocreatine stores – the quickest source of energy/ATP under anaerobic conditions
» high glycogen stores – the preferred fuel during near-maximal efforts calling upon the lactic acid system
» high glycolytic enzymes – these speed up glycogen breakdown during high-intensity efforts lasting beyond 10 seconds.

CHAPTER CHECK-UP

1 Clearly indicate what happens to each of the following during eccentric and concentric muscular contractions by using the words 'increase', 'decrease' or 'no change'.

Type of contraction	I-band	A-band	H-zone
Eccentric			
Concentric			

2 Briefly explain why isokinetic actions are responsible for greater gains in muscular strength and power than isometric contractions.

3 What is the main difference between fast-twitch A fibres and fast-twitch B fibres?

4 Complete the following table of fibre characteristics by inserting the words 'high' or 'low'. You can access the table online via http://www.nelsonnet.com.au, using your login code.

Scaffold

Characteristic	Slow-twitch	Fast-twitch
Oxidative enzymes		
Myoglobin content		
Force produced		
Susceptibility to fatigue		
Mitochondria density		
Glycogen stores and glycolytic enzymes		
Phosphocreatine stores		
Motor neuron size		
Triglyceride stores		

FACTORS AFFECTING MUSCLE STRENGTH

Various factors affect the amount of muscular strength performers are able to generate:

» **Fibre arrangement** – multipennate muscles are stronger than bipennate and unipennate muscles; fusiform muscles can develop the least strength.

» **Muscle fibre recruitment** – when maximal force is required, the fibres in all motor units must be recruited; an easy task such as throwing a dart requires only a couple.

» **Muscle fibre type** – fast-twitch fibres are able to generate greater strength than slow-twitch fibres. Fast-twitch B fibres are 'stronger' than fast-twitch A fibres, though fast-twitch A fibres have some aerobic qualities that can be developed through aerobic training.

» **Speed of contraction** – multipennate muscles tend to have the smallest range of movement and contraction speed, but are able to develop the greatest strength. As the speed of contraction increases, the amount of force a muscle can generate proportionately decreases.

» **Gender differences** –muscles of the same cross-sectional area in males and females are equally strong. However, females' muscles generally have smaller cross-sectional areas than those of males, and so are about two-thirds as strong.

» **Age differences** – muscles tend to be at their 'strongest' between the ages of 20 and 30 and then progressively deteriorate by about 1 per cent every year after this. This is because our bodies synthesise less protein, required for the building of muscles, after our mid-20s. This natural deterioration can be arrested by performing regular weight-bearing and resistance exercises.

LABORATORY REPORT

MUSCLE CROSS-SECTIONAL AREA VS STRENGTH

AIM

To see if any relationship exists between the cross-sectional area of muscle and the force it is able to generate.

METHOD

You cannot slice through the biceps to obtain its true cross-sectional area, so you will measure its circumference with a tape measure.

1 For a group of subjects, measure and record the circumference of each biceps (fully flexed).
2 Each subject is to perform biceps curls with a dumbbell, increasing the weight of the dumbbell until a weight is reached with which they cannot complete a biceps curl. Choose weights that the subjects believe to be close to their maximum. (Subjects are being tested for strength, not endurance.) Subjects should only use their biceps. In order to avoid swinging or swaying the back to initiate the curl, they should stand side-on in a doorway, leaning their back against the door frame so they have either side to move the weights on the downward phase.
3 Record the most successful maximal effort of each subject in a table such as that shown here.

Name of subject	Biceps circumference (cm)	Maximal weight curled (kg)

4 Plot your results on a graph to show the relationship between biceps circumference and weight curled (strength).

DISCUSSION

1 Does a relationship exist between cross-sectional area and strength generated by muscles? If so, what is it?
2 Are there any exceptions? In other words, are any results different from the general trend?
   a How do you account for these differences?
   b If applicable, compare the results obtained for females to those obtained for male class members.
   c If you could not obtain results from both males and females, which gender do you believe would obtain the greatest results given the same biceps circumferences? Why?
3 Comment on the speed of contraction required to obtain the greatest force/maximal contraction.

CHAPTER SUMMARY

- The musculoskeletal system consists of the skeletal system and the voluntary muscle system.
- Muscles have four key functions: support, posture, movement and heat production.
- Muscles can be further classified according to their shape (fusiform or pennate) and the presence of slow-twitch or fast-twitch fibres.
- Muscles are attached to bones via tendons. The origin is where a muscle 'anchors' or attaches (usually a flat bone). The insertion usually occurs across a joint and is where the muscle pulls on a bone.
- Muscles usually work as agonist and antagonist to produce coordinated movement. Reciprocal inhibition describes the relationship when one muscle shortens and its opposite lengthens.
- Fixator muscles or stabilisers provide stability to the origin so maximal contraction force can be applied. During elbow flexion the trapezius contracts to stabilise the scapula and provide a strong, rigid base for the biceps to pull on.
- Muscles can contract concentrically, eccentrically or isometrically.
- A motor unit consists of a motor neurone and all of the fibres it stimulates.
- The all or nothing principle states that unless a nervous impulse reaches a certain threshold, none of the fibres it is connected to will respond. However, once this threshold is reached, all the fibres will respond maximally.
- Contractions controlled by the brain can be made more powerful by sending more signals or sending them more frequently. This results in a larger number of motor units and muscle fibres being used.
- Sensory neurons conduct impulses from the sense receptors to the brain; motor neurons carry impulses from the brain and central nervous system to muscles and ultimately bring about movement.
- Fibres are recruited preferentially depending on the activity. If low contraction force is required, slow-twitch fibres will be predominantly stimulated, but if an explosive effort is required, fast-twitch fibres will be stimulated.
- Muscles, joints and nerves must work together to produce movements. Open kinetic chain exercises are usually performed in a non-weight bearing position and allow the involved limb to move freely. Closed kinetic chain exercises are performed in a weight-bearing position with movement of multiple joints.
- The functions of the skeleton are protection, support, movement/leverage, blood production and mineral storage.
- The skeleton is made up of the axial and appendicular skeletons. The axial section provides the main support for the body and includes the skull, vertebral column and rib cage. The appendicular section is made up of the limb bones and their 'girdles', which connect onto the axial skeleton.
- The vertebral column consists of the cervical vertebrae (seven unfused bones), thoracic vertebrae (12 unfused bones), lumbar vertebrae (five unfused bones), sacrum (five fused bones) and coccyx (four fused bones).
- Muscles are attached to bones. When muscles contract, they pull on the bones and movement occurs.
- When two or more bones meet, a joint is formed. Joints are classified according to the amount of movement they allow: fixed (no movement), cartilaginous (slight movement) and synovial (unrestricted movement).
- There are six types of synovial joints, which are classified according to their shape and the type of movement they allow: pivot, gliding, ball and socket, hinge, saddle and condyloid.
- The movements possible at synovial joints include flexion, extension, abduction, adduction, rotation, circumduction, pronation, supination, dorsiflexion, plantarflexion, inversion and eversion.

CHAPTER REVIEW

Multiple-choice questions

1 Fast-twitch B fibres:
   A can be converted into fast-twitch A fibres after 12 months of aerobic training
   B are best suited to high-intensity activities
   C are found in high proportions in endurance athletes
   D none of the above.

2 During isometric contractions, the H-zone:
   A increases slightly
   B decreases
   C remains unchanged
   D doubles in size.

3 Answer true or false for each of the following statements.
   i Doing chest-flys using dumbbells on a weight bench is an open kinetic chain example.
   ii Doing push-ups on the gym floor is an open kinetic chain example.
   iii Performing a seated leg extension on a machine is a closed kinetic chain example.
   iv Performing a standing calf raise is a closed kinetic chain example.

Short-answer questions

4 List two characteristics of slow-twitch fibres that enhance their ability to take up and utilise oxygen. Briefly discuss the role of each of these characteristics.

5 Provide a brief summary of the nervous control of muscular contraction. For example, describe how a message sent from the brain allows you to pick up a pen to take notes in class.

6 a Discuss the different ways nervous control and muscles are involved in a golf putt over 10 metres compared to a drive off the tee with a 1-wood that travels over 200 metres. Your response should consider the number of motor units recruited as well as the fibre types recruited and the signals sent by the brain to the muscles.
   b Discuss the difference between motor and sensory neurons in part a, and how sensory neurons can be used to provide feedback to the golfer.

7 You have just been appointed the coach of the women's national weightlifting team, who are training for the Commonwealth Games.
   a Clearly indicate why you would include eccentric activities in the resistance training program.
   b Why would it be relevant to include isometric contractions in some of the sessions?
   c Which fibre characteristics would you be attempting to develop or improve in fast-twitch fibres to bring about improvements? Clearly outline how these improvements would lead to improved weightlifting performances.
   d You are sometimes confronted by situations where muscles 'spasm' and seem to be constantly contracting. Clearly outline the neuromuscular conditions when this would occur.

8 For each of the following joints, state which muscles are used for the movements indicated in brackets:
   a ankle (dorsiflexion and inversion)
   b shoulder (extension and circumduction)
   c elbow (flexion and extension)
   d hip (adduction and flexion).

9 What movements occur at the:
   a shoulder and elbow during a freestyle stroke out of the water?
   b hip and knee during a soccer free kick?
   c shoulder, elbow and wrist during an overarm volleyball serve?

CHAPTER 3

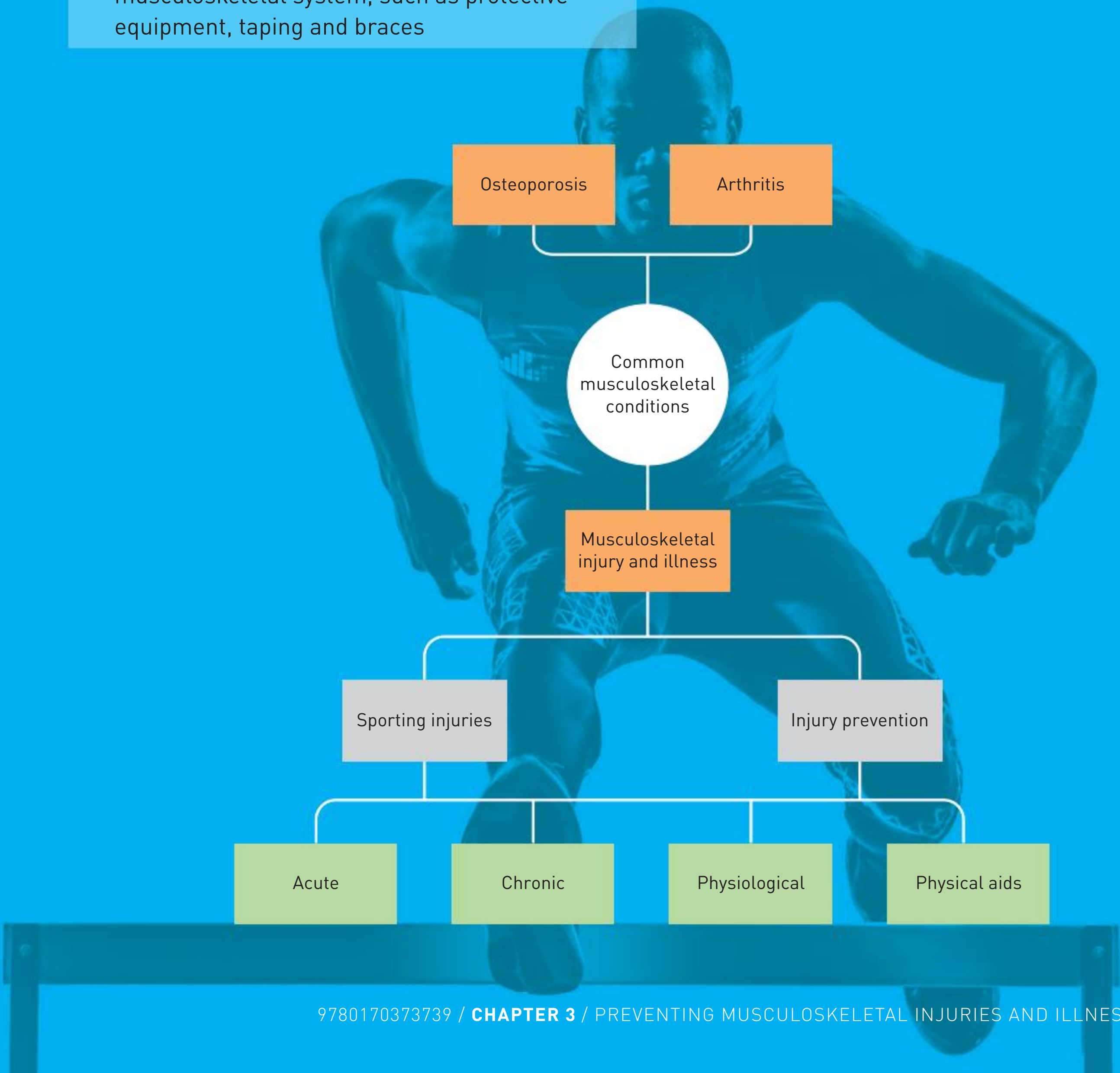
PREVENTING MUSCULOSKELETAL INJURIES AND ILLNESSES

Key knowledge

- causes of potential acute and chronic injuries and illness associated with the muscular and skeletal systems, such as arthritis, osteoporosis and other musculoskeletal conditions
- physiological strategies to prevent musculoskeletal injuries, such as physical preparation of athletes, warm-ups and cool-downs
- the role of physical aids that support the musculoskeletal system, such as protective equipment, taping and braces

Key skills

- examine a variety of causes of musculoskeletal injuries
- describe and implement the correct application of techniques and physiological strategies in a variety of sporting activities to maintain optimal functioning of the musculoskeletal system



iStock.com/OSTILL

This chapter will initially focus on injury prevention and rehabilitation techniques in sport and physical activity before exploring some common musculoskeletal illnesses such as arthritis and osteoporosis.

Australia, like most Western countries, is being confronted with an ever-increasing rate of obesity and an associated increase in lifestyle diseases related to decreased activity, such as atherosclerosis, heart disease, stroke and type 2 diabetes. This is placing an overwhelming strain on our public healthcare system. Maintaining an acceptable level of physical activity has been clearly linked to a reduction in several risk factors associated with these lifestyle diseases, as well as helping to improve quality of life. These concepts will be explored further in chapter 13.

One approach to combating lifestyle inactivity has been to encourage increased participation in both sport and recreational pursuits. There have been numerous campaigns, strategies and policies implemented at all levels of government to support this strategy. This is an appropriate reaction to the alarming increase in lifestyle diseases. However, care also needs to be exercised to minimise the risk of injury (particularly serious injury) from sport and physical activity. According to a Victorian government sports injury prevention taskforce, 'Sports-related injury is a major component of accidental injury in Victoria. It is second only to road traffic injuries in terms of years lost to disability and direct hospital costs. For children under 15 years, sports-related injuries now represent four times the public health burden when compared to road trauma related costs.' Minimising the risk of injury will reduce the strain on the public healthcare system, and – perhaps more importantly – allow participants to benefit from a lifetime of enjoyment of their sporting pursuits.

Increasing participation in physical activity and sport across all segments of the population is a key policy objective of governments. However, participation in physical activity and sport will always carry a risk of acquiring activity-related injuries.

The immediate and long-term 'cost' of sports-related injuries results from:

» healthcare costs for treatment
» health system costs for insurance
» time and productivity lost to employment, school and home activities
» time lost to future sporting activities
» the cost of long-term physical, psychological or emotional damage
» equipment and program costs for rehabilitation and prevention.

However, the immediate and long-term 'cost' of inactivity, or insufficient physical activity to stimulate health benefits, also has an impact on individuals as well as on population-wide health and wellbeing.

SPORTS INJURY CLASSIFICATION

A simple, but effective, method of classifying sports injuries is based on how the injury occurred. **Acute** injuries occur suddenly and usually without warning – for example, a hamstring strain. **Chronic** injuries are usually associated with overuse of a particular area of the body over a period of time – 'shin splints' are an example.

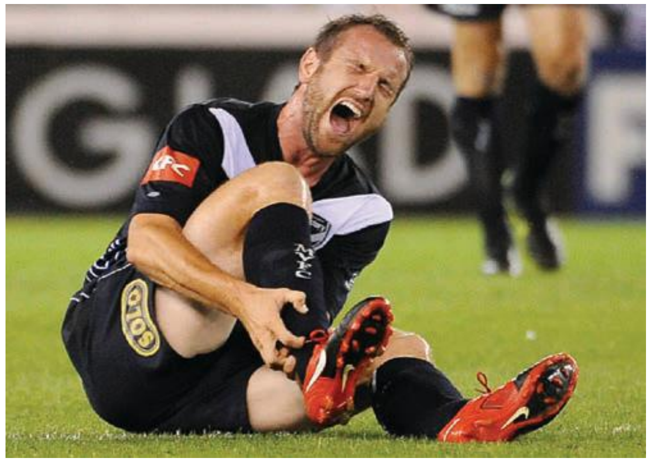
Acute injuries can be further classified as either direct or indirect injuries.

Acute direct injuries

Direct injuries are the result of an external force and can be caused by:

» a collision with another person, either intentional or unintentional, such as being tackled or simply running into another person on a sporting field
» a direct blow from an implement such as a hockey stick, or being struck by a projectile such as a cricket ball.

Getty Images / Marianna Massey



Newspix / George Salpigtidis

Direct injuries

These injuries may cause minor damage such as a bruise (haematoma), or major damage such as a broken bone.

Acute indirect injuries

Indirect injuries are usually caused by a sudden change in either direction or intensity, where the force required is greater than the **load** the muscle or ligament can sustain.

Ligaments are damaged when joints move further than the ideal physiological range (i.e. hyperextensions, subluxation, dislocation) or in a direction that is not the proper movement, such as a knee moving sideways.

When this damage occurs to a ligament, it is known as a sprain, and can be classified as either a grade 1, 2 or 3 sprain:

- A grade 1 sprain is defined as mild damage to a ligament.
- A grade 2 sprain is considered a partial tear of the ligament.
- A grade 3 sprain is a complete tear of the ligament.

Muscles are usually injured under eccentric loading or plyometric movements, as almost twice the force goes through a lengthening muscle as is used in a shortening concentric contraction. Eccentric contractions usually control movement, working against gravity or slowing down concentric movements.

Damage to a muscle, known as a strain, can also be classified according to severity:

- A grade 1 strain comprises damage to less than 5 per cent of muscle fibres.
- A grade 2 strain involves more extensive damage than a grade 1 strain, but the muscle is not completely ruptured.
- A grade 3 strain is a complete rupture of the muscle.

Indirect injuries can also be caused by simply losing balance and tripping over, resulting in minimal injury such as a bruise or major trauma such as a broken bone or loss of consciousness.

The immediate application of first aid to a sprained ligament or strained muscle can help to reduce recovery time. This should involve the cessation of the activity, followed by 'RICER'.

Getty Images / Mark Dadswell

A strained muscle; the result of an indirect injury

Weblink

QUICKVID

Take a look at a short video by St John Ambulance on treating sprains and strains, if you are unsure of the procedure. You can link via http://vcepe12.nelsonnet.com.au.

INVESTIGATION

Investigate an acute strain injury, sustained during a sport of your choice. In your report include:

- a diagram and/or photo of the injury
- examples of elite sportspeople who have had the injury
- early warning signs of the injury
- possible cause(s) of the injury
- suggested strategies to treat the effects of injury, including surgery
- likely time frame before returning to sport
- suggested rehabilitation/recovery strategies
- an outline of preventative measures to avoid, or minimise, likely occurrence of the injury.

Overuse injuries

Overuse injuries result from the continual performance of some type of movement. They include shin splints from running and elbow tendonitis from tennis. A variety of factors can lead to overuse injuries, including:

» the repetitive nature of the activity
» insufficient recovery time between training sessions
» inappropriate increase in training load
» inadequate footwear
» inappropriate training surface.

If early warning signs (usually pain) of an overuse injury are ignored, more serious injuries, such as stress fractures, may result.

Dr P Marazzi/Science Photo Library

This X-ray shows a stress fracture of the second metatarsal bone (circled). This type of sport injury is common in runners, ballet dancers and gymnasts.

INVESTIGATION

Investigate an overuse injury such as shin splints or osteitis pubis. In your report include:

- a diagram and/or photo of the injury
- examples of elite sportspeople who have had the injury
- early warning signs of the injury
- possible cause(s) of the injury
- suggested strategies to treat the effects of injury, including surgery
- likely time frame before returning to sport
- suggested rehabilitation/recovery strategies
- an outline of preventative measures to avoid, or minimise, likely occurrence of the injury.

SPORTS INJURY PREVALENCE

Collecting accurate statistical data about sports injuries is extremely difficult. An individual may slightly strain a muscle during a training session without this statistic being recorded. This is just one example of the difficulty in obtaining accurate information on sports injuries. Data is often cited from hospital statistics, yet the majority of sports injuries are never treated in a hospital.

In a study by Mitchell, Finch & Boufous (2010) more than 2000 sports participants in New South Wales completed a survey on sports injuries. Of those surveyed, 31 per cent had sustained some form of sports injury within a 12-month period. The two most common treatment methods were self-treatment (34 per cent) and physiotherapy (25 per cent).

CHAPTER CHECK-UP

1 What is meant by the term 'lifestyle disease'?
2 List three examples of lifestyle diseases.
3 Most athletes perform a warm-up before competing. Briefly discuss how this improves oxygen uptake when they start their activity and decreases oxygen deficits.
4 For a sport of your choice, list three possible:
   a direct injuries
   b indirect injuries.
5 Explain what happens within the body when a haematoma injury occurs.
6 Visit the Sports Medicine Australia (SMA) Injury Fact Sheets page (link via http://vcepe12.nelsonnet.com.au). Prepare a written report on one of the injuries listed.

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REAL WORLD APPLICATION

Sports Medicine Australia

Sports Medicine Australia is Australia's peak national umbrella body for the prevention of lifestyle diseases through sports medicine and sports science and injury prevention. Sports Medicine Australia is widely acknowledged internationally as the world's leading multi-disciplinary sports medicine body.

Sports Medicine Australia, through its individual and organisational members, is Australia's peak advisory body on all medical and health issues for active people at all stages of life, with a focus on prevention of chronic lifestyle diseases. The safe participation of Australians in sport and healthy physical activity to prevent obesity and lifestyle diseases associated with inactivity is the primary concern for all involved with Sports Medicine Australia.

Sports Medicine Australia can provide expert information, advice and commentary on a diverse range of issues. These range from government policy and funding for programs and activities which lead to the prevention of chronic diseases, sports medicine and community activity through to sports health, health promotion, gender equity, participation of the aged in sport, safe sport for children and drugs in sport problems.

Sports Medicine Australia plays an active role in educating professionals and community members about safe participation in sport, recreation and physical activity to create healthier outcomes to help control and combat preventable chronic disease.

Sports Medicine Australia draws together all sports medicine and sports science and population health professionals. These groups include:

- orthopedic surgeons
- physicians
- doctors
- physiotherapists
- population health specialists
- exercise physiologists
- dietitians
- academics
- sports scientists
- optometrists
- dentists
- podiatrists
- psychologists
- nurses
- teachers
- chiropractors.

At a community level, Sports Medicine Australia is responsible for creating a safe playing field in which all Australians can actively and freely participate, encouraging recreational and physical activity for the associated benefits of reducing preventable lifestyle diseases and educating community members about healthy lifestyle choices. The delivery of the Safer Sport message throughout Australia is achieved through the development and design of courses and educational resources for coaches, trainers, teachers and participants.

Sports Medicine Australia works to advance the health and activity of all Australians, and to support the continued professional development of persons interested in sports science, sports medicine and healthy activity.

Source: Sports Medicine Australia, http://sma.org.au/about-us/about-us/

Questions

Weblink

Visit the Sports Medicine Australia (SMA) website.

1 Briefly outline the philosophy of SMA.

2 SMA has a range of programs for the community that promote physical activity through safe participation, e.g. Smartplay, Oz on the Move, Sports Injury Tracker, CleanEdge. Prepare a report outlining some of the information available about one of these programs.

3 SMA also has a range of policies relating to hot weather, infectious diseases, active children, active women, active older people, asthma management, concussion and dental injuries. Prepare an oral presentation (3–5 minutes) on one of these policies.

PHYSIOLOGICAL STRATEGIES TO PREVENT MUSCULOSKELETAL INJURIES

This section will look at the role of physiological strategies in preventing musculoskeletal injuries. It will discuss the importance of properly warming up, some important training methods in preventing musculoskeletal injuries, and the cool-down. But first, it is important to consider the relevance of pre-activity screening and the role it may play in minimising the risk of injury.

Pre-activity screening

The purpose of pre-activity screening is to minimise the risk of injury resulting from physical activity. Pre-activity screening is highly recommended for older adults and those with health concerns. In reality, anyone who is involved in, or intends to commence, any kind of physical activity should complete some form of pre-activity screening every 12 months. This may be part of a coach's duty of care.

A common pre-activity screening is a Physical Activity Readiness Questionnaire (**PAR-Q**) for participants between the ages of 15 and 69 (see below). However, some conditions affect people younger than this age group; for example, Osgood-Schlatter disease of the knee. A reduced training volume is recommended for those with this condition. Without pre-activity screening this information would not be made available to the coach.

Regular physical activity is fun and healthy, and being more active is very safe for most people. However, some people should check with their doctor before undertaking regular physical activity.

If you are planning to increase your physical activity, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age and you are not used to being regularly active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly.

Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

Physical Activity Readiness Questionnaire (PAR-Q)

Source: Canadian Society for Exercise Physiology, 2002

While not an exhaustive list, the pre-activity screening should provide information on:

» current health issues such as asthma and diabetes
» musculoskeletal conditions such as Osgood-Schlatter disease
» previous injuries that may impact on participation in some activities, such as a knee reconstruction
» information on current intake of any prescription medication
» family and personal medical history. (In some circumstances it may be more appropriate to obtain a separate medical history.)

If respondents to pre-activity screening such as the PAR-Q answered 'no' to all questions, and are not over the age of 69, a medical practitioner is not required to complete an evaluation of the participant.

There may be circumstances where a medical practitioner is required to complete pre-activity screening in order to clear a participant for a particular type of sporting activity. For example, in Victoria, the Professional Boxing and Combat Sports Board requires that participants have a medical clearance before they can register to compete.

Warm-up

A proper warm-up enables the performer to prepare both physiologically and psychologically for the main work to follow. From a psychological perspective, it enables the performer to focus on, and mentally prepare for, the upcoming work. It also enables the performer to increase their arousal.

A suitable warm-up usually lasts about 8 to 10 minutes and is characterised by an increase in core body temperature of 1 degree Celsius, or a slight sweat. The warm-up will commence with some light aerobic activity (for example, slow jogging) before gradually increasing in intensity. After 4 to 5 minutes of light aerobic activity, the warm-up should become more specific, as follows:

» If anaerobic type activities (such as speed work) are to follow, it would be appropriate to incorporate some stride-throughs.
» If weight training is to follow, the intended exercises should be performed with a significantly lighter load for the first two **sets**.
» If aerobic training is to follow, the performer could to start to increase the intensity (after producing a slight sweat) until the required level is reached.

Below is an example of a general warm-up for a team-based running sport such as netball, hockey, soccer or Australian Rules football. For other activities such as cycling and swimming, the above suggestions could be modified to suit the intended activity.

- » 4 – 5 minute jog
- » 6 strides of 50 metres:
  - 2 @ 60%
  - 1 @ 70%
  - 1 @ 80%
  - 1 @ 90%
  - 1 @ 95%
- » 2 × triggers
- » Dynamic stretching if required
- » No static stretching

There has been much debate about whether stretching should be included in a warm-up. There is no evidence to support the inclusion of static stretching, other than for the few sports that require participants to hold a static stretch as part of their performance. Static stretching may, in fact, be counterproductive. While the individual is performing static stretching (usually sitting down), the acute responses they have initiated in the warm-up (such as increased cardiac output and minute ventilation) will start to reverse.

Depending on the activity, it may be appropriate to incorporate some dynamic stretching specific to the activity about to follow. Dynamic stretching involves moving a joint through its range of motion with controlled momentum. This is ideal as part of a warm-up, and should mimic some of the movements about to be performed. A classic example of this is a footballer gently kicking his legs up to simulate kicking a football, or a swimmer rotating her arms at the shoulders to loosen up her upper body. Care needs to be taken to ensure that dynamic stretching does not turn into ballistic stretching, which involves the same movements as dynamic stretching performed with much greater force. This can be dangerous for most performers, as the increased momentum may lead to muscle strain. Ballistic stretching is appropriate only in very limited circumstances, such as ballet dancing, where the performers have spent years preparing their bodies for these types of movements.

Physical preparation

All training sessions will involve a conditioning component that may incorporate a variety of training methods such as continuous or interval training, resistance training, Pilates and core strength work. There is overwhelming evidence of the health benefits of being involved in physical activity. However, before looking at these training methods in more detail, it is important to consider the role of periodisation in any training program.

Periodisation is simply the structured planning of a training program. It ensures that progression is planned to avoid placing undue stress on the body. It also ensures that appropriate recovery is built into any training program to avoid the possibility of overtraining, which will dramatically increase the risk of injury. These concepts are explored in much greater detail in physical education Units 3 & 4. It is worth noting that any increase in the workload of a training program, known as overload, is carefully planned. Having easier weeks/training sessions every four to six weeks, known as unloading, is also critical in avoiding injury. It is important that training diaries are kept to record the details of training sessions as a point of reference for future planning.

Training methods to reduce the likelihood of musculoskeletal injuries include:

» strength training
» core training
» flexibility training.

Strength training

Strength training refers to a training method where a load is applied to a muscle or group of muscles. Generally this is achieved through weight training, either via free weights such as barbells and dumbbells or via machine-loaded resistance. Strength training can also simply involve a person's own body weight, or the use of resistance bands.

Strength training is very effective for injury prevention as improvements in muscle and tendon strength help hold the body in proper alignment, particularly when moving or dealing with contact. Bone development is also enhanced through strength training.

Sport-specific training can also overdevelop specific muscle groups, causing an imbalance between groups. A carefully structured strength program can help overcome these imbalances, reducing the likelihood of injury.

Weight training

There are many weight-training programs and exercises. Some of these may actually increase the risk of injury. While research continues into the best sequencing, number of sets and **repetitions**, it is widely agreed that a properly constructed and individualised weight-training program will enhance sporting performance and help prevent injury.

iStock.com / RapidEye

When training with free weights, partners often spot for each other.

Core training

Core strength is important in preventing injury. It can contribute to:
» improved running efficiency
» decreased risk of injury, particularly of the lower back
» improved transfer of power between the lower and upper body extremities, and vice versa (for example, a tennis serve will transfer power from the legs to the arms)
» improved balance.

TABLE 3.1 Weight-training terminology

Term	Meaning	Term	Meaning
Repetitions (reps)	The number of times a weight will be lifted in a sequence	Set	A group of repetitions performed without a rest
Load	The amount of weight to be lifted	**Velocity**	The speed at which the weight is lifted
1RM	The maximum weight that can be lifted in one maximal exertion	**Novice** or beginner	Person with less than 6 months' consistent weight-training experience
Multi-joint	Where two or more joints are involved, such as a squat	**Single-joint**	Where only one joint is involved, such as a biceps curl, which only uses the elbow joint
Isokinetic	The speed of the contraction is controlled	Isotonic	Concentric and eccentric phase
Isometric	A static contraction		

PRACTICAL ACTIVITY

DESIGNING A TRAINING SESSION

1 Resistance training:
- Design a resistance-training session aimed at developing whole body strength with the facilities you have available at your school. (There are plenty of websites aimed at developing strength.)
- Don't forget to include both a warm-up and a cool-down
- Participate in this training session either individually or as a class.

2 Core training:
- Design a core training program that could also be completed at home
- Participate in this training session either individually or as a class.

FYI

Delayed onset muscle soreness (DOMS) is a normal response to unaccustomed exercise or heavy eccentric work. It is normally felt 24–48 hours after exercise. Of course, if pain persists, you should seek medical advice.

Flexibility training

Improved flexibility will:
» improve sporting performance by enhancing speed, strength and power
» reduce the likelihood of injury, particularly for performers who need a full range of motion
» reduce the impact of delayed onset muscle soreness (DOMS).

Flexibility training should always be done after you have warmed up. The cool-down phase is a good time to use a flexibility program. However, flexibility training can also be done by itself.

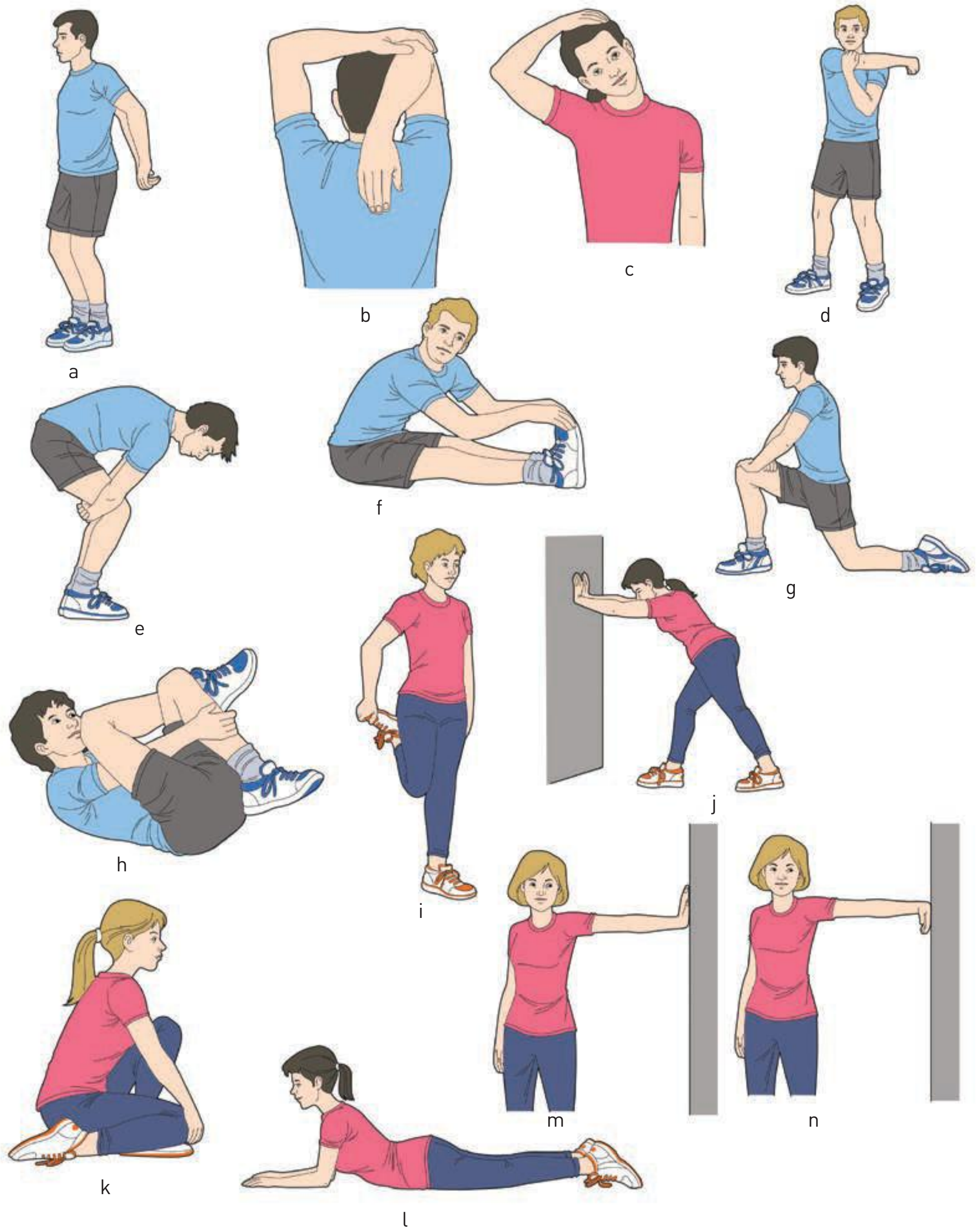
Cool-down

For most sports, the best cool-down repeats the actions of the sport, but at a reduced intensity. This is active recovery. Active recovery helps a player return to pre-exercise levels.

A cool-down also helps reduce the effects of DOMS. This is the best time to perform stretching exercises, as the body is warm and will benefit from some flexibility exercises.

Static stretching

Static stretching occurs when a person stretches to a position and holds it for 10 seconds or more. An example of this is the seated hamstring stretch. There has been considerable research into static stretching; evidence suggests that it should not be performed during a warm-up preceding other activities as it may increase the risk of injury. This type of stretching is appropriate at the end of a training session or as an independent training method performed in isolation.



Stretches for all the major muscle groups: (a) pectorals, deltoids, biceps, (b) latissimus dorsi, triceps, (c) trapezius, (d) rear deltoid, upper back, (e) spine extensors, (f) lower back, hamstrings, (g) hip flexors, (h) gluteals, (i) quadriceps, (j) calves, (k) shins, (l) abdominals, (m) wrist flexors, (n) wrist extensors

WHAT CAN GO WRONG IN TRAINING AND RECOVERY?

Inadequate pre-participation screening

Inadequate pre-participation screening and fitness assessments could result in trainers being unaware of medical conditions or an individual's physical limitations. (See PAR-Q, on page 57, which is used for screening pre-participation.) Individuals commencing training may have a low level of physical conditioning, and may also have a low skill level. The entry point for the individual, along with assessment of their existing fitness level, must be factored in when designing a suitable training program, and sufficient provision should be made for recovery, to avoid training loads being set too high for the participant's skill and fitness level.

Coaching conduct and practices

Some coaches may conduct themselves in an unprofessional manner, providing advice and implementing programs that are beyond their knowledge and qualification base. A coach whose qualifications and accreditation are not current could include unsuitable activities in training programs, such as the 'hurdler' stretch. If an injury occurs, unsafe coaching practices and unqualified people developing training programs or administering first aid, as well as poor immediate management procedures, could result in an injury becoming more serious.

Program design

Overtraining, sprains, strains and particularly back injuries can result from poorly designed training programs. Flaws in program design can include inappropriate application of training principles and inappropriate choices of training methods. Activities set up by coaches that are not in accordance with safety guidelines could also present a problem.

Activities and equipment

When designing a training program, careful consideration must be given to the participant's age, size, body shape, sex, skill level and level of psychological and physical maturity. If a program is not tailored to individual participants' capacities, needs and physical profiles, injury is more likely. Failing to develop skill levels or adequate core stability before competing could also result in injury or illness. Appropriate education about suitable warm-up, cool-down and stretching activities may not be provided to the participant, or they might be aware of appropriate strategies but choose not to undertake them when training.

Equipment can contribute to injury in training and recovery if:

» it is used incorrectly
» it is not cared for or maintained properly
» it is not used for the purposes for which it was designed
» safety dress codes are not observed during training and competition
» inspections of facilities and equipment are not regularly and routinely undertaken
» uneven and poorly maintained playing surfaces are not repaired.

Insufficient recovery

Training or competing without adequate recovery may expose an athlete to a greater risk of injury. It is during the recovery process that many important physiological responses occur. This enables a performer to approach the next competition or training session in a better physiological state.

Performing a functional assessment for a safe return to physical activity after rehabilitation is also important in reducing the risk of further injury.

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A physiotherapist can assess whether returning to activity is safe.

Environmental conditions

Conducting training and competition during inclement weather without regard for the accepted guidelines, and thereby failing to implement prevention and treatment of environmental stress factors, could also result in injury or illness. Examples of inappropriate environmental conditions include storms, lightning, extreme heat, extreme cold or peak ultraviolet times. Training in poor environmental conditions, failing to provide adequate rest periods, fluid or shade, and lack of protection during training could also contribute to injury and illness.

CHAPTER CHECK-UP

1 Why is pre-activity screening so important?
2 Outline two benefits of weight training.
3 Outline two benefits of core strength training.
4 Explain the importance of performing a warm-up.
5 What type of stretching should be performed during a warm-up? Justify your answer.

PHYSICAL AIDS THAT SUPPORT THE MUSCULOSKELETAL SYSTEM

This section will explore the role of protective equipment, taping and braces in helping to minimise musculoskeletal injuries.

Protective equipment

Sport-specific protective equipment has been designed to help reduce, or prevent, musculoskeletal injuries. Some sporting organisations have made specific sporting equipment compulsory, such as a catcher's helmet in softball, while in other organisations the use of protective equipment is optional, such as mouthguards in Australian Rules football.

Getty Images / Brett Hemmings

Getty Images / Koji Watanabe

Getty Images / Dean Mouhtaropoulos

Examples of protective sporting equipment range from the extensive protection worn by catchers in baseball and goalkeepers in hockey to a soccer player's shin pads.

TABLE 3.2 Common sporting protective equipment

Protective equipment	Purpose
Mouthguards	Reduce cuts to the lips, mouth and tongue. Also help to protect teeth. Used in sports with a risk of head contact.
Helmets	Help to protect the brain from injury during impact. Also help protect the head from cuts in contact sports such as rugby.
Guards	Absorb impact, reducing the direct impact on a body part, such as knee pads worn when skateboarding
Appropriate footwear	Provides some protection from impact, as well as support for the foot and ankle
Eyewear	Reduces the impact of fast-moving objects such as a squash ball
Shin pads	Help to reduce injuries acquired in sports where there are fast-moving objects, such as hockey, and to protect against direct contact to the shin in sports such as soccer
Shoulder padding and body protectors	In heavy tackling sports such as rugby union and league, shoulder padding can help protect the top of the shoulder. Padded body protectors can help reduce the impact of fast-moving objects in sports such as cricket.

Taping and bracing

The main function of taping and bracing is to:

» provide joint stability during physical activity. The tape serves to restrict the amount of movement in a particular joint, commonly the ankle joint. This helps prevent ligament sprains. It is particularly beneficial in recovery from ligament sprains, as the tape can help strengthen the joint.

» provide stability for joints involved in landing, such as ankle taping for netball

» provide kinaesthetic feedback to the brain

» give individuals confidence that they are less likely to injure a joint, which is particularly important for those with a history of joint problems.

Alamy Stock Photo / fStop Images GmbH

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Taping and bracing serve a number of different purposes.

There are a variety of different taping methods used for different joints. To date, there is little scientific evidence of which is the 'best' method, though several websites make recommendations. You can find many reputable examples of taping on YouTube.

PRACTICAL ACTIVITY

TAPING

Visit a reputable website to investigate taping techniques. Following the instructions on the website, attempt to tape a joint. You can link to the Elastoplast website via http://vcepe12.nelsonnet.com.au.

Weblink

Bracing can offer greater joint stability, as the support provided by taping diminishes throughout the activity. Braces are also reusable. They are more commonly worn to support either the knee or ankle.

Shutterstock.com / Poznyakov

Ankle braces provide greater stability than taping

CHAPTER CHECK-UP

1 Outline two functions of taping.
2 Explain the difference between taping and bracing.
3 Provide two reasons why someone may choose to wear, or not to wear, optional protective equipment such as a mouthguard.

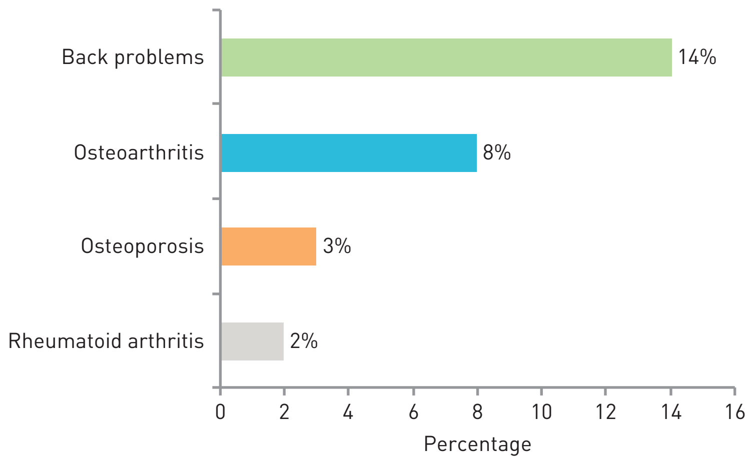
COMMON MUSCULOSKELETAL CONDITIONS

Musculoskeletal conditions are disorders of the bones, muscles and their attachments. They are the most common chronic conditions in Australia.

Common musculoskeletal conditions include:

» osteoporosis
» osteoarthritis
» rheumatoid arthritis
» back pain and other back problems.

According to Australia's national agency for health and welfare statistics and information (AIHW), 28 per cent of Australians (more than 6 million people) have arthritis and other musculoskeletal conditions.



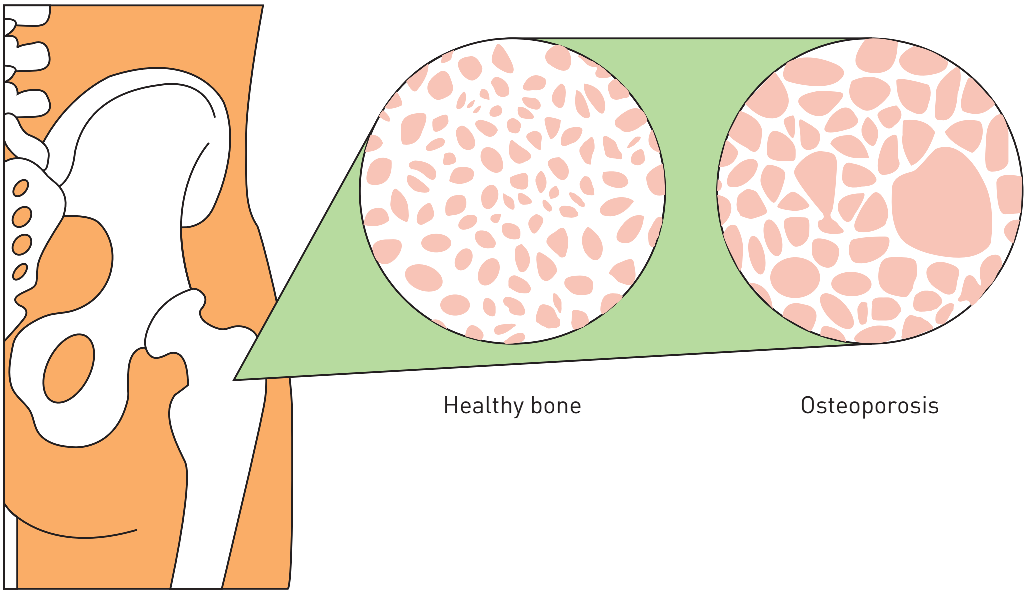
The most common musculoskeletal conditions affecting Australians

Source: Australian Institute of Health and Welfare. Licensed under CC BY 3.0 AU.

Osteoporosis

Osteoporosis is a disease that affects more than 1 million Australians. Osteoporosis literally means 'bone with holes', and it occurs when bones lose minerals such as calcium at a faster rate than they can be absorbed. As a result, the bones become less dense, losing strength and becoming more susceptible to breaks. Osteoporosis has no visible warning signs, and for sufferers of this disease the risk of future fractures increases with each new fracture.

Bone is made mostly of the protein collagen, as well as calcium and minerals that add strength to the bone. It is living tissue, so it is constantly being broken down and renewed. By about the age of 25 to 30, most people have usually achieved peak bone mass. Women are at an increased risk of osteoporosis after menopause, as drops in oestrogen levels reduce the uptake of calcium in bone formation.



The difference between healthy bone, and bone affected by osteoporosis

Source: Australian Institute of Health and Welfare. Licensed under CC BY 3.0 AU.

QUICKVID

Watch this seven-minute animation to gain a more detailed understanding of bone formation. You can link via http://vcepe12.nelsonnet.com.au.

Weblink

Science Photo Library / Dr P Marazzi

DEXA scanning machine, used to measure bone density.

Diagnosis of osteoporosis

Osteoporosis can be diagnosed by measuring a person's bone mineral density. The 'gold standard' for this measurement is the technique known as dual-energy X-ray absorptiometry (DEXA). Results are compared to normative data.

Prevention of osteoporosis

Steps can be taken from an early age to prevent osteoporosis, including:

» ensuring an adequate intake of dietary calcium
» engaging in regular weight-bearing and strength-training activities. These encourage increased bone remodelling (see Table 3.3).
» ensuring sufficient vitamin D absorption, which assists in bone calcium uptake
» avoiding smoking.

TABLE 3.3 Bone building (osteogenic) capacity of selected exercises

Highly osteogenic	Moderately osteogenic	Low osteogenic	Non-osteogenic
Basketball Netball Aerobics Gymnastics	Running Jogging Resistance training Brisk walking	Leisure walking Lawn bowls Yoga Pilates	Swimming* Cycling*

*Swimming and cycling have other health-related benefits, but not osteogenic benefits.

Adapted from Osteoporosis Australia

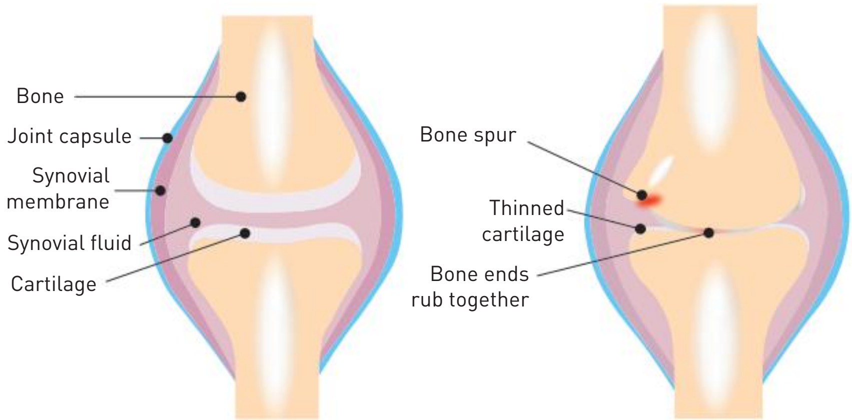
Arthritis

Arthritis is a disorder that involves inflammation in one or more joints. There are more than 100 different types of arthritis. Problems associated with arthritis include pain, stiffness and inflammation. Joint weakness may also be a symptom, limiting everyday basic tasks such as walking or driving. Arthritis is reported to be the major cause of disability and chronic pain in Australia, affecting nearly 4 million people.

The most common type of arthritis is osteoarthritis, a degenerative joint disease often caused by either trauma to, or infection of, one or more specific joints. Rheumatoid arthritis is another common form of arthritis, in which the body's own immune system begins to attack body tissues.

Osteoarthritis

Cartilage is the smooth white tissue that covers the ends of bones, making it easier for them to slide over each other at joints with very little friction. In osteoarthritis this healthy cartilage starts to break down and wear away, allowing bones to rub together, causing swelling, reduced movement and pain. Initially pain is felt when undertaking activity that utilises the affected joint, but as the condition worsens pain may be felt even during rest. Typically, affected joints will become enlarged and tender, making it difficult to perform tasks involving the affected joint.



A normal joint (left) and a joint with osteoarthritis (right)

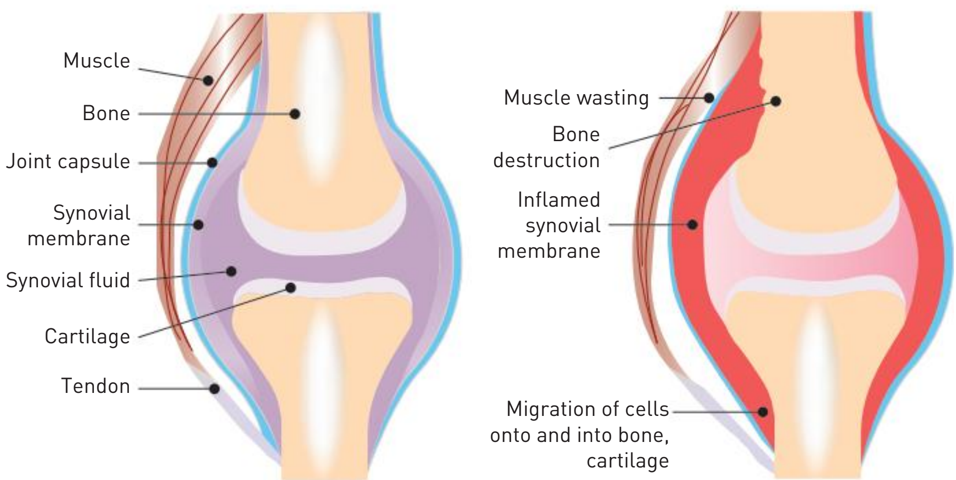
Factors that contribute to the onset and development of osteoarthritis include:

» joint injury or trauma (i.e. a dislocation or fracture)
» excess weight
» repetitive joint-loading tasks
» sedentary lifestyle.

Rheumatoid arthritis

Rheumatoid arthritis is a chronic disease causing inflammation of the joints, particularly the hands. It is classified as an autoimmune disease, but the causes of rheumatoid arthritis are not yet fully understood.

Normally our immune system functions to fight off infections. An autoimmune disease occurs when the immune system starts to attack the body's healthy tissues instead. In rheumatoid arthritis the immune system attacks the synovial membrane (the lining of our joints), causing inflammation, pain and joint damage. In response to the inflammation, the joint then produces excessive synovial (lubricating) fluid, which results in unwanted tissue growth and bone erosion.



A normal joint (left) and a joint with rheumatoid arthritis (right)

INVESTIGATION

BACK PROBLEMS

Back problems affect 14 per cent of Australians, or more than 3 million people. Investigate a back problem and write a report on your findings. In your report include:

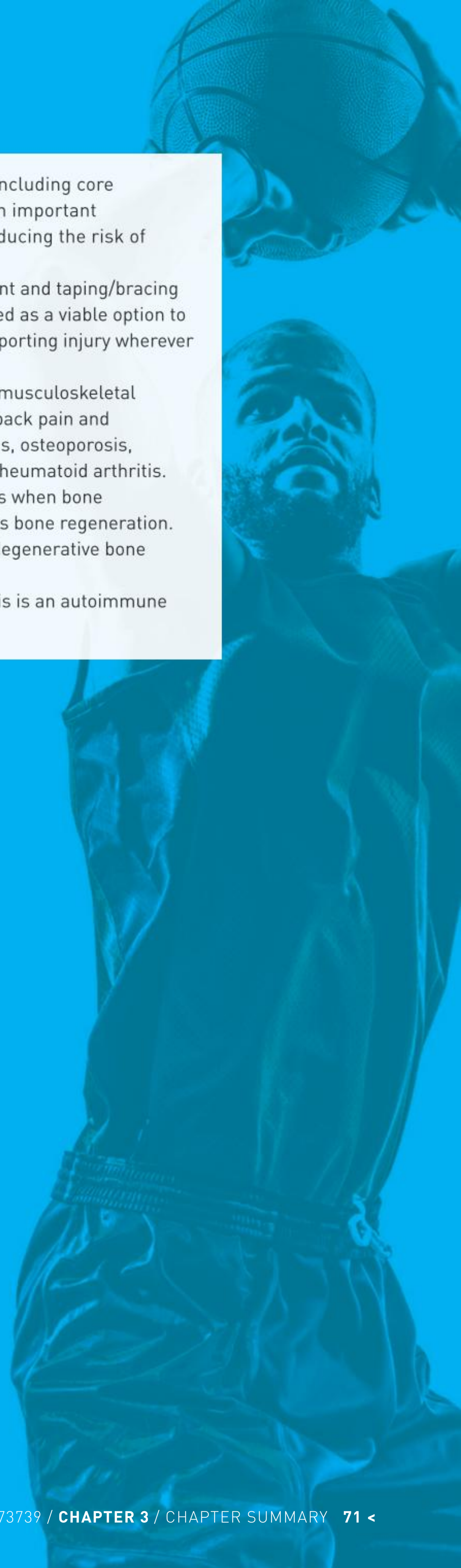
- likely cause of the problem
- early warning signs of the problem
- strategies to alleviate or reduce the problem
- an outline of preventative measures to avoid, or minimise, the likely occurrence of the problem.

CHAPTER CHECK-UP

1 Outline the main components of bone.
2 What is osteoporosis?
3 Explain the cause of osteoarthritis.
4 Explain what an autoimmune disease is.

CHAPTER SUMMARY

- Increased participation in physical activity, which includes sport, is vital to help combat the increase in lifestyle diseases such as heart disease and type 2 diabetes.
- Sports injuries are a major component of accidental injury in Victoria.
- Injuries can be classified as either acute (immediate) or chronic (long-term).
- Sprains occur when ligaments are stretched beyond their range, while a muscle tear is known as a strain.
- To help minimise injuries related to physical activity and sport, pre-screening should occur to ensure the participant is ready to commence the activity.
- Warming up and cooling down, including stretching, can help minimise the risk of sporting injuries.
- Strength training, including core strength work, is an important consideration in reducing the risk of sports injuries.
- Protective equipment and taping/bracing should be considered as a viable option to reduce the risk of sporting injury wherever possible.
- The most common musculoskeletal conditions include back pain and associated problems, osteoporosis, osteoarthritis and rheumatoid arthritis.
- Osteoporosis occurs when bone degradation exceeds bone regeneration.
- Osteoarthritis is a degenerative bone disease.
- Rheumatoid arthritis is an autoimmune disease.



CHAPTER REVIEW

Multiple-choice questions

1 Lifestyle diseases are:
   A diseases associated with what a person eats
   B diseases associated with the way a person chooses to live
   C diseases associated with the amount of physical activity a person is involved in
   D diseases that are mainly genetic.

2 Overuse injuries are caused by:
   A the repetitive nature of the activity
   B insufficient recovery time between training sessions
   C an inappropriate increase in training load
   D all of the above.

3 Identify the correct statement:
   A Bone is made mostly of minerals.
   B Bone is living tissue.
   C Males are more likely to suffer from osteoporosis than females.
   D Vitamin D inhibits bone calcium uptake.

4 Steps that can be taken to avoid osteoporosis include:
   A ensuring an adequate intake of dietary calcium
   B avoiding smoking
   C engaging in regular weight-bearing exercise
   D all of the above.

5 Identify the correct statement:
   A Cartilage makes it difficult for bones to slide over each other.
   B Excess weight can contribute to the onset of osteoarthritis.
   C Rheumatoid arthritis causes inflammation of the joints.
   D There are three types of arthritis.

Short-answer questions

6 What role does vitamin D play in bone formation?

7 There is often concern for astronauts who spend extended periods of time in zero gravity environments. Suggest one reason for this concern.

8 Outline two 'costs' associated with sports injuries.

9 Explain the difference between direct and indirect acute injuries, giving examples to illustrate your answer.

10 a Expand the acronym RICER.
   b Under what circumstances should RICER be applied?

11 Describe a suitable warm-up for a running-based team sport.

12 Outline one problem associated with performing static stretching during a warm-up.

13 Explain the difference between dynamic and ballistic stretching.

14 Present an argument for the inclusion of weight training in the training regime of a recreational sportsperson.

CHAPTER 4

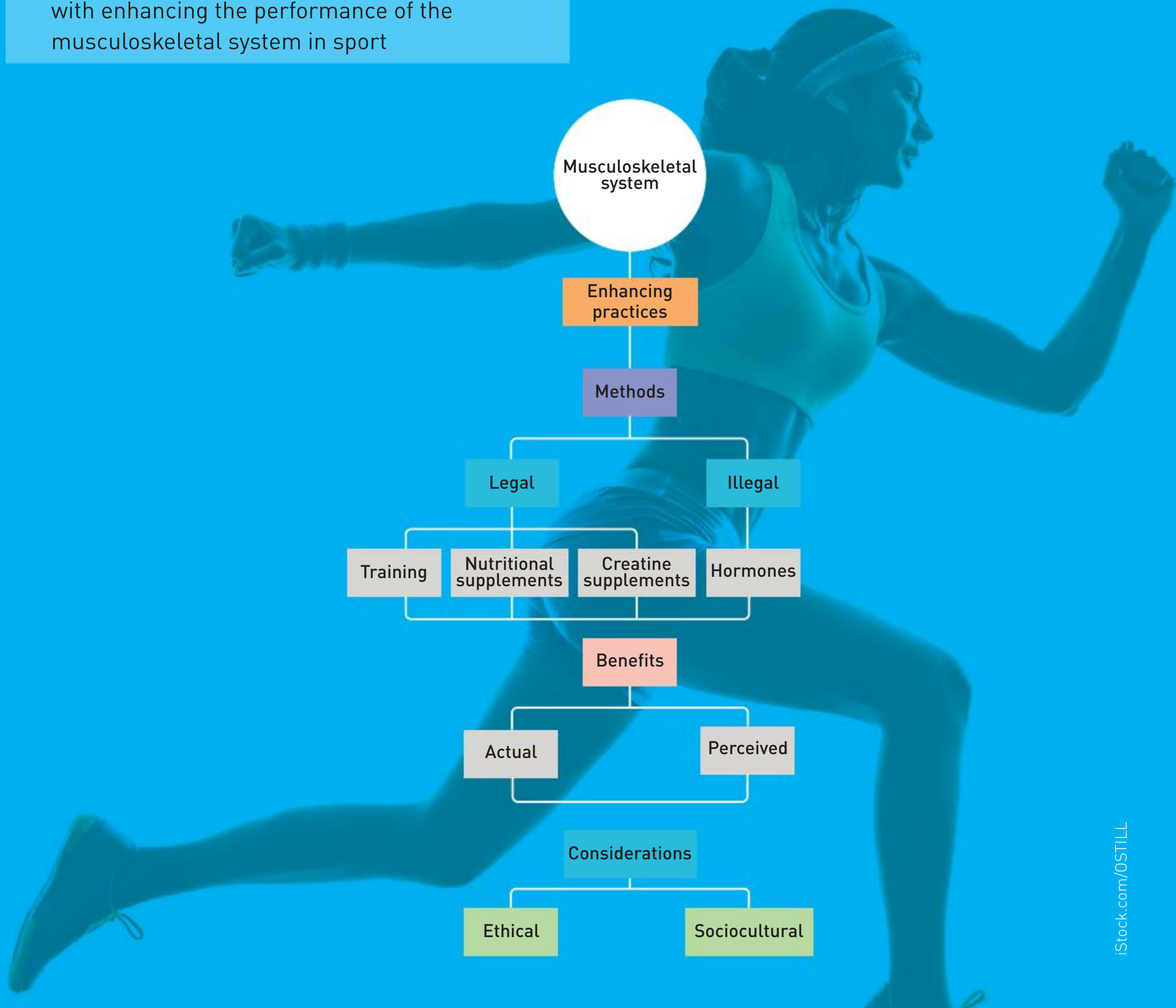
LEGAL AND ILLEGAL METHODS THAT ENHANCE PERFORMANCE OF THE MUSCULOSKELETAL SYSTEM

Key knowledge

- actual and perceived benefits and potential harms of legal and illegal substances and methods that enhance performance of the musculoskeletal system, such as training, nutritional supplements, creatine supplementation and hormones (including steroids and growth hormones)
- the ethical and sociocultural considerations of legal and illegal practices associated with enhancing the performance of the musculoskeletal system in sport

Key skills

- investigate, evaluate and critically analyse a range of performance-enhancing practices from a physiological perspective
- discuss the ethical considerations and sociocultural influence on the use of legal and illegal practices associated with improving the function of the musculoskeletal system



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The musculoskeletal system is the largest system in the body and it has two equally important functions – movement and support. There are seven structures that make up the musculoskeletal system. Four of these structures are sensitive and three are insensitive.

TABLE 4.1 The structures of the musculoskeletal system

Structure	Description
1 Bone	Bone itself is insensitive, but its periosteum and endosteum are highly sensitive.
2 Hyaline cartilage	The most abundant kind of cartilage in the body. It is found at joints over the ends of long bones, allows for flexibility and support, and is insensitive.
3 Fibrocartilage	Found at the symphysis pubis and in the discs between the vertebrae, and is insensitive.
4 Synovial capsule	The bones of a **synovial joint** are surrounded by a synovial capsule that secretes synovial fluid to lubricate and nourish the joint while also acting as a shock absorber; highly sensitive.
5 Muscles	A body tissue that can contract and cause movement; highly insensitive.
6 Ligaments and tendons	A ligament is a tough, fibrous band of tissue that connects two bones to form a joint; it is extremely sensitive. A tendon is fibrous connective tissue and usually attaches to a small area of bone and is sensitive.
7 Bursae	Various movements of the body create friction between moving parts. To reduce the friction, saclike structures called bursae are situated in the body tissues. These are sensitive structures.

LEGAL AND ILLEGAL PERFORMANCE ENHANCERS

Chapter 2 summarised the structure and functions of the musculoskeletal system. This chapter will investigate and evaluate a range of practices, strategies and methods (both legal and illegal) that can be used to enhance the performance of the musculoskeletal system, including its capacity to train, recover and perform. It will also explore the ethical considerations and sociocultural influences of these practices.

Enhancing the performance of the musculoskeletal system means improving the efficiency, endurance and recovery of the muscles. Why do individuals seek to do this? What are they hoping to achieve? The answer will vary according to the goal, motivation and purpose of the individual, as well as the level of sporting competition or physical activity they are involved in.

For example, the practices chosen by someone in their twenties undertaking recreational weight training will vary from the practices chosen by someone in post-operation rehabilitation. An elite sportsperson seeking advice on nutritional supplements, or an elderly person experiencing sarcopenia, will make different choices again. But the end goal is the same for all – to enhance the performance of the musculoskeletal system.

Recent years have seen an increase in workplace incidents involving the musculoskeletal system. While some of the resulting injuries may be associated with lifting or moving heavy objects, many are related to overuse or repetitive movements. This category includes postures that may place abnormal stress on specific areas or parts of the body. Many occupations require us to spend long hours working at computers, which can lead to chronic postural adaptations.

When selecting a performance-enhancing method, there are several questions to be considered:

- Is it safe?
- Is it legal?
- Is it effective?
- Is it necessary?

These questions raise many ethical and sociocultural considerations for the individual. Some methods and practices are legal and ethical, while others are prohibited by the World Anti-Doping Agency (WADA) and the Australian Sports Anti-doping Authority (ASADA) because they are both illegal and unethical.

What is a legal practice that enhances performance?

A legal method or practice is one that enhances performance and does not violate the WADA Code, does not threaten the health or safety of the individual and provides a measurable performance enhancement.

These methods may include anything from good nutrition or a training program to the consumption of nutritional supplements. Legal training methods that enhance the performance of the musculoskeletal system include resistance training, flexibility training, yoga and core training. As is the case with all training, the performance-enhancing practices must be tailored and must be specific to training and competition demands. For example, a practice that may improve the performance of endurance athletes might bring limited benefits to power-based performers.

What is an illegal practice that enhances performance?

An illegal method or practice is one that enhances performance and violates the WADA Code, threatens the health or safety of the individual and provides a measurable performance enhancement.

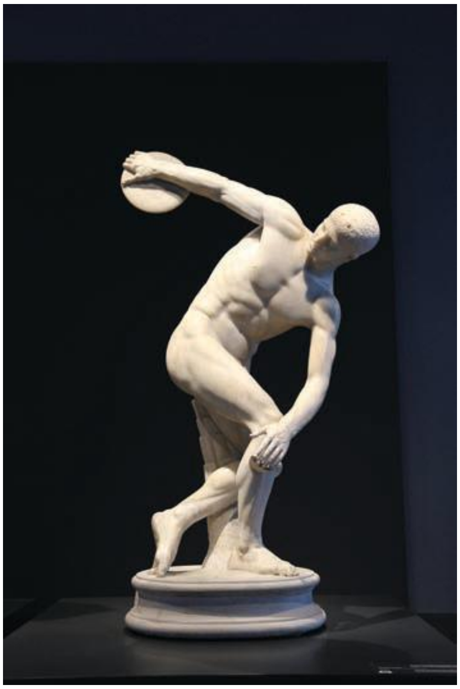
Illegal methods or practices allow an individual to gain an unfair advantage over other competitors. Such practices go against many of society's values, ethics and social norms, and challenge the notion of fairness. In sport, such practices are usually considered as cheating because the notion of a 'level playing field' is removed.

Ethical considerations of illegal methods

Ethical behaviour is generally considered to be behaviour that falls within moral and socially accepted standards. Using an illegal method or substance to improve performance poses moral and ethical questions for all of us, and goes beyond the boundaries of sport.

Sport plays an important role in many cultures around the world. It could be argued that the key benefits of sport are enjoyment, friendship, improved health, development of life skills, social behaviour, enhanced self-esteem, social cohesion, education, participation without discrimination, and the spirit of fair play. The punishment for those athletes found guilty of breaching the spirit of fair play has over time included reprimands, penalties, suspensions and even permanent banishment from the sport, not to mention the resulting social ostracism.

The first evidence of performance-enhancing practices can be traced back to the original Olympic Games in ancient Greece, where it is alleged that plant-based stimulants were used by competitors to increase strength and overcome fatigue. In recent times such practices


Alamy Stock Photo / Lanmas

The use of performance-enhancing substances can be traced back as far as the first Olympic Games in ancient Greece.

have often been linked to – but are not solely restricted to – drug use. When discussing the use of illegal substances to enhance performance, the word 'drugs' invariably comes up. Certain drugs can increase athletic performance, but their use carries the risk of side effects, which may include lifelong morbidity or death.

Another term often used in conjunction with illegal methods is 'doping'. Doping is the use of any kind of drug to improve athletic performance. This is not limited to professional sports. Increasingly, amateur and recreational athletes are also doping, a practice that poses significant sociocultural issues. Medical practitioners and medical teams must keep abreast of banned practices and substances and educate and guide their patients to make responsible and informed decisions.

SOCIOCULTURAL CONSIDERATIONS ASSOCIATED WITH ENHANCING PERFORMANCE

Children grow up in specific physical, social, cultural, economic and historical circumstances (their sociocultural context), all of which influence their childhood. Research has shown that children's sociocultural context can have a significant influence on their development.

This is also the case in the context of sport and physical activity. Our beliefs about what constitute accepted behaviours and practices in sport and physical activity are shaped at an early age. These beliefs can become ingrained, especially if the behaviours are allowed to run unchecked.

This chapter looks at how certain behaviours and practices relating to performance enhancement have become accepted in sporting situations around the world, from a local gymnasium to the world stage. Let's start by taking a closer look at how sociocultural influences can influence behaviours. Consider the following cases.

1 Performance-enhancing methods used at a national team level

Professional sports players and national level athletes can have an enormous influence on the values of individual cultures. In cultures that value sports, professional sportspeople are often hailed as icons.

During the 1970s and early 1980s there were whispers that the performance of some athletes from Eastern Bloc countries was not the result of hard work and training alone. Sporting success on the world stage was culturally very important, and sporting institutes were established specifically to produce champion athletes. At the time, East German swimmers were particularly dominant on the world stage, but with labs continuously reporting negative drug tests, FINA (the international governing body of swimming) did not investigate the possibility that doping was taking place. However, after the fall of the Berlin Wall in 1989, documents of the Ministry of State Security revealed that a systematic doping program was indeed in place – the country's sports officials and coaches had been providing athletes, many of them teenage girls, with steroids. Some East German swimmers have since admitted to having knowingly taken performance-enhancing drugs.

At the 1994 world swimming championships in Rome, expectations of the Chinese swimmers were modest. The Chinese, however, won 19 medals, including 12 gold. Like the East German women before them, China's athletes had deep voices and abnormally broad backs (both symptomatic of steroid use), yet they slipped through the drug-testing process. In the years that followed, though, numerous Chinese swimmers tested positive for drug use, confirming what many had suspected in Rome.

Getty Images / AFP

Chinese swimmer Wu Yanyan waves to the crowd at the awards ceremony after breaking the world record for the women's 200m individual medley 17 October 1997 at the 8th China National Games in Shanghai. This record is considered to be tainted after Wu failed a blood test in 2000, when she tested positive to anabolic steroids. She received a four-year ban.

2 Performance-enhancing drugs in the Tour de France

The use of performance-enhancing drugs (PEDs) in cycling has long been suspected, particularly in the Tour de France. Rumours of alleged doping dogged the most famous cycling race in the world until the 1998 Tour de France, when the French government intervened.

Drug misuse has tainted the Tour for the last 20 years, with some winners remaining under a cloud of suspicion. Some winners have even been stripped of their title for allegedly taking performance-enhancing supplements. In 2012 the US Anti-Doping Agency (USADA) concluded that seven-time Tour winner and national icon Lance Armstrong had used performance-enhancing drugs. In 2013, Armstrong came clean, admitting his actions, after years of staunchly denying accusations of doping. Floyd Landis was stripped of his Tour de France title after drug tests were upheld in September 2007. A urine sample taken after a stage win revealed a higher than allowed level of testosterone. In 2010 he finally admitted that he had used anabolic steroids for most of his professional career.

Getty Images / Bryn Lennon

Floyd Landis of the USA celebrates winning the 93rd Tour de France on 23 July 2006 in Paris, France.

3 The Essendon Football Club supplements controversy

The Essendon Football Club supplements controversy, which played out during the 2012 season, culminated in 2016 when the Court of Arbitration for Sport found 34 past and current players guilty of taking a banned substance and suspended them for the entire 2016 playing season. Questions were raised about duty of care and governance issues, as well as why the players didn't question what they were being given.

ASADA CEO Ben McDevitt said, 'This unfortunate episode has chronicled the most devastating self-inflicted injury by a sporting club in Australian history.' He said there was 'little ground' for the players to claim they were at no significant fault, given their responsibility for all substances that entered their bodies. 'At best, the players did not ask the questions, or the people, they should have. At worst, they were complicit in a culture of secrecy and concealment.'

Fairfax / Rohan Thomson

ASADA CEO Ben McDevitt speaks to media at a press conference on 12 January 2016 following the Court of Arbitration for Sport's announcement of one-year bans for 34 past and present Essendon Bombers players for violating anti-doping rules in 2012.

4 Performance-enhancing practices among young people

In recent times, there has been increasing concern about young people using performance-enhancing drugs, as some turn to the use of banned substances, seeking a competitive edge. These young people see professional athletes using illegal substances or methods, and think that it is an acceptable practice.

Researchers in the United States studied 2800 youths during the 2009–10 school year. The study found that 5 per cent of these students had used anabolic steroids, and approximately 5–10 per cent had used other substances, such as creatine, to build muscle. Meanwhile, approximately 33 per cent of boys and 20 per cent of girls had used protein powders or similar supplements. Approximately 500 000 high-school students in the United States were believed to have used performance-enhancing drugs. The users tended to be athletes in power sports such as football, baseball, weightlifting and gymnastics.

The use of performance-enhancing substances among young people raises questions, not only about fairness and integrity, but also about the effect these substances have on young bodies. Little is known about the long-term effect of anabolic steroids and other performance-enhancing substances on young people.

Young people may use performance-enhancing substances for many reasons. Some use them to become bigger and stronger; others are overwhelmed by the pressure to succeed.

REASONS FOR USING ILLEGAL PERFORMANCE-ENHANCING SUBSTANCES AND METHODS

People turn to illegal performance-enhancing substances and methods for a variety of personal reasons, and in response to a range of sociocultural influences.

Personal reasons

The personal reasons for an individual using illegal performance-enhancing substances and methods may include:

» ongoing dissatisfaction with their own performance or lack of progress
» psychological dependence
» self-pressure and doubt, lack of confidence, nervousness, stress, anxiety or depression
» for relaxation or socialisation
» the belief that such practices won't cause long-term harm
» wanting to keep up with other individuals who are also using illegal practices
» the belief that they will get away with it because of poor testing procedures
» being easily influenced by peers
» meeting the expectations of their coach
» a win-at-all-costs mentality
» personal pride and the need to retain the status of a hero or role model.

Sociocultural influences

Sociocultural influences that lead athletes to use illegal performance enhancers may include:

» drug culture (friends or peers using illegal practices and achieving improved results)
» pressure/expectation of coach, parents, public and media to win
» unreasonable scheduling of events that doesn't allow sufficient recovery time
» product endorsements and the financial rewards offered by sponsors
» the prestige and fame associated with being 'the best'
» the influence of being a role model or having hero status
» the demanding qualifying standards required to make national selection
» societal and cultural customs
» national honour and pride.

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The headquarters of the World Anti-Doping Agency in Montreal, Canada

HOW DO SUBSTANCES BECOME PROHIBITED?

For a substance or method to be prohibited, it must meet two of the following three conditions:

1 The substance or method has the potential to enhance or does enhance performance in sport.
2 The substance or method has the potential to risk the athlete's health.
3 The World Anti-Doping Agency has determined that the substance or method violates the spirit of sport.

The list of prohibited substances is reviewed annually and comes into effect on 1 January each year, with no amnesty period. The prohibited list ensures consistency across all sports that are compliant with the World Anti-Doping Code. This Code is the core document that contains anti-doping policies, rules and regulations for sports organisations and public authorities around the world.

World Anti-Doping Agency

The World Anti-Doping Agency (WADA) was established in 1999 to promote, coordinate and monitor the fight against the use of illegal substances and other performance-enhancing methods in sport. WADA is responsible for developing and implementing uniform anti-doping standards worldwide, establishing lists of banned drugs and setting the penalties for misusing them.

WADA publishes an annual 'List of Prohibited Substances and Methods', which details performance-enhancing substances, methods and practices that individuals participating in sporting competitions governed by WADA are not permitted to use. This is designed to establish a level playing field for all participants, as well as aiming to ensure a safe and fair environment for participation in sport.

Weblink

INVESTIGATION

WORLD ANTI-DOPING AUTHORITY

Visit the WADA website via http://vcepe12.nelsonnet.com.au.
Navigate around the website and explain three key elements and the purpose of the organisation.

Australian Sports Anti-doping Authority

The Australian Sports Anti-doping Authority (ASADA) is Australia's national anti-doping organisation. Established in 2006 by the Australian government, ASADA is consistent with the requirements of WADA and the World Anti-Doping Code.

Weblink

QUICKVID

Read about ASADA's role via http://vcepe12.nelsonnet.com.au. It is the responsibility of the individual to be aware of which performance-enhancement practices, substances and methods are classified as legal or illegal, as dictated by the relevant governing body. Individuals are considered responsible for any and all performance-enhancing substances found in their bodies or in biological samples they provide.

CHAPTER CHECK-UP

1 Give an example of a legal method of enhancing performance.
2 Are we facing a doping pandemic of huge proportions? How is doping in sport a sociocultural issue and how do we address this issue? Discuss.
3 Explain the WADA Code and its purpose.

PRACTICAL ACTIVITY

DESIGN A CAMPAIGN

In an interview with CBC Sports Online (2003), the former head of WADA, Dick Pound, was asked, 'What drives you in the fight against drugs in sports? Why do you feel this is such an important issue?' His reply reveals much about the motivation of the anti-doping campaigners: 'Well, sport is so important to so many people, particularly young people, and it's a precursor to how you're going to behave in other aspects of social intercourse ... [I]t's very important to have some kind of activity where you can say to people "this is on the level". You respect the rules, you respect your opponents, you respect yourself. You play fair.'

Source: Foddy & Savulescu, 2007

Design a presentation outlining how you would achieve the aim of Dick Pound's campaign. Your presentation can take any one of the following forms:

- a multimedia presentation
- an oral presentation such as a podcast
- a written report
- another presentation method of your choice (discuss this option with your teacher).

FYI

According to ASADA, 'Some drugs, medications and substances are banned in sport, as are some methods. Athletes competing in sports governed by a World Anti-Doping Code compliant anti-doping policy need to be aware that they cannot just take any drug or medication, or even use certain methods.'

LEGAL METHODS OF ENHANCING PERFORMANCE

Training

When an individual commences training to enhance their overall fitness, the results they achieve will depend on the conditioning program they engage in. The term 'conditioning' generally refers to the process of becoming physically fit by adhering to a particular training regime. The training methods employed by each individual will be determined by what they want to achieve and what is best for them. Exercise prescription and subsequent training should always be specific to an individual's needs.

When undertaking a conditioning/training program, an individual will choose specific activities that target particular body systems and muscle groups. Before beginning a training program it is important to make sure it is safe to do so, and to build training sessions gradually as fitness increases.

During conditioning, the body adapts microscopically to perform the work it is being asked to do. The purpose or goal of any training program is to facilitate chronic adaptations in the desired fitness components, energy systems and muscle groups to improve or enhance performance. Training can bring about a variety of significant physiological changes, which allow the body to perform at a higher level and/or with greater efficiency, resulting in enhanced performance.

In order to ensure that the most appropriate training method or methods are chosen, an activity analysis should first be conducted. This will enable an individual to identify and prioritise the training required and tailor their program accordingly – this is often referred to as the principle of specificity. The appropriate sequencing of training is critical in ensuring the best possible outcomes.

To achieve conditioning, individuals apply the training principle of progressive overload – the systematic and progressive overloading of the work being undertaken. As a general rule, the scale of improvement is directly related to the degree of overload. Once the body has adapted to the increased load, an additional strategic increase is required to produce further gains. Progressive overload and specificity, along with the other fundamental training principles, will be explored in far greater detail in *Physical Education VCE Units 3 & 4*, chapter 12. Let's now take a closer look at the training methods that can be employed to enhance the musculoskeletal system.

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Resistance training exercises, from top to bottom: free weights; kettlebells; your own body weight

Resistance training

Resistance training is any form of exercise that causes your skeletal muscles to contract against an external form of resistance with the aim of increasing strength, tone, power, mass and/or endurance.

People often say that they lift weights or go to a gym and do weight training. What these people are referring to is resistance training. Generally speaking, lifting weights with the aim of becoming stronger, bigger or more toned, or of increasing muscular endurance, can be termed resistance exercise or resistance training.

Resistance training works by causing microscopic damage or tearing to the muscle cells, which the body then quickly repairs to help the muscles regenerate and grow stronger. The breakdown of the muscle fibre is called 'catabolism' and the repair and regrowth of the muscle tissue is called 'anabolism'.

There are many types of resistance training equipment, including:

- free weights – dumbbells, barbells, weights benches
- resistance tubes and resistance bands
- weight machines – resistance training devices that have cables, pin-loaded weight stacks or fixed lever arms
- kettlebells – a cast iron or cast steel weight. Typical kettlebell exercises build strength and endurance, particularly in the lower back, legs and shoulders, as well as increasing grip strength
- your own body weight – chin-ups, push-ups, or any other activity that uses your body weight as the resistance. Body weight exercise requires minimal equipment, making it an affordable option.

Strength and endurance training

Depending on the focus, resistance training can build muscle strength, muscle power and muscle endurance. To target muscle strength, heavy weights would be combined with a low number of repetitions. To focus on muscle endurance, lighter weights would be combined with a high number of repetitions.

TABLE 4.2 Weight-training guidelines

Desired outcome	Repetition maximum	Repetition range	Sets	Repetition speed	Rest periods
Novice and intermediate					
Muscular strength	60–70%	8–12	1–3	Slow and moderate	2–3 minutes between sets
Muscular hypertrophy	70–85%	8–12	1–3	Slow to moderate	1–2 minutes between sets
Muscular power	30–60%	3–6	1–3	As fast as possible	2–3 minutes between sets
Muscular endurance	40–60%	15–25	1–3	Slow to moderate	1 minute
Advanced					
Muscular strength	80–100%	1–12 (emphasis on 1–6)	3–6	CON* 1–2 seconds ECC** 1–2 seconds	2–3 minutes between sets
Muscular hypertrophy	70–100%	1–12 (emphasis on 1–6)	3–6	Continuum	2–3 minutes between sets
Muscular power	30–60%	3–6	3–6	As fast as possible	2–3 minutes between sets
Muscular endurance	40–60%	15–25	3–6	Slow to moderate	1 minute

*CON = concentric muscle actions **ECC = eccentric muscle actions

Adapted from ACSM, 2010

The changes in the muscular system differ according to whether strength or endurance training is being employed.

Strength training results in:

» increased stores of ATP, creatine phosphate and glycogen
» increased enzyme levels for anaerobic energy production
» muscular hypertrophy (excessive growth)
» increased strength of tendons and ligaments
» increased speed of muscular contraction
» increased efficiency in muscular recruitment.

Endurance training results in:

» increased stores of glycogen and triglycerides
» increased size and number of mitochondria
» increased myoglobin content
» enhanced ATP production through aerobic glycolysis
» improved fat oxidisation and glycogen sparing.

Benefits of resistance training

Adding resistance training to a conditioning/training program increases lean body mass, develops and maintains muscle strength and endurance, and has other benefits such as maximising and maintaining bone density. Progressive resistance training increases muscle strength and endurance, prevents and manages several chronic diseases, including cardiovascular disease, and can improve psychological wellbeing.

FYI

To keep bones healthy, a person should engage in regular weight training or weight training endurance activities. Adults can maximise and maintain bone density with a regular program of weight training.

Resistance training strengthens both the axial (head, neck and trunk) and appendicular (upper and lower limbs) musculoskeletal systems. This improves biomechanics by making your musculoskeletal system more efficient at various movements, while also improving posture by strengthening core and back muscles.

Increased range of motion is an additional benefit of resistance training. By taking your muscles and joints through a greater range of motion, resistance training can improve your mobility, promote healthy joints and decrease your risk of injury.

Resistance training can directly enhance your performance in your chosen sport or activity too. For example, it could enable a soccer player to kick the ball further, and a boxer to throw a punch with greater force.

CHAPTER CHECK-UP

1 Define resistance training.
2 Define hypertrophy, giving an example in your response.
3 Explain the difference between a resistance training program that focuses on strength training and one that focuses on endurance training.

PRACTICAL ACTIVITY

MY RESISTANCE TRAINING PROGRAM

A resistance training program should be designed with your specific fitness goals in mind. Find a sport or activity of your choice and design a resistance training program, addressing the following key elements:

- warm-up
- pre-exercise stretching
- specificity of exercises
- order of exercises: start with large or multiple muscle groups, followed by small muscle groups
- number of repetitions and sets to be completed
- weight to be lifted: the correct weight should produce fatigue by the last repetition in each set
- post-exercise stretching
- frequency.

Flexibility

Flexibility is the capacity of a joint or muscle to move through its full **range of motion**. It also refers to the mobility of the muscles (and connective tissues, such as ligaments and tendons), which allows for more movement around the joints. This means the joints can move freely, reducing the risk of injury and falls, which is vitally important in everyday fitness.

Flexibility is required in all our activities of daily living, from getting out of bed to walking, bending down to pick something up, or lifting objects. Flexibility is specific to a particular movement or joint; the degree of flexibility can vary around the body. Being flexible helps to reduce muscle soreness and can improve posture. It allows muscles to remain mobile, enabling pain-free exercise. Tight muscles or a lack of flexibility can contribute to pain or difficulty in performing the activities of daily living.

As people age, their lean muscle mass decreases. The muscles naturally lose strength and size, and can become less supple. This can affect the range of movement around joints, causing stiffness in the muscles and joints. The loss of tissue elasticity can cause muscles and joints to tighten up, resulting in changes in normal muscle function as well as increasing the chance of injury.

A lack of general physical activity can also cause muscles to lose flexibility and become prone to strains, tears and general pain. It is important for people to include flexibility exercises as part of their daily routine. This is a vital component of health that many people neglect.

Flexibility training

So how can training improve flexibility, and how does flexibility training benefit the musculoskeletal system? One of the best ways to maintain flexibility is to stretch regularly. It is important to note that there is a difference between flexibility and stretching. Flexibility is the capacity of a joint or muscle to move through its full range of motion. Stretching is a form of exercise that can lead to an increase in flexibility.

Regardless of age, significant improvements can be achieved by stretching at least once a day. There are several straightforward stretching exercises that can be done while sitting at a desk, or lying in bed or on the couch. If time is limited, focus on stretches that target specific muscle groups such as the gastrocnemius and soleus, the hamstrings, the hip flexors, and the neck and back muscles. These muscles in particular are prone to stiffness and soreness as people grow older.

As with all training methods/programs, it is important to start slowly and build gradually; doing too much too soon can result in injury. It is important to execute correct technique when stretching. It is best to perform a light cardiovascular warm-up prior to stretching, as this increases blood flow to the muscle, which will warm the muscle and increase its flexibility.

Stretching can also be incorporated into a pre-exercise workout, whether as a part of the warm-up for a team game such as netball or football, preparation for a dance class or preparing to run 5 km. In these cases, the individual will target the specific muscles to be used, replicating the movement patterns of the activity at a reduced intensity.

FS

Fact sheet

Types of stretching

The four recognised methods of flexibility (or stretching) training are static stretching, passive stretching, dynamic and ballistic stretching, and proprioceptive neuromuscular facilitation (PNF) stretching. These are briefly discussed below as you will look at stretching in detail in Units 3&4. You can also access a fact sheet via http://nelsonnet.com.au using your login code, for more detail.

FYI

To get the most out of your flexibility training, always wait until your body has warmed up. The end of a workout is a great time to do it.

Static stretching

Static stretching occurs when a person stretches a muscle to the farthest point possible and holds the stretch for 10 seconds or more. An example of this is the seated hamstring stretch. Static stretching is appropriate at the end of a training session or as an independent training method performed in isolation.

Passive stretching

Passive stretching is also a static stretch, but the individual remains relaxed and makes no contribution to the range of motion. Instead, the stretch is created by an outside force, such as a partner.

Dynamic and ballistic stretching

Dynamic stretching involves moving a joint through its range of motion with controlled momentum.

Ballistic stretching uses the momentum of a moving body or a limb in an attempt to force it beyond its normal range of motion. This can involve fast 'bouncing' movements where a double bounce is performed at the end range of movement. This can be dangerous for many individuals, as the increased momentum may lead to muscle strain.

Proprioceptive neuromuscular facilitation (PNF) stretching

When performed correctly, PNF stretching is very effective at improving flexibility. As with any conditioning training, the specific PNF activity undertaken needs to be tailored to the ability of the individual.

Yoga

Yoga has recently become very popular in the fitness industry. Yoga provides a number of well-documented physical, mental and emotional benefits, including reduced blood pressure, enhanced feelings of relaxation, stress reduction, better posture, increased strength and flexibility and improved balance.

There are many different types of yoga, each with a different focus. One of the most popular is hatha yoga, which focuses on asanas (postures or poses) and breathing. Yoga poses stretch your muscles and increase your range of motion. Holding your body in a balanced pose requires controlled strength, and doing yoga regularly can improve your flexibility. Regular yoga practice will strengthen the muscles of your arms, back, legs, and core, thus enhancing your musculoskeletal system.

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Core strength training

What is the core?

The body's core is like a muscular box, defined by the abdominal muscles at the front, the paraspinals and gluteals in the back, the diaphragm at the top, and the pelvic floor and hip girdle musculature at the bottom. Whenever a person moves, their core is activated. Improved core strength is associated with:

» improved running efficiency
» decreased risk of injury, particularly of the lower back
» improved transfer of power between the lower and upper body
» improved balance
» the potential to improve both acceleration and deceleration.

Successful development of the core can be achieved through Pilates and Swiss ball exercises. These are discussed briefly below, but you can go to the website http://nelsonnet.com.au using your login code to read a fact sheet with more detail.

FS
Fact sheet

Pilates

Pilates uses coordinated breathing and movements to stretch and strengthen the body, targeting balance, posture and core strength.

Swiss ball

Like Pilates, the Swiss ball is used to develop core stability.

CHAPTER CHECK-UP

1 Define flexibility training.
2 In what situation would you use static stretching?
3 When would you recommend that an individual undertake Pilates training? Justify your response.

Benefits and harms of nutritional supplements

A supplement can be defined as 'any pill, capsule, tablet, liquid or powder that contains vitamins, minerals, herbs or amino acids; intended to increase dietary intake of these substances' (Crowe et al., 2014). Many individuals believe that taking nutritional supplements will enhance their physical performance. These beliefs are sometimes reinforced, and indeed promoted, by information in a variety of mediums – websites, fitness magazines, people in the fitness industry, peers and coaches.

'Sometimes it is difficult to distinguish valid claims from bogus ones. Fitness magazines and Internet websites are particularly troublesome because many of them present both valid and invalid nutrition information along with slick advertisements for nutrition products. Advertisements often feature colourful anatomical figures, graphs and tables that appear scientific. Some ads even include references, citing or linking to such credible sources as the *American Journal of Clinical Nutrition* and the journal of the American Medical Association. These ads create the illusion of endorsement and credibility to gain readers' trust. Keep in mind, however, that the ads are created not to teach, but to sell. A careful reading of the cited research might reveal that the ads have presented the research findings out of context. For example, an ad might use a research article to conclude that its human growth hormone supplement "increases lean body mass and bone mineral", when in fact, the researchers would conclude that "its general use now or in the immediate future is not justified". Scientific facts are often exaggerated and twisted to promote sales.' (Crowe et al., 2014, p. 474)

Farifax / Andrew Quilty

Nutritional supplements are readily available from pharmacies and some supermarkets.

FYI

Over the last 10 to 15 years there has been an unprecedented spike in sales in the global nutrition and supplements market. According to the estimates of the *Nutrition Business Journal* report, as of 2013 the global nutrition and supplements market was worth US$104 billion per year.

The promise of enhanced performance in return for very little effort can be very seductive. However, some supplements can be harmful. Let's look at a variety of nutritional supplements and their impact on the performance of the musculoskeletal system.

Creatine supplementation

Creatine supplementation is a method of improving performance for those engaged in high-intensity explosive power activity. Creatine is an amino acid that occurs naturally in high levels in meat and fish. It is used to improve muscular power, and reduces muscle damage caused by exercise.

Creatine is not on the WADA doping list; however, as Crowe et al. (2014) note, 'the question of short term use of creatine supplements continues to be studied, but so far the supplements are viewed to be safe for healthy adults. More research is needed however to confirm the safety of larger doses and long term creatine use. One side effect of creatine supplementation that no one disputes is weight gain.' Creatine usage has also been linked to cramping, diarrhoea, dehydration and dizziness (Graham & Hattan, 1999).

Creatine improves performance most significantly during short-duration, high-intensity activities; it is not useful for endurance sports (Graham & Hattan, 1999). Individuals whose training has a power focus may take creatine supplements to enhance creatine phosphate stores in working muscles. High levels of creatine phosphate enable the individual to train at higher intensity. Challenging the muscles to work at higher intensities means they are forced to adapt, enhancing the efficiency and performance of the musculoskeletal system.

It is not yet fully understood how creatine supplements bring about improved performance. One theory is that higher concentrations of creatine phosphate in the muscles decrease dependence on anaerobic glycolysis for the resynthesis of adenosine triphosophate (ATP), which provides extra energy, delaying the onset of fatigue and stimulating muscle growth. Another theory is that creatine supplements stimulate protein synthesis, decreasing protein degradation and increasing the rates of muscle enlargement. There may be an improved buffering effect on ADP, leading to a relatively greater supply of ATP.

Getty Images / Scott Halleran

Athletes who need explosive power can benefit from the use of creatine supplements. An example is weightlifter Jong Sim Rim of North Korea, seen here competing in the women's 75 kg weight class during the 2015 International Weightlifting Federation World Championships.

Protein supplementation

Because the body builds muscle protein from amino acids, which are the basis of proteins, many individuals take protein powders, hoping to stimulate muscle growth. However, only specifically targeted muscle work builds muscle – protein supplements do not.

Protein supplements have long been used by individuals such as body builders and weightlifters, who call upon power and strength, in an attempt to develop and maintain skeletal muscle. Proteins are composed of 20 different types of amino acids and make up one of the three essential components of the human diet, along with carbohydrates and fats. Protein:

» provides the raw material for both muscle construction and repair
» promotes glycogen resynthesis
» plays an important role in the immune system
» is critical to the endocrine (hormone production) system
» facilitates the transmission of nerve impulses throughout the nervous system
» prevents sports anaemia (iron deficiency) by promoting increased synthesis of haemoglobin, myoglobin and oxidative enzymes.

Protein supplements are popular among sportspeople. However, many nutritional experts contend that the best way to ingest protein is by way of a well-balanced, natural food diet. Natural foods often contain phytochemicals, which are missing from synthetic supplements. These promote healthy functions within the body, such as anti-oxidation and the bolstering of the immune system.

If the body has a shortage of protein, supplements will help correct this deficiency. Protein deficiency will inhibit all of the important functions outlined above, and will also delay recovery. Unlike carbohydrates, which have several storage mechanisms, excess proteins are broken down into their amino acid components for elimination. The breakdown of amino acids produces several by-products, including urea. Dealing with large quantities of urea can place a significant strain on the kidneys.

The consumption of additional protein (over and above the recommended daily intake) must be approached with caution. In 2009, the American College of Sports Medicine (ACSM), the American Dietetic Association and the Dieticians of Canada declared that protein requirements are higher in very active individuals and suggested that resistance athletes need 1.6–1.7 grams of protein per kilogram of body weight (g/kg), while endurance athletes need approximately 1.2–1.4 g/kg. These values are about 150 to 200 per cent of the current recommended dietary allowances in the United States (ACSM, 2009).

Protein supplements are popular because they provide concentrated amounts of high-quality protein that is easily consumed after training or competition. It would be impractical to obtain the same amount of protein from food, because of both preparation time and the large quantity of food that would be required.

Any health food outlet or shop specialising in dietary performance will offer a multitude of protein supplements. Some of the most popular protein supplements on the market are described below. For those who are whey intolerant, other options include soy protein, rice protein and egg protein.

FYI

Chemically speaking, proteins are more complex than carbohydrates or lipids.

Whey isolate protein

This is the highest-quality form of protein powder. All the fat and lactose (sugar) has been removed from the original milk product, leaving just the protein.

Whey concentrate protein

Although still a high-quality form of protein powder, this has not been processed to the same extent that whey isolate protein has, and some fat and carbohydrates still remain. This product is particularly popular with individuals hoping to achieve greater muscle gains. When combined with strength training, whey supplements may increase protein synthesis slightly, but they do not enhance athletic performance.

Combined whey isolate and concentrate

A common way to obtain a high-quality protein supplement at a reasonable price is to use a combination of whey isolate and concentrate.

Protein is optimally absorbed through the small intestine within 30–60 minutes of training or competition, so it is easier to take supplements as drinks rather than sitting down and eating a meal. After activities lasting longer than 90 minutes, athletes also require carbohydrate replenishment, so it is common for them to consume a carbohydrate-protein mix.

ILLEGAL METHODS OF ENHANCING PERFORMANCE

FYI

The typical diet of Australians provides adequate energy from carbohydrate and fat and delivers approximately 64 grams of protein per day (or 0.84g/kg/day) for healthy-weight males and 46 grams of protein per day (0.75g/kg/day) for healthy-weight females.

Anabolic steroids

One of the most dangerous and illegal performance-enhancing practices is taking anabolic steroids. Anabolic steroids are derived from the male sex hormone testosterone, which promotes the development of male characteristics and lean body mass. Testosterone is responsible for the growth of bone and muscle during puberty, as well as for secondary sex characteristics. Synthetically produced steroids attempt to maximise the anabolic properties of testosterone while minimising the androgenic side effects.

The International Olympic Committee, along with almost all sporting agencies and governing organisations, specifically bans the use of anabolic steroids.

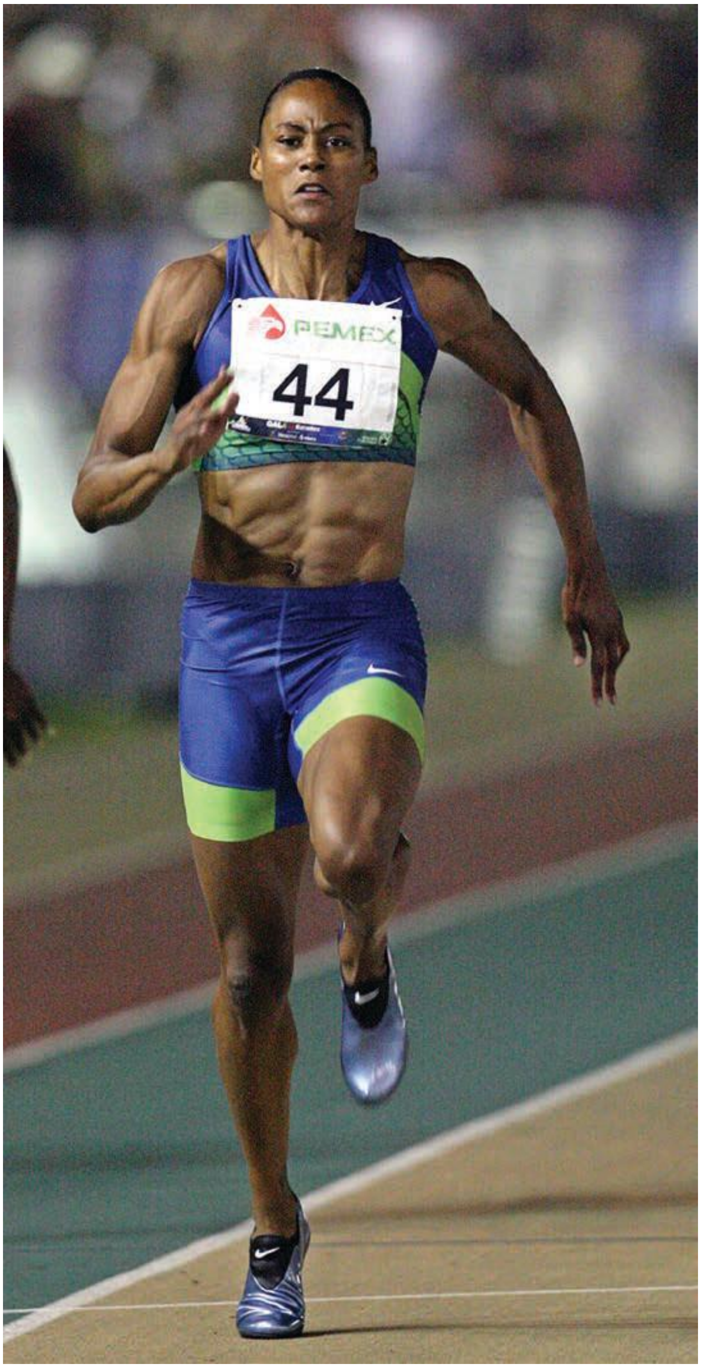
Steroids are taken in tablet form or injected into the muscle to build muscle mass. They are complex chemicals that the body reacts to in many ways, particularly when taken in large amounts.

Athletes who take anabolic steroids do so to increase muscle bulk, power and strength. These effects are achieved by:

» increasing protein synthesis
» blocking the hormones that cause muscle tissue to break down following very intensive exercise
» enhancing aggressive behaviour, which promotes greater quality and quantity of weight training
» reducing recovery time between 'heavy' training sessions that use loads close to repetition maximums.

Most steroid users are thought to be body-builders or athletes looking to gain an edge on their opponents. However, a growing number of young Americans are using steroids either for cosmetic reasons (to look muscular) or for the feelings of invincibility they can produce (known as 'roid rage'). Some athletes take sedatives and tranquillisers to counter the side effects of anabolic steroids or to mask their presence in the blood. Potential harms of anabolic steroids include liver and heart disease, and stroke. Physiological effects include of drug dependence and increased aggression.

Getty Images / AFP



In 2007, track star Marion Jones admitted to having used anabolic steroids during her Olympic career.

Growth hormones and related substances

A range of individuals use human growth hormone (HGH) to build lean tissue and enhance athletic performance. Some athletes believe that the use of HGH will provide the benefits of anabolic steroids without the dangerous side effects.

Hormones such as HGH and corticosteroids are used to increase muscle and bone development, to induce a state of euphoria, as an anti-inflammatory preparation, and to normalise the testosterone–epi-testosterone ratio that is scrutinised in dope testing. Side effects include diabetes, thyroid disorder, heart disease, hypotension, decreased immune function, sodium and water retention, skin changes, impotence and shortened life span. Taken in large quantities, HGH causes the disease acromegaly, in which the body becomes huge and the organs and bones over-enlarge.

Insulin-like growth factors (IGFs)

Increasingly, insulin-like growth factors (IGFs) are being used to enhance performance. IGF-1 is a naturally occurring hormone that stimulates many processes in the body, including protein synthesis. The growth hormone exerts most of its growth-promoting effects through IGF-1. Some athletes use IGF-1 in an attempt to increase muscle bulk, reduce muscle cell breakdown and reduce body fat. However, very large doses are required to achieve these things, and there is a risk of significant adverse effects, including hypoglycaemia, swelling of the brain, enlargement of the heart and diabetic coma, all of which can be fatal.

CHAPTER CHECK-UP

1 Define nutritional supplements.
2 In what situation would an individual choose to use creatine?
3 Why would an individual use human growth hormone (HGH)?

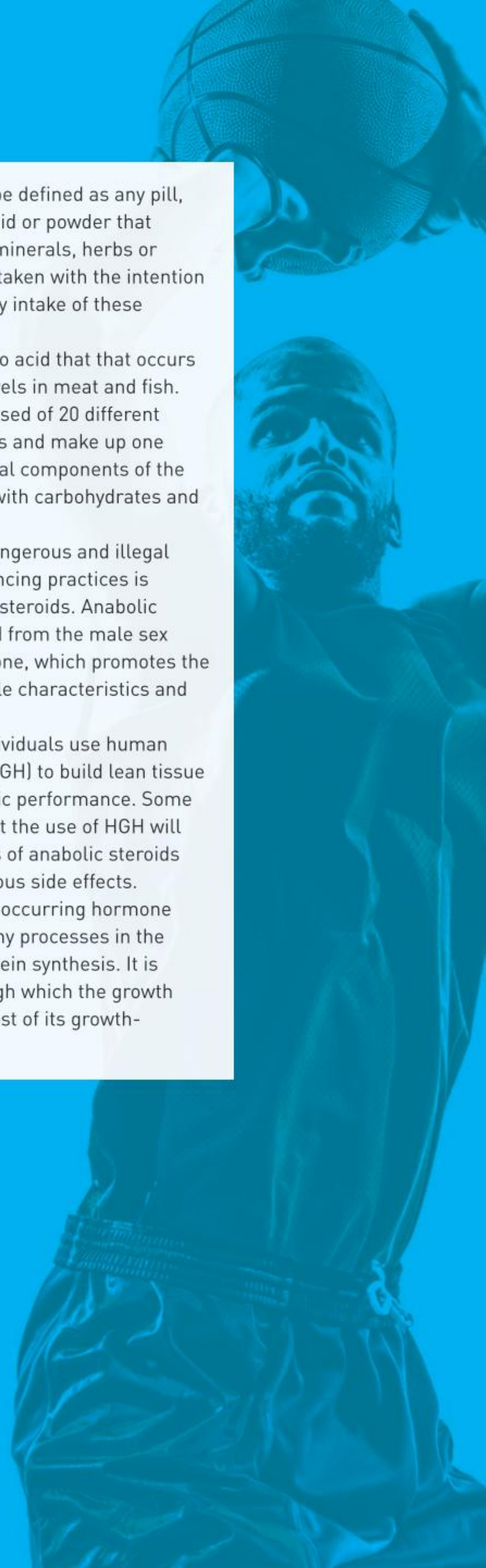
REAL WORLD APPLICATION

Video

Watch a short interview with Theo Kapakoulakis about legal and illegal methods that enhance performance of the musculoskeletal system, by logging in with your code to http:/nelsonnet.com.au and going to chapter 4, page 92.

CHAPTER SUMMARY

- The musculoskeletal system is the largest system in the body and it has two equally important functions. The first is movement and the second is support. There are seven structures that make up this system.
- A legal method or practice that enhances performance is one that does not violate the WADA Code, does not threaten the health or safety of the individual and yet provides a measurable performance enhancement. These methods may include anything from good nutrition or a training program to the consumption of nutritional supplements.
- An illegal method that enhances performance is a method or practice that enhances physical or sporting performance through artificial means, and that allows an individual to gain an unfair edge or unjust advantage over their competitor.
- The World Anti-Doping Agency (WADA) was established in 1999 to promote, coordinate and monitor the fight against drugs and illegal substances and methods in sport. Since 2004, WADA has published an annual list of prohibited substances and methods that sportspeople are not allowed to take or use.
- Legal training methods that enhance the performance of the musculoskeletal system include resistance training, flexibility training, yoga and core training.
- A supplement can be defined as any pill, capsule, tablet, liquid or powder that contains vitamins, minerals, herbs or amino acids and is taken with the intention of increasing dietary intake of these substances.
- Creatine is an amino acid that that occurs naturally in high levels in meat and fish.
- Proteins are composed of 20 different types of amino acids and make up one of the three essential components of the human diet, along with carbohydrates and fats.
- Among the most dangerous and illegal performance-enhancing practices is the use of anabolic steroids. Anabolic steroids are derived from the male sex hormone testosterone, which promotes the development of male characteristics and lean body mass.
- A wide range of individuals use human growth hormone (HGH) to build lean tissue and enhance athletic performance. Some athletes believe that the use of HGH will provide the benefits of anabolic steroids without the dangerous side effects.
- IGF-1 is a naturally occurring hormone that stimulates many processes in the body, including protein synthesis. It is the hormone through which the growth hormone exerts most of its growth-promoting effects.



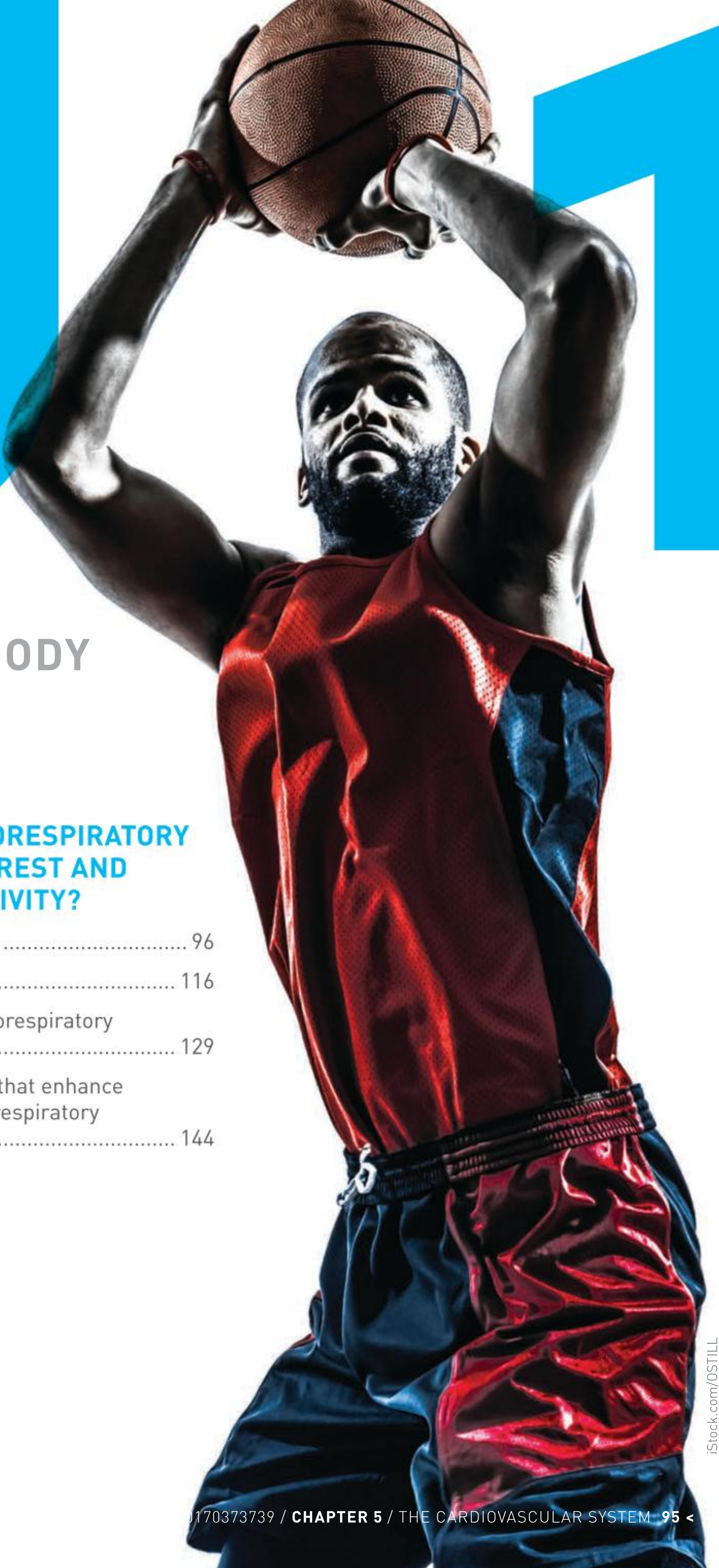
CHAPTER REVIEW

Multiple-choice questions

1 How many structures make up the musculoskeletal system?
   A Nine
   B Three
   C Seven
   D Five
2 What is an example of an illegal method of performance enhancement?
   A Drinking coconut juice
   B Using anabolic steroids
   C Undertaking a Pilates training session
   D Taking a creatine supplement
3 Which of the following would not be classified as a legal training method?
   A Resistance training
   B Yoga
   C Human growth hormone
   D Flexibility training

Short-answer questions

4 Define and give an example of an illegal method that enhances performance.
5 Explain the role of ASADA.
6 Explain how, according to WADA, a substance becomes prohibited.
7 Research one type of resistance training and explain two benefits this has in enhancing the musculoskeletal system.
8 Why is it important to maintain flexibility?



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UNIT 1

THE HUMAN BODY IN MOTION

AREA OF STUDY 2

HOW DOES THE CARDIORESPIRATORY SYSTEM FUNCTION AT REST AND DURING PHYSICAL ACTIVITY?

CHAPTER 5

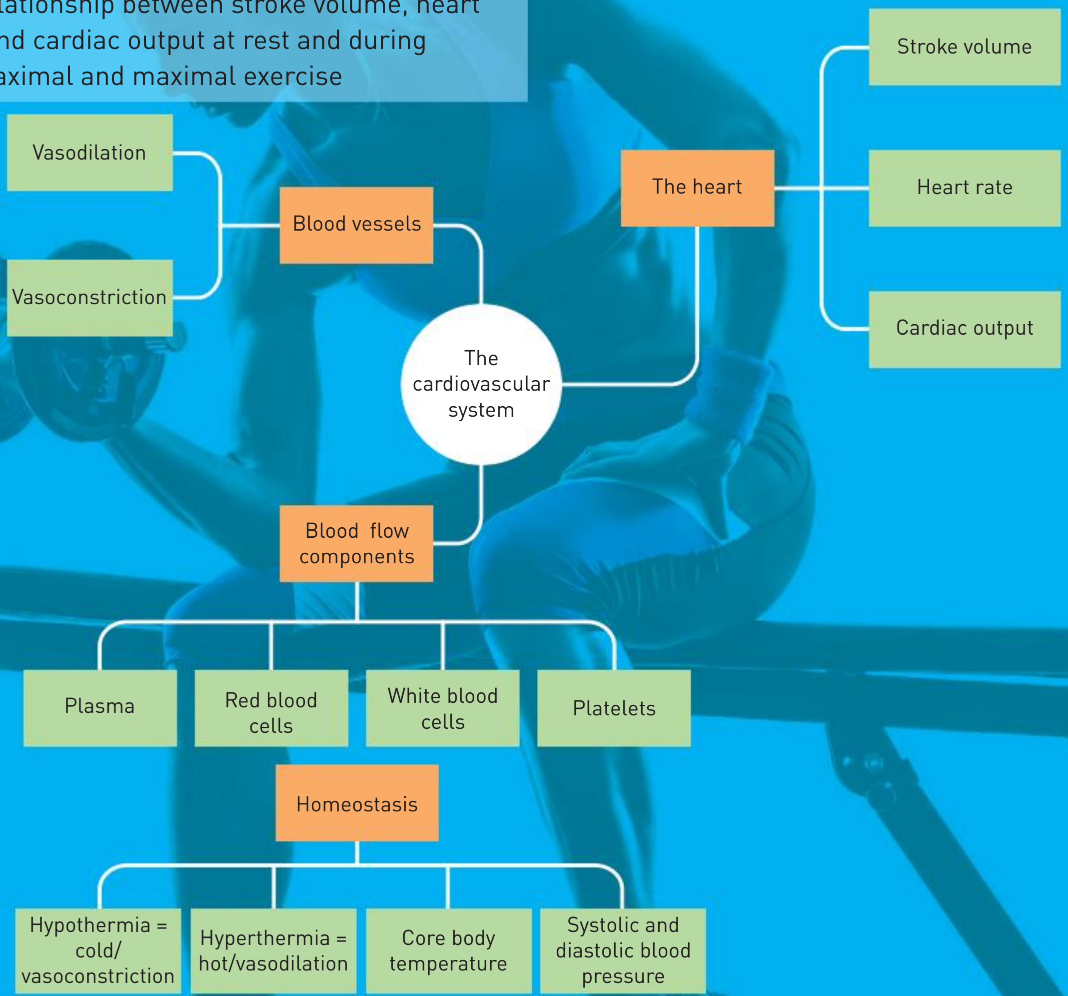
THE CARDIOVASCULAR SYSTEM

Key knowledge

- » the structure and function of the cardiovascular system, including the structure and function of the heart and blood vessels, and blood flow around the body at rest and during exercise
- » components of blood, including red blood cells, white blood cells, platelets and plasma and their function at rest and during exercise
- » the role of the cardiovascular system in thermoregulation: homeostasis, hyperthermia and hypothermia
- » vasodilation and vasoconstriction of the blood vessels to regulate blood distribution at rest and during exercise
- » the relationship between stroke volume, heart rate and cardiac output at rest and during submaximal and maximal exercise

Key skills

- » use and apply correct anatomical terminology to identify the structures of the cardiovascular system
- » describe the role and function of blood components
- » examine the role of the cardiovascular system in thermoregulation
- » analyse the relationship between stroke volume, heart rate and cardiac output at rest and during submaximal and maximal exercise



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This chapter considers the structure and function of the cardiovascular system, which is made up of the heart, blood vessels and blood. The cardiovascular system is responsible for many functions, including transportation of gases and fuels, immunity, cellular repair and regrowth, and thermoregulation. The next chapter investigates the structure and function of the respiratory system, which consists of the respiratory airways that bring air into the body and lungs. To transport gases throughout the body, the cardiovascular and respiratory systems must work together.

Once you have developed a sound understanding of the vital structures that make up these systems you will have a better understanding of how the two respond to physical activity to meet performance demands. You will also develop a better understanding of how the two systems work together to ensure **homeostasis** is maintained.

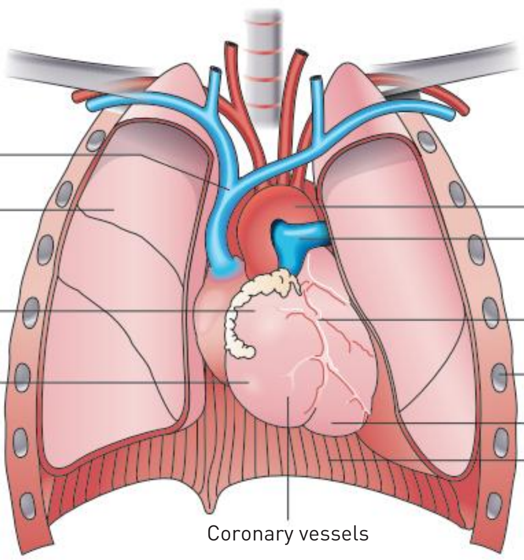
STRUCTURE AND FUNCTION OF THE HEART

FYI

The heart is a muscular pump that beats over 100 000 times per day. During an average lifetime of 75 years, the heart will pump between 120 and 180 million litres of blood and beat over 3 billion times.

Chapter 2 looked at the way the ribs protect the heart and how the intercostal muscles assist with the mechanics of breathing. The heart is situated behind the sternum and is made up of four chambers:

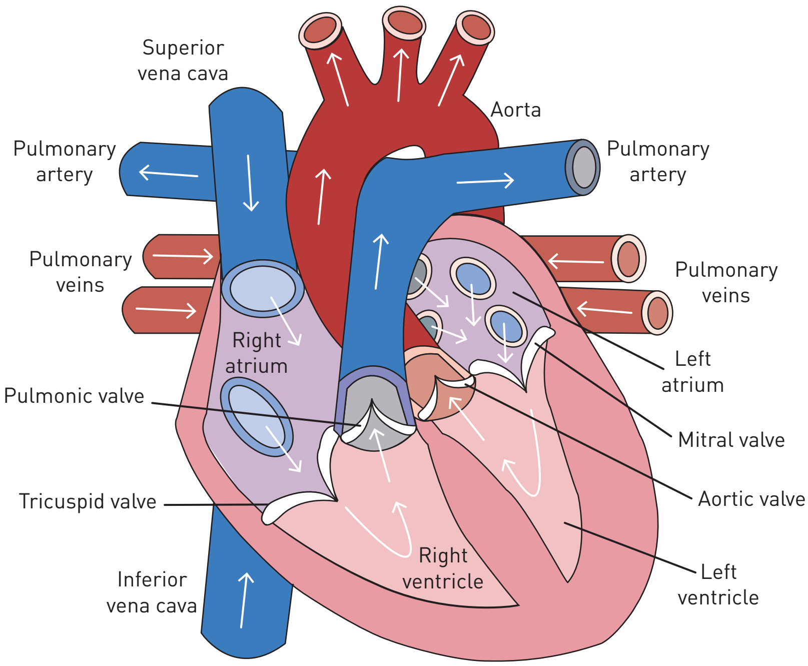
» two upper chambers – the atria (singular: atrium)
» two lower chambers – the ventricles.



Location of the heart behind the sternum and its relationship to rib cage, lungs and diaphragm. Note that, because the heart is a muscle, it has its own blood supply (coronary vessels, made up of arterioles and venules) and needs oxygen and fuel to function.

The ventricles are responsible for pumping blood throughout the body, so they are more muscular than the atria. The atria act like collecting vessels at the top of the heart.

The heart can be divided **transversely** into **superior** and **inferior** parts (atria and ventricles) and **sagitally** into left and right sides divided by the septum. One-way valves ensure blood flows in the right direction through the heart. When the atria contract, the valves open, but they close when the ventricles contract to prevent any 'backflow'. The bicuspid (or mitral) valve on the left side between the atrium and ventricle is made up of two flaps, and the tricuspid valve on the right side is made up of three flaps. Sometimes these valves break down but they can be replaced by artificial valves.



Structure of the heart showing main chambers, blood vessels and one-way valves

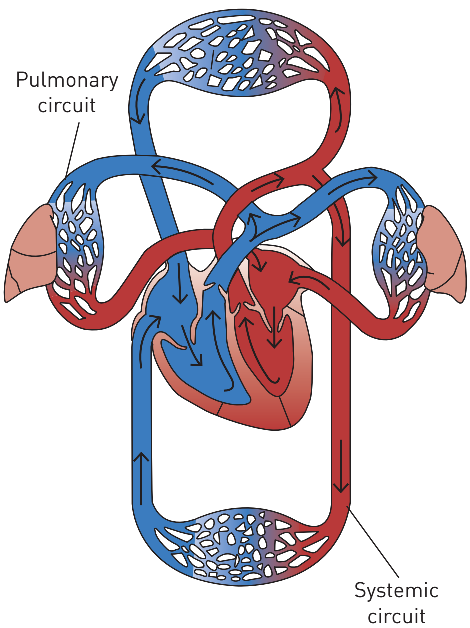
FYI

The heart is sometimes referred to as a 'double pump'. The left side pumps oxygen-rich blood to the entire body (systemic circulation) while the right side receives oxygen-poor blood and then pumps this to the lungs to be re-oxygenated (pulmonary circulation).

The cardiac cycle

The cardiac cycle involves the heart filling with blood and then pumping this to the rest of the body via the arterial system. It takes just under one second to complete a heartbeat. There are four stages to each heartbeat:

» Stage 1 – atrial diastole
» Stage 2 – ventricular diastole
» Stage 3 – atrial systole
» Stage 4 – ventricular systole



The pulmonary and systemic circuits

Stage 1

The atria fill with blood returning from two key areas – the body and the lungs. Blood from the body returns through the vena cava into the right atrium; blood from the lungs returns through the pulmonary vein into the left atrium. At this time, the heart valves remain shut.

Stage 2

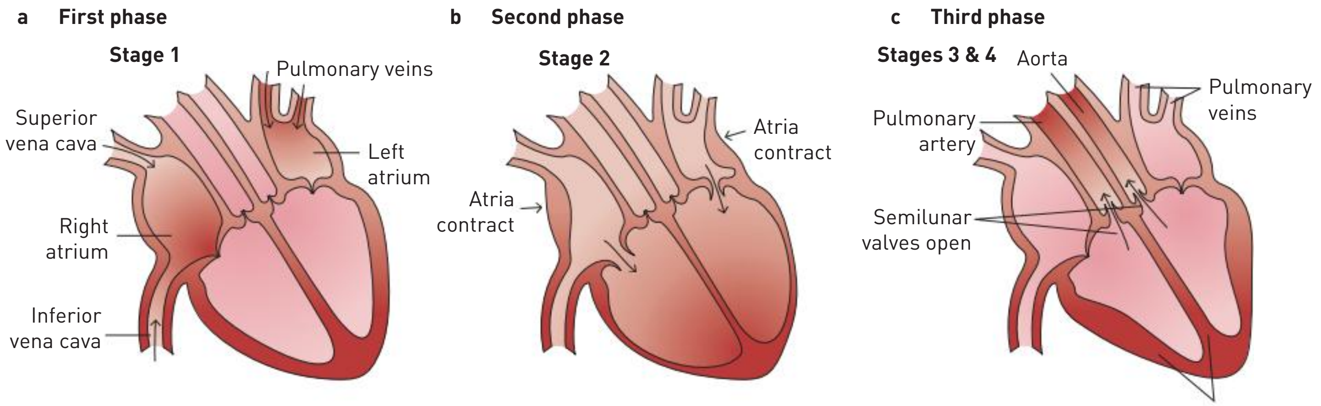
The pressure build-up in the atria causes the bicuspid and tricuspid valves to open; blood flows into the ventricles, then the valves shut again.

Stage 3

The atria contract and blood is forced into the ventricles and pressure increases to become greater than that in the aorta and pulmonary artery.

Stage 4

The pulmonary valve and aortic valve at the top of the heart both open and the ventricles contract, forcing blood into the aorta to move to the rest of the body, or into the pulmonary artery to go to the lungs.



Blood is transported back to the heart via the pulmonary veins, which carry oxygenated blood from the lungs, or the two venae cavae, which carry deoxygenated blood from the rest of the body.

The two atria contract and the valves separating these from the ventricles open, allowing blood to be pumped into the ventricle.

The valves between the atria and ventricles close, preventing back flow as both ventricles contract. Blood is forced out of the heart to either the lungs or the rest of the body.

Blood flow through the heart

RELATIONSHIP BETWEEN STROKE VOLUME, HEART RATE AND CARDIAC OUTPUT

QUICKVID

This short video will reinforce the different cycles the heart experiences while pumping blood to the lungs and rest of the body. Link to it via http://vcepe12.nelsonnet.com.au.

Weblink

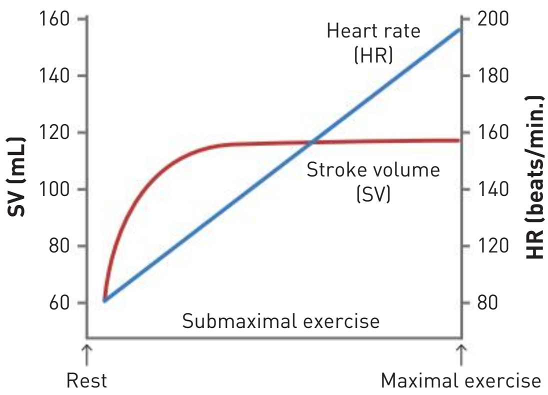
Stroke volume is a measure of how much blood is squeezed out of the heart into the aorta each time it beats, i.e. per systole (think of systolic blood pressure). The average adult stroke volume at rest is between 70 and 90 mL. As you start to exercise, the heart pumps more forcefully and more blood is squeezed out per beat, so the stroke volume increases. In adults, this typically increases by 40 per cent when maximum exercise levels are reached (see Table 5.1).

Cardiac output is the amount of blood pumped out of the heart per minute and is easily calculated:

Cardiac output (Q) = **stroke volume** x **heart rate**

At rest, cardiac output might be 80 mL x 60 bpm = 4800 mL/min or 4.8 litres/min. At maximal exercise, cardiac output might increase to be 130 mL x 200 bpm = 26 000 mL or 26 litres/min.

The following graph clearly shows that stroke volume reaches its maximum at around 50–60 per cent of maximal **heart rate** equivalent, but cardiac output increases when the heart rate keeps increasing to meet the increased exercise demands.



Heart rate and stroke volume response to increased workloads deemed to be **submaximal**

TABLE 5.1 Stroke volumes and cardiac outputs for untrained, trained and endurance athletes

	Untrained athletes	Trained athletes	Endurance athletes
Stroke volume (mL)			
at rest	80	110	125
at maximal exercise	120	130	190
Cardiac output (L/min)			
at rest	4.8	6.0	6.5
at maximal exercise	20	30	45

BLOOD

Adult males have approximately 5–6 litres of blood in their bodies, and adult females have approximately 4–5 litres of blood.

Functions of blood

Blood is responsible for:
» transportation of gases, fuels and minerals
» protection against dehydration
» maintaining equilibrium (homeostasis) via enzyme and hormone regulation
» thermoregulation
» carrying cells and antibodies that fight infection
» bringing waste products to the kidneys and liver, which filter and clean the blood.

Blood transports oxygen from the lungs and heart to working muscles and cells, and then removes metabolic by-products such as carbon dioxide from muscle sites. It also transports fuels such as glucose to working muscles and removes lactate that might be produced under anaerobic conditions.

Blood acts to protect the body by moving white blood cells to sites of infection and platelets to areas that need blood flow stopped and clotted in order to limit haemorrhaging, loss of blood and cell damage.

The blood moves enzymes and chemicals to areas where metabolic processes require them – especially for maintaining a constant pH. The blood also regulates temperature and maintains homeostasis by moving heat away from working muscles to other areas of the body, including the skin's surface. This means the blood is very important in bringing about peak performance during physical activity.

FYI

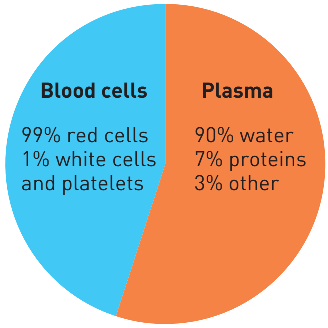
It takes approximately 20 seconds for a blood cell to circulate around the entire body at rest. Blood makes up around 8 per cent of your total body weight.

BLOOD COMPOSITION

Blood consists of many components in two broad categories, namely plasma (55 per cent) and blood cells (45 per cent).

Red blood cells

Red blood cells give blood its colour. They are produced in bone marrow (in bones such as the sternum, ribs and vertebrae). They contain the protein haemoglobin, which carries oxygen to body tissues and muscles. Women have slightly lower haemoglobin levels than men.



Composition of blood

White blood cells

White blood cells fight infection by absorbing and digesting disease-causing organisms. They are produced in bone marrow, lymph tissue and the spleen.

Platelets

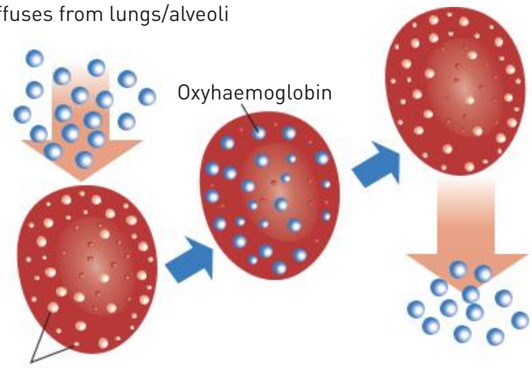
Platelets are cells that help form blood clots to stop bleeding. They are produced in bone marrow.

Plasma

Blood plasma is a clear yellowish fluid that carries nutrients. It also transports waste products and assists with their removal from the body. Plasma is 90 per cent water, which counters dehydration, but it also contains the protein fibrinogen, which assists platelets in blood clotting.

TABLE 5.2 The different components of blood

	Function(s)
Red blood cells (erythrocytes)	» Carry oxygen to working muscles and other cells and remove carbon dioxide. Red blood cells contain haemoglobin, a respiratory pigment that binds to either oxygen or carbon dioxide. This allows oxygen to be transported around our body to our tissues and organs and carbon dioxide to be taken away.
White blood cells (leucocytes)	» Form a major part of the immune system
Platelets (thrombocytes)	» Facilitate blood clotting – the purpose of which is to prevent loss of body fluids
Plasma	» The medium in which the blood cells are transported around the body (by the blood vessels) and are able to operate effectively » Helps maintain optimum body temperature » Helps control the pH of the blood and the body tissues, maintaining this within a range at which the cells optimally function » Helps maintain an ideal balance of electrolytes in the blood and tissues of the body » Removes wastes from the body



Red blood cells contain haemoglobin molecules. One haemoglobin molecule can bind with up to four oxygen molecules, forming what is known as oxyhaemoglobin. This is how oxygen is transported to working muscles.

Weblink

QUICKVID

The short clip 'What is blood?' summarises the different components that make up blood, and their roles in our bodies. Link via http://vcepe12.nelsonnet.com.au.

In summary, the plasma and red blood cell components of blood work together to ensure that nutrients, hormones and proteins are transported to the parts of the body as required. They are also important in the removal of wastes from cells. Red blood cells contain a special protein called haemoglobin, which helps carry oxygen from the lungs to the rest of the body and then returns carbon dioxide from the body to the lungs so it can be exhaled.

The plasma and red blood cells respond to increased demands during exercise, transporting gases, fuels, hormones and enzymes as required and also helping with the removal of wastes. White blood cells and platelets are less important during exercise and sport, but are vital to ensuring our immune system functions properly .They also minimise fluid loss via bleeding by helping with the clotting process.

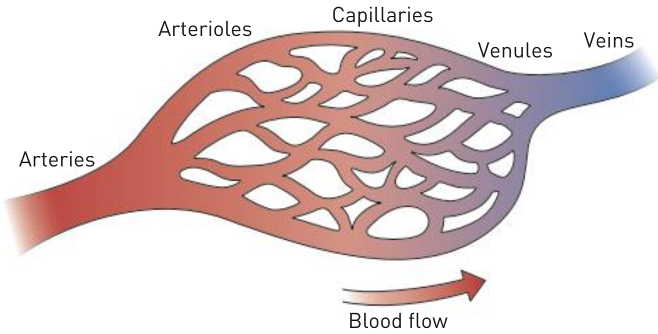
CHAPTER CHECK-UP

1. Red blood cells are known for their role in carrying oxygen, but they also transport carbon dioxide, a process that is important in maintaining homeostasis.
   a. What is homeostasis?
   b. Explain the role red blood cells play in removing carbon dioxide, and describe what would happen if this process was slowed down.
2. When we play sport in hot temperatures, our plasma levels decrease significantly. Outline the effect this would have on the cardiovascular system and list three functions that would be severely affected.
3. Discuss how the blood acts to stop bleeding in order to prevent our blood pressure from dropping.

BLOOD VESSELS

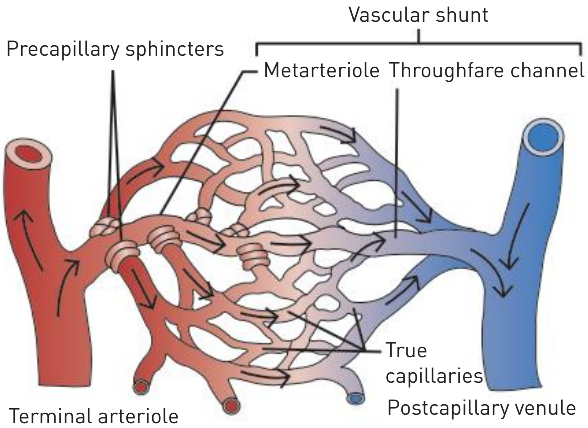
Blood vessels make up the vascular network through which all blood flows to all parts of the body. The vascular network consists of arteries that branch into arterioles, which further branch into capillaries (the smallest blood vessels in the network), which then connect to venules that then become veins.

Veins and arteries transport blood around the body. Arteries transport blood away from the heart and veins return blood back to the heart. The largest artery in the body is the aorta and this is found closest to the heart. The aorta subdivides many times into smaller arteries and arterioles; every time this division or 'split' happens, the cross-sectional area of the blood vessel increases. This allows for greater exchange of gases, nutrients, fuels and wastes. Arteries have strong elastic walls and transport oxygen-rich blood, which gives them their bright red colour.

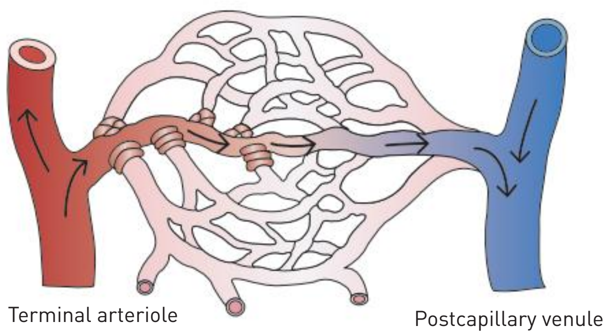


Blood flow through the vascular network

Arterioles 'connect' to capillaries, which in turn 'connect' to venules. Capillaries are so small that only single red blood cells can pass through. Blood flow through capillaries is controlled by minute structures called **precapillary sphincters**. These bands of smooth muscle encircle each capillary branch at the point where it branches from the arteriole. Forceful contraction of the precapillary sphincter can close the branches off to blood flow while opening others. In this way, more blood is sent to working muscles and less to major organs as exercise intensifies (see diagram below). This leads to more oxygen and fuels being transported to muscles and facilitates quicker metabolic waste removal.



Sphincters open – blood flows through the capillaries



Sphincters closed – blood flows through metarteriole-throughfare channel and bypasses true capillaries

Vasoconstriction results in less blood moving through capillaries, and more blood being redirected to areas where vasodilation is occurring, resulting in more oxygen and fuels being supplied, and wastes being removed.

QUICKVID

The Khan Academy has a clear video clip on precapillary sphincters on its website. Spend a couple of minutes going over how blood is redistributed to areas of need and away from areas that don't have high oxygen demands. Link via http://vcepe12.nelsonnet.com.au.

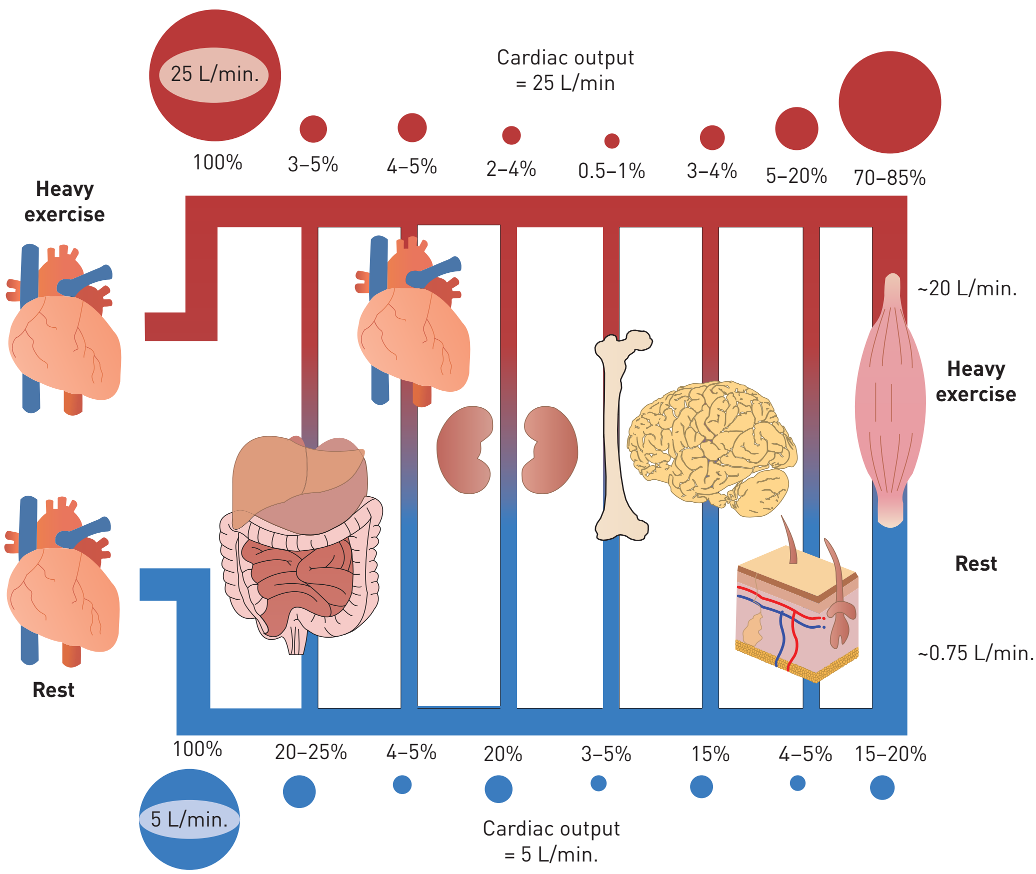
Weblink

Vasoconstriction and vasodilation

When a person exercises, many physiological changes take place to make sure their muscles receive sufficient oxygen and fuels to meet the demands of the activity. Blood vessels are able to dilate (widen) and constrict (narrow) to redirect the flow of oxygenated blood to working muscles and away from non-essential organs and sites. Because the cardiovascular system is what is known as a 'closed circuit', whenever blood vessels dilate in one part of the body, they must also constrict somewhere else.

With the onset of exercise, a remarkable balancing act begins. Blood that would have gone to the stomach, kidneys or other vital organs gets redirected to the muscles. As exercise commences, the sympathetic nervous system stimulates the nerves to the heart and blood vessels, causing those blood vessels to contract or constrict (**vasoconstriction**). This vasoconstriction reduces blood flow to tissues. Our muscles also get the signal to vasoconstrict, but the metabolic by-products produced within the muscles override this command and cause **vasodilation**, a widening or opening of the blood vessels. Because the rest of the body gets the message to constrict the blood vessels while the muscles dilate theirs, blood flow from non-essential organs (stomach, intestines, kidney, etc.) is diverted to working muscle. This helps increase the delivery of oxygenated blood and fuels to working muscles.

Venules join together to become veins, which return blood to the heart. The blood carried by veins is relatively low in oxygen (deoxygenated) and high in carbon dioxide due to exchanges occurring at the capillaries. For this reason, blood transported in veins tends to be a dark red or blue colour. Veins are much less elastic than arteries and keep blood flowing back to the heart in one direction via pocket valves that close intermittently to prevent backflow. The pumping of the heart is actively assisted by muscles surrounding the veins, which contract



Redistribution of cardiac output during rest and maximal exercise and push blood towards the heart. For this reason, an active recovery involving low-intensity exercise is recommended after vigorous physical activity.

Once blood reaches the heart it is pumped to the lungs through the pulmonary artery, which quickly subdivides into the pulmonary capillaries, where gaseous exchange takes place. Carbon dioxide and other excretory products are exchanged (exhaled) for oxygen (which is inhaled).

Blood pressure is the force exerted by the blood against the blood vessel walls. Blood pressure in the arteries increases and decreases during the cardiac cycle. It is greatest when blood is pumped into the aorta during ventricular systole and lowest during ventricular diastole. By the time blood reaches the capillaries, blood pressure is much less than when it travelled through the coronary (heart) arteries. Systolic blood pressure is experienced when blood is pumped into the system from the heart, and diastolic blood pressure is experienced when the heart relaxes and fills with blood. Blood pressure can be measured using a **sphygmomanometer**. A typical reading at rest is $\frac{120\text{ mmHg}}{80\text{ mmHg}}$, where mmHg stands for millimetres of mercury.

FYI

There are more than 100 000 km of capillaries in the body, forming a vast network throughout the body tissues.

Blood flow through the heart: a summary

The flow of blood from the heart to the lungs and other body tissues through the cardiovascular system can be summarised as follows:

1 Pulmonary circulation occurs when the right side of the heart receives deoxygenated blood from most of the body and pumps it to the lungs. Blood is pumped through the superior vena cava and inferior vena cava (veins) into the right atrium.

2 The right atrium contracts, forcing the tricuspid valve open and the blood into the right ventricle. The tricuspid valve then closes, preventing any backflow of blood into the right atrium. Blood is then forced out of the right ventricle into the pulmonary artery to the lungs, where it exchanges carbon dioxide and waste products for oxygen.

3 The now oxygenated blood is pumped into the left side of the heart via the pulmonary vein into the left atrium. When the left atrium contracts, the bicuspid valve opens and blood is forced into the left ventricle. This valve then closes again, preventing backflow into the left atrium.

4 Systemic circulation starts when the left ventricle contracts and pumps the blood into the aorta under high pressure. This blood is then pumped through the thousands of arteries to all parts of the body. As blood enters the capillaries, the pressure gradually drops.

QUICKVID

To cement your understanding, take a look at a short video comparing redistribution of blood at rest and during exercise. Link via http://vcepe12.nelsonnet.com.au

Weblink

CHAPTER CHECK-UP

1 What are the major differences between the cardiovascular systems of males and females?

2 Why does systolic blood pressure show a greater increase than diastolic blood pressure during exercise?

3 Precapillary sphincters can redirect blood to the skin's surface to assist in cooling the body down. Describe how this happens.

4 What happens to blood flow to the stomach and muscles if a person has a meal and then goes for a swim?

Australia leading the way in heart transplants

Alamy Stock Photo / BSIP SA

by Melissa Gray, CNN, 25 October 2014

Pioneering heart transplant surgery announced Friday in Australia may lead to a new option for patients awaiting transplants by boosting the number of donor hearts available.

Doctors at St. Vincent's Hospital in Sydney said they performed three successful transplants of hearts that had naturally stopped beating in the donor, rather than using the typical method of removing donor hearts from patients who are brain-dead but still have cardiovascular function.

The donor hearts had stopped beating for as long as 20 minutes before surgeons were able to remove them from the patients. The three surgeries were done in the past few months. All patients are doing well; one of them told reporters she feels like a 'different person' who can perform more physical activity than before the surgery.

The procedure involves injecting the hearts with a preservation solution developed by the institute and hospital, then placing them in a machine that perfuses them with warm oxygenated blood. The machine keeps the heart replenished with oxygen, nutrients and hormones during transport, according to TransMedics, the maker of the machine.

Typically, donated organs are transported on ice, which carries the risk of damage.

The Victor Chang Cardiac Research Institute in Sydney, which worked with St. Vincent's on the procedure, said it 'will result in a major increase in the pool of hearts available for transplantation.'

The transplanting of hearts that have naturally stopped beating in donors – which are called DCD hearts, for 'donors after circulatory death' – is already the subject of research internationally, said Dr. Joseph Woo, a cardiothoracic surgeon at Stanford Health Care and chairman of cardiothoracic surgery at Stanford Medicine in Palo Alto, California.

Stanford researchers have been studying the process in human DCD hearts, and researchers elsewhere are studying it in pigs and other animals, he said. Transplants involving other DCD organs such as kidneys, livers and lungs are already widely accepted, he said.

In 2008, an article in the *New England Journal of Medicine* reported the successful transplants of DCD hearts into infants at Denver Children's Hospital. Three babies younger than 18 months received hearts from donors who had died from cardiocirculatory causes; the recipients' six-month survival rate was 100%, according to the article.

The authors, all members of the hospital's Pediatric Heart Transplant Team, said the results were promising for others awaiting critical transplants. 'Donors who died from cardiocirculatory causes offer an opportunity to reduce waiting time and waiting-list mortality among children whose survival depends on a heart transplant,' wrote the authors.

'For pediatric heart donation and transplantation involving patients who die from cardiocirculatory causes to become a more frequent option for end-of-life care and to affect significantly the nationwide risk of dying while waiting, the concept of distant sharing of donated organs from these donors should be considered.'

Woo said the number of heart transplants in the United States has remained at around 2,000 for years, limited by the number of viable donors. New methods like the one performed successfully in Australia may help save more lives.

>

'The thinking is if you change the way that families are able to permit donation, that you might have more donors,' he said. Two of the patients who received the new hearts in Sydney beamed as they spoke to reporters Friday. Michelle Gribilas said she feels years younger. Before the surgery, she couldn't walk more than 100 metres at a time.

'I'm a different person altogether. Like I walk 3 kilometres a day, I go up the stairs, about 120 … stairs a day,' she said. 'It's a wild thing to get your head around, that your heart's (come from) a stranger, someone you don't know – part of them is now inside you,' said another recipient, Jan Damen. 'It's a privilege. It's an amazing thing.'

Source: http://edition.cnn.com/2014/10/24/health/australia-heart-transplants/

Questions

Research the following:

1 How many Australian heart transplants occur every year?
2 People often say that the first few weeks following transplant surgery are the hardest – why is this?
3 The procedures discussed in the article involve transplanting actual hearts that have come from other people. See if you can find out where medical science currently is with regard to successfully transplanting a mechanical heart, and how many additional years of life this might offer recipients.

LABORATORY

HEART RATE AND BLOOD PRESSURE

AIM

To investigate heart rate and blood pressure response during rest and exercise for different class members.

Scaffold

EQUIPMENT

Exercise bike (Repco, Monarch or similar), blood-pressure monitor (preferably electronic) or sphygmomanometer, heart-rate monitor (manual readings are acceptable)

METHOD

1 Divide the class (wherever practical) into three groups, according to the kind of exercise they do in their daily lives:
   - Group 1 – students involved in no training
   - Group 2 – students involved in aerobic training
   - Group 3 – students involved in anaerobic training
2 Work in pairs. One student takes a comfortable seated position on the exercise bike and has their resting blood pressure and heart rate recorded by the other student. The student on the bike starts pedalling. Once they have reached 75 watts workload, they maintain an even pace for 3 minutes. Their heart rate and blood pressure are recorded over the last 15 seconds of this 3-minute period. Then, over the next minute, the student should slow their pedalling rate down to stationary.
3 Record the heart rate and blood pressure at the end of the first minute of 'cool-down' and then again at the 3-minute mark of rest/recovery.
4 Repeat steps 2 and 3 for a workload of 300 watts.
5 Use a table similar to this to record your results. There is a blank table online if you prefer, at http://www.nelsonnet.com.au and use your login code.

	Workload	
	75 watts	300 watts
Heart rate		
Resting		
End of 3-minute exercise period		
First minute of recovery		
Third minute of recovery		
Systolic blood pressure		
Resting		
End of 3-minute exercise period		
First minute of recovery		
Third minute of recovery		
Diastolic blood pressure		
Resting		
End of 3-minute exercise period		
First minute of recovery		
Third minute of recovery		

6 Share the heart/pulse rates for the class. Construct two graphs, one for each workload, showing the effect exercise has on both heart rate and blood pressure for each member of the different groups.

DISCUSSION

1 What is the relationship between systolic blood pressure and exercise intensity?

2 Are there any differences in either heart rate or blood pressure response to the different workloads from students in each of the three groups?

3 Are there any advantages to having blood pressure increase minimally in response to exercise?

4 During recovery, which group took the longest for heart rates and blood pressure to return to resting levels?

THERMOREGULATION

Homeostasis

Homeostasis literally means 'same state', and it refers to the process of keeping the internal body environment in a steady state when the external environment has changed. All homeostatic mechanisms use negative feedback to maintain a constant value (called the set point). Temperature homeostasis, known as thermoregulation, is controlled by the thermoregulatory centre in the hypothalamus. It receives input from two sets of **thermoreceptors**: receptors in the hypothalamus itself monitor the temperature of the blood as it passes through the brain (the core temperature), and receptors in the skin (especially on the trunk) monitor the external temperature. Both sets of information are needed so that the body can make adjustments as required. The thermoregulatory centre sends impulses to several different effectors to adjust body temperature.

TABLE 5.3 The way our body changes to meet external changes, causing decreases or increases in core temperature and associated physiological responses

CORE TEMPERATURE OF BLOOD									
DECREASE				↓	↓		INCREASE		
HYPOTHERMIA				↓	↓		HYPERTHERMIA		
Mild hypothermia: 32–35 °C **Moderate hypothermia:** 28–31 °C **Severe hypothermia:** Lower than 28 °C							**Heat cramps:** 36–37 °C **Heat exhaustion:** 37–40 °C **Heat stroke:** Higher than 40 °C		
↓			HYPOTHALAMUS = 'THERMOSTAT'				↓		
HEAT CONVERSION RESPONSES						HEAT LOSS RESPONSES			
↙	↓	↓	↘			↙	↓	↓	↘
Vasoconstriction	Increased metabolism	Shivering	Body hair raised			Vasodilation	Decreased metabolism	Sweating	Body hair lowered
RETURN TO CORE TEMPERATURE OF BLOOD									

Hypothermia and hyperthermia are conditions that occur when body mechanisms are overwhelmed and the hypothalamus is trying to bring the body 'back to normal'. When the core temperature of the body falls below the minimum temperature required to maintain basic metabolic functions, it is called hypothermia, and when the body gains more heat than it loses it is called hyperthermia.

Hypothermia

Causes of hypothermia

During exposure to cold environments, most heat loss escapes through the skin (up to 90 per cent). The remainder tends to be exhaled from the lungs. Heat loss through the skin happens primarily through radiation and speeds up when skin is exposed to wind, moisture or cold water.

The hypothalamus, the brain's thermostat, works to raise body temperature by triggering processes that heat the body. Shivering when exposed to cold temperatures is a protective response designed to produce heat through muscle activity. In another heat-preserving response, the blood vessels temporarily narrow via vasoconstriction.

Alamy Stock Photo / Gordon Shoosmith

UK television presenter Davina McCall (leaning on the side of the canoe) was rescued from the freezing waters of Lake Windermere after completing a 2.4-km charity swim. She was immediately taken into medical care due to concerns she was suffering hypothermia.

The heart and liver produce most of our body heat, but as core body temperatures drop, these organs produce less heat, due to a protective 'shut down' designed to preserve heat and protect the brain. Low body temperature can slow brain activity, breathing and heart rate. Confusion and fatigue can set in, hampering a person's ability to understand what is happening and make intelligent and informed decisions.

Hypothermia symptoms coincide with the physiological body responses and include:

» shivering, which may stop as hypothermia progresses (shivering is actually a sign that a person's heat regulation systems are still active)
» slow, shallow breathing
» confusion
» drowsiness, muscular fatigue, exhaustion
» slurred/mumbled speech
» loss of coordination
» a slow, weak pulse (hypotension).

FYI

Heat loss due to being immersed in cold water can occur 25 times faster than it would if exposed to air of the same temperature.

Treatment for hypothermia

Hypothermia is a potentially life-threatening condition that needs emergency medical attention. If medical care isn't immediately available:

» Remove any wet clothes, including hats, gloves, shoes and socks.
» Protect the person against wind, draughts and further heat loss with warm, dry clothes and blankets.
» Move the person gently to a warm, dry shelter as soon as possible.
» Begin rewarming the person with extra clothing. Use warm blankets. Other helpful items may include an electric blanket to the torso area and hot packs and heating pad on the torso, armpits, neck and groin; however, be aware that these can cause burns to the skin. Use your own body heat if nothing else is available.
» Offer warm liquids, but avoid alcohol and caffeine, which speed up heat loss. Don't try to give fluids to an unconscious person.

If the hypothermic person is unconscious, or has no pulse or signs of breathing, call 000 immediately. If a pulse can't be felt and there is no sign of breathing, CPR should be given immediately. Feel for the pulse for up to a whole minute before starting CPR, because the heart rate may be extremely slow. You should not start CPR if there is any heartbeat present.

FYI

During exercise, heat produced by the working muscles can increase to up to 15–20 times that of resting levels. This translates to a 1 degree Celsius increase in core body temperature every five minutes. Excessive heat build-up can do tremendous damage to the human body and, in extreme cases, can be fatal.

Hyperthermia

Under normal conditions, the body's thermoregulatory system maintains a constant body temperature of 37 °C and increases blood flow to working muscles during exercise. There is a concurrent increase in sweating and evaporation to counter this heat production. This so-called 'cooling' mechanism continues to work as long as an adequate volume of body fluid is maintained. Dehydration causes surface blood vessels to constrict, effectively halting sweat production to conserve blood volume. This leads to a dramatic increase in core temperature, breakdown in the thermoregulatory system, and a concurrent increase in body temperature. Hyperthermia develops when the body gains more heat than it loses.

When the body's core temperature begins to rise, this tends to occur in three stages – heat cramps, heat exhaustion and heat stroke – with the last being the most serious.

Heat cramps

Heat cramps are often an early sign of heat illness and dehydration. Typically, the athlete complains of cramping in the specific muscles exercised, which cannot be relieved with stretching. Cramps can occur after intense, prolonged exercise and result from water loss and imbalances of body electrolytes. Physical exhaustion and dizziness (especially notable in younger participants) may also be experienced. Poorly acclimatised athletes are more susceptible. It is important to immediately treat the athlete in order to avoid more serious thermal injury.

Getty Images / Al Bello

On the first two days of the US Tennis Open 2015, 12 players retired due to heat-related injuries. For the second straight year, American Jack Sock was affected by the heat and cramps at the US Open.

Heat exhaustion

Heat exhaustion is more serious, and is caused by an excessive loss of body fluids due to prolonged sweating. This condition is characterised by profuse sweating, cool, clammy and pale skin, and a weak, rapid pulse. The athlete is usually lightheaded, experiences chills or shivering and is unable to concentrate. If left untreated, this can progress to heat stroke, which is a severe, acute life-threatening injury that can quickly result in severe brain damage or death.

Heat stroke

Heat stroke is an emergency requiring immediate medical attention and is characterised by three major symptoms – core temperature greater than 40 °C, marked mental confusion and/or unconsciousness, and shock. The individual will likely not be sweating, and their skin will be hot, dry and red. Their pulse will be rapid and bounding and their breathing fast and deep.

First aid and treatment

Heat cramps: this relatively mild condition is a warning to decrease or stop exercise. Remove the athlete from the heat source, re-hydrate with fluids such as water and diluted fruit juices, and monitor for symptoms of a more serious thermal injury. Eating fresh fruit such as a banana will help replenish potassium.

Heat exhaustion and **heat stroke:** remove the athlete from the heat source and move them to a cool area (in the shade or indoors). Heat stroke deaths are directly related to the length and degree of temperature elevation, so the aim is to bring the temperature down to normal as soon as possible. The person's clothing should be loosened or removed. Sponging cold water on their body while cooling them with a fan will help increase the rate of heat loss. If shivering occurs, stop fanning the body.

As long as the athlete is conscious, have them drink cool fluids. In cases where the athlete is unconscious, seek emergency medical attention so IV fluids can be applied. Finally, applying ice packs to major arteries in the neck, groin and armpit regions and placing cold, water-soaked sheets, towels or clothing over the athlete will help cool the blood returning to the heart.

INVESTIGATION

Link via http://vcepe12.nelsonnet.com.au to a website with an animation showing the physiological changes that occur as core temperature changes.

Weblink

CHAPTER CHECK-UP

1 Why do muscles shiver when core temperatures drop – wouldn't it be better to conserve energy?

2 Cramps are often caused by loss of electrolytes. Investigate the importance of electrolytes in maintaining homeostasis. You may want to read the fact sheet about electrolytes on your student website. Go to http://nelsonnet.com.au and use your login code.

3 Explain what 'wind chill factor' is, and how it relates to hypothermia.

Fact sheet

QUICKVID

Go to http:/nelsonnet.com.au and enter your login code to see a short video of the author explaining vasodilation and vasoconstriction, and redistribution of blood to areas requiring oxygen or heat dissipation.

Video

REAL WORLD APPLICATION

Getting your body used to the heat — inside and out

Fairfax Media NZ / Waikato Times

By Tawnee Prazak, 24 July 2014

What is heat acclimatisation, and why is it important?

Fortunately, the human body can adapt to the stress of heat with repeated exposure, resulting in less strain and increased comfort. So whether you're training for a hot race or live in a hot climate, here's what you need to know about heat acclimatisation for optimal performance.

What happens with acclimatisation?

1 You become a better sweater:

After acclimatising to exercise in the heat we begin to sweat earlier, we sweat more and at a faster rate, our sweat glands fatigue less and the body better distributes sweat.

There's also less sodium content in the sweat, which helps with water retention and maintaining fluid levels to prevent dehydration. The result of better sweating is better cooling, meaning skin and core temperatures stay within reason and early fatigue, hyperthermia and heat illness are less likely. Fluid intake is essential to maintain these functions.

2 Cardiovascular function improves:

Benefits include a decrease in heart rate, increase in plasma volume and improved blood flow. With more plasma, there's more blood available to go to the skin's surface for heat dissipation and to the working muscles. Most important, adaptations put less stress on the heart, resulting in a decrease in heart rate at any given intensity and increase in stroke volume (amount of blood pumped out of the heart chamber).

3 Exercise performance increases:

The non-acclimatised person will run slower and fatigue faster in heat; but, as acclimatisation takes place, these negative effects will fade and running capacity and performance will increase due to improved thermal comfort and lower perceived exertion.

How to acclimatise

Each runner is slightly different, but generally it takes about two weeks of continual training in the heat to acclimatise. Averaging at least one hour of moderate exercise daily in hot conditions is enough to get results in that timeframe. Gradually ease into heat training by keeping a low intensity at first (quality runs can be done in a cool gym).

Depending on your normal running volume, fitness level, and natural heat tolerance, you may need to reduce your running volume slightly or significantly in the first days of heat exposure. As adaptations occur, intensity and volume can increase.

Certain adaptations occur quicker than others. Decreased heart rate can occur in as little as five days, while changes in sweating response could take weeks. Furthermore, trained endurance athletes usually adapt faster than untrained individuals.

How long does acclimatisation last?

Unfortunately, adaptations to heat are reversed at twice the rate they are acquired once exposure to heat ends. Generally, most adaptations will be lost in about two weeks. The first to go are cardiovascular improvements.

Adapt your own environment

Training in cool conditions for two to three months at intensities above 50 per cent VO_2 max (66 per cent of max heart rate) will evoke some physiological adaptations that are beneficial to exercising in heat. The key is maintaining an elevated core temperature during long, continuous exercise bouts. The adaptations aren't as substantial as heat training itself, but they're better than nothing.

There's also the option of creating an artificial hot and/or humid environment by wearing extra clothing during exercise, training in a hot room, using a humidifier, etc.

Hydrate properly

Guzzling fluid does not enhance the effects of acclimatisation. However, failure to hydrate enough

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to replace sweat loss has negative implications that are intensified in heat, negating adaptations to heat. Consequences of under-hydrating include decreased skin blood flow, decreased sweat rate and heat dissipation, reduced blood volume and increased core temperature. A decrease of just 2 per cent in body weight via sweat loss means dehydration is setting in and performance will start to suffer.

Fluid requirements may double when exercising in heat. To find your specific needs, practise weighing yourself before and after exercise. Weight lost, if any, is weight that needs to be replaced via hydration.

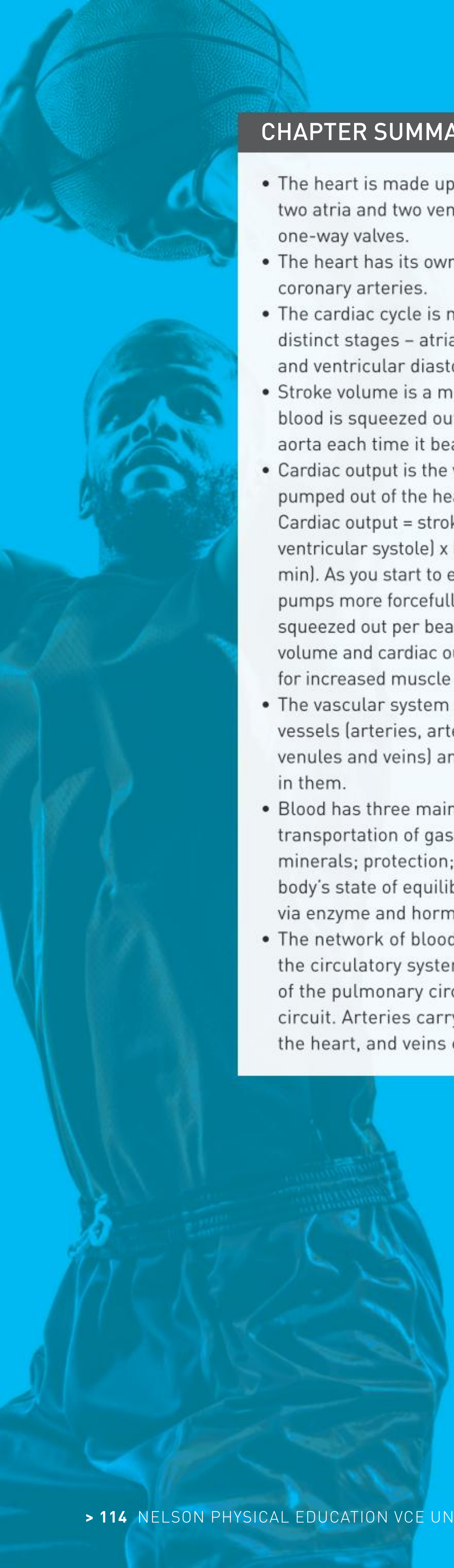
Plan your race strategy

Arriving at the event site at least two weeks before the race to train would be ideal; however, this is not always practical and trying to acclimatise right before a race can interfere with tapering. If heat training occurred at home, arriving three to seven days before a race is advised to allow further adjustments to the specific climate.

Also, research the weather conditions at the race venue. Dry heat and humid heat are very different, and adaptations made in dry heat may not provide necessary benefits for exercising in humidity (remember: humidity hinders sweat evaporation, and thus negatively affects cooling).

Questions

1. How would increasing tolerance time in heat by 15–20 per cent be an advantage to a marathon runner preparing to compete in a much warmer climate?
2. List two advantages associated with setting up a 'simulated hot environment' to train in, compared to actually travelling to a hotter training environment/location.
3. List three benefits associated with drinking sports drinks, and explain why they are flavoured.
4. Why do coaches weigh athletes when they train/compete in warm/hot conditions?



CHAPTER SUMMARY

- The heart is made up of four chambers – two atria and two ventricles – separated by one-way valves.
- The heart has its own blood supply via the coronary arteries.
- The cardiac cycle is made up of four distinct stages – atrial diastole and systole, and ventricular diastole and systole.
- Stroke volume is a measure of how much blood is squeezed out of the heart into the aorta each time it beats, i.e. per systole.
- Cardiac output is the volume of blood pumped out of the heart per minute: Cardiac output = stroke volume (mL per ventricular systole) x heart rate (beats per min). As you start to exercise, your heart pumps more forcefully and more blood is squeezed out per beat, so both the stroke volume and cardiac output increase to cater for increased muscle contractions.
- The vascular system consists of the blood vessels (arteries, arterioles, capillaries, venules and veins) and the blood that flows in them.
- Blood has three main functions: transportation of gases, fuels and minerals; protection; and maintaining the body's state of equilibrium (homeostasis) via enzyme and hormone regulation.
- The network of blood vessels is known as the circulatory system, which is made up of the pulmonary circuit and the systemic circuit. Arteries carry blood away from the heart, and veins carry blood back to the heart. Blood returning to the heart in veins is assisted by muscular and respiratory contractions.
- Precapillary sphincters regulate the distribution of blood through capillaries. During exercise, they direct more blood to working muscles and less to major organs, thereby transporting more oxygen and fuels to muscles and facilitating removal of wastes.
- Vasodilation results in blood vessels widening so more oxygen and fuels can be transported to working muscles, along with greater removal of by-products.
- Vasoconstriction results in blood vessels narrowing and less oxygen and fuels reaching muscles and vital organs.
- Blood pressure is the force exerted by the blood against the blood vessel walls. It is greatest during ventricular systole (systolic blood pressure) and lowest during ventricular diastole (diastolic blood pressure).
- Homeostasis refers to the process of keeping the internal body environment in a steady state when the external environment is changed. This is controlled by the hypothalamus.
- When the core temperature of the body falls below the minimum temperature required to maintain basic metabolic functions, this is called hypothermia. When the body gains more heat than it loses, it is called hyperthermia.

CHAPTER REVIEW

Multiple-choice questions

1 During exercise, cardiac output:
   A decreases as heart rate increases
   B increases up to about 60% max HR and then levels off
   C increases linearly throughout
   D represents the amount of blood reaching working muscles.

2 When vasodilation occurs at the blood vessels supplying the muscles:
   A less blood is directed towards the muscles
   B more blood is directed to the brain and heart
   C less blood is sent through the pulmonary circuit
   D vasoconstriction occurs at vessels supplying major organs.

3 The blood vessel that supplies blood to most of the body is the:
   A superior vena cava
   B pulmonary vein
   C pulmonary artery
   D aorta.

4 The main function of plasma is to:
   A transport red blood cells via the vascular system
   B remove wastes
   C regulate body temperature
   D do all of the above.

5 The following are likely symptoms of hyperthermia:
   A uncontrolled shivering
   B slow and shallow breathing
   C a pulse that is rapid and bounding and breathing that is fast and deep
   D a slow, weak pulse.

Short-answer questions

6 Explain how vasoconstriction and vasodilatation occur in the body and the effect they have on the performance of an athlete.

7 Draw a simple flow chart or diagram to demonstrate an understanding of the movement of blood between the heart and lungs. Draw oxygenated blood as red and deoxygenated blood as blue, and use arrows to show direction of flow.

8 Plan a three-day acclimatisation camp for a group of Year 12 students who are travelling to Darwin to play in a major hockey tournament. They will be required to play two matches per day in temperatures that will exceed 38 °C, and the humidity throughout the competition is predicted to be high to very high.

9 Some athletes increase their red blood cell count illegally by using 'blood boosting' practices that are prohibited by WADA.
   a Discuss how this practice would benefit an endurance athlete such as a marathon runner or triathlete.
   b Discuss at least two potential harms that could be detrimental to athletes using this practice to boost their red blood cell count.

CHAPTER 6

THE RESPIRATORY SYSTEM

Key knowledge

» the structure and function of the respiratory system, including the structure and function of the lungs, mechanics of breathing and gaseous exchange at the alveoli/capillary and the capillary/muscle interfaces

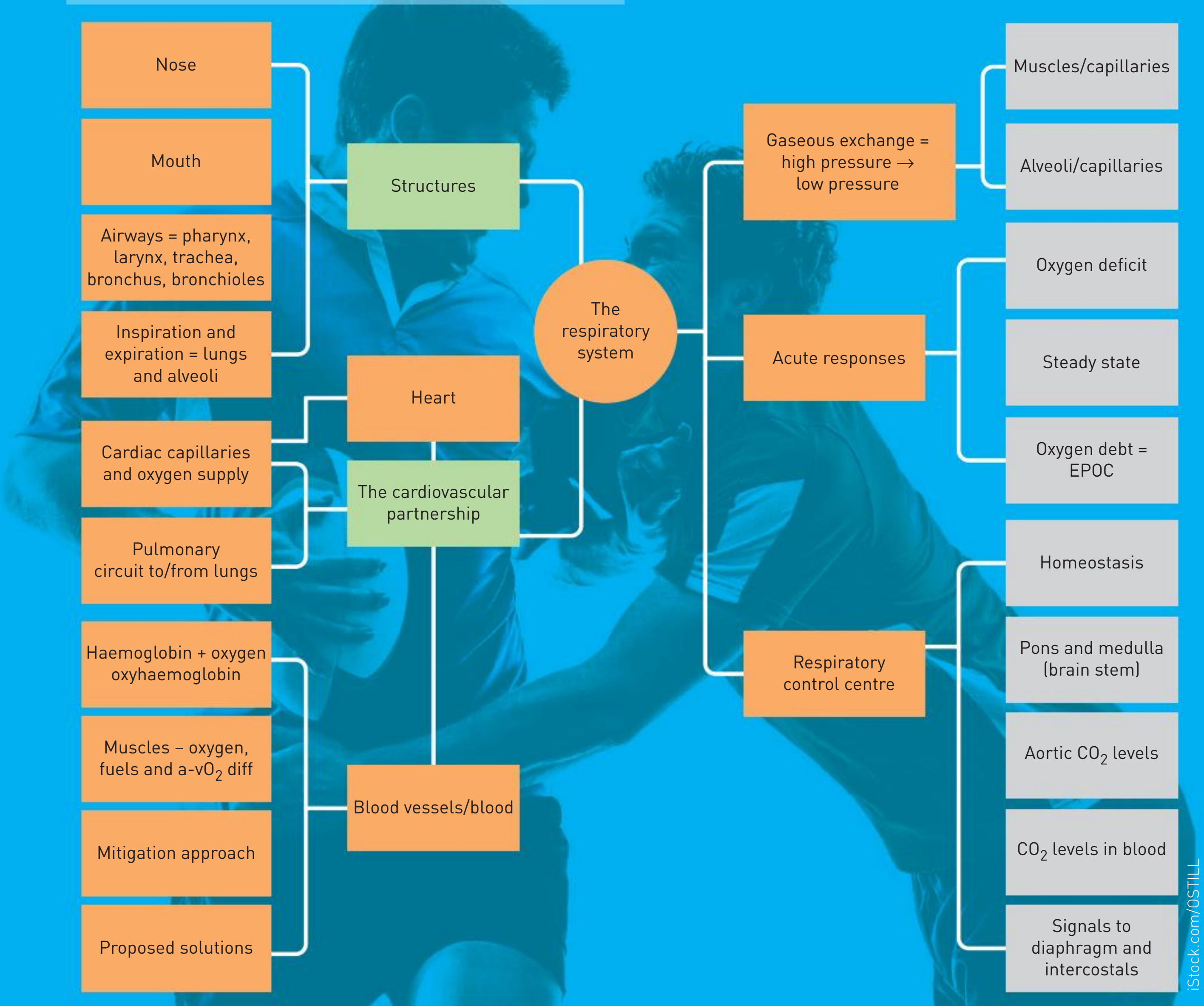
» the interrelationship of the cardiovascular and respiratory systems to transport oxygen around the body at rest and during exercise

Key skills

» use and apply correct anatomical terminology to identify the structures of the cardiovascular and respiratory systems

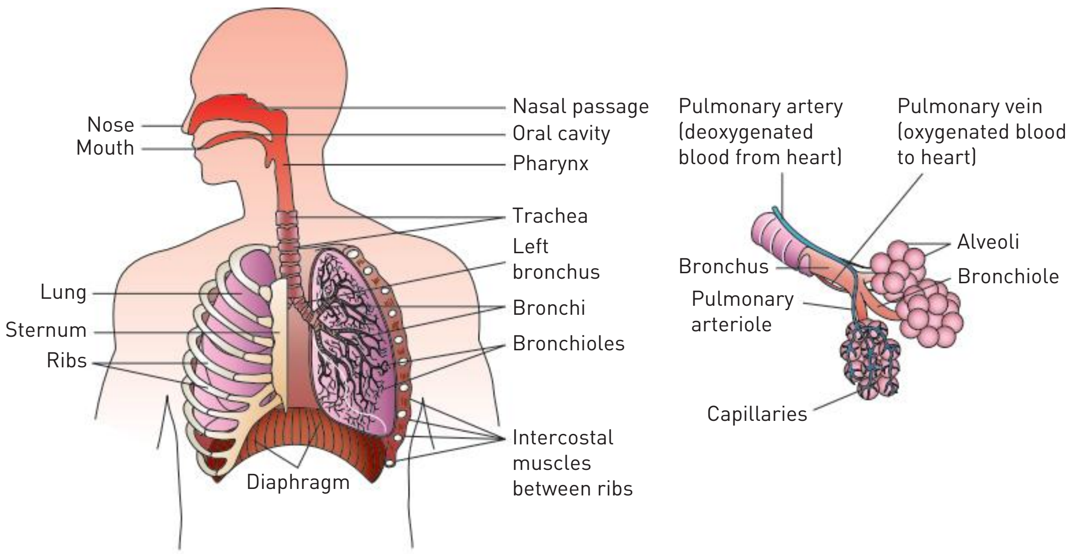
» describe the process of gaseous exchange

» perform, measure and report on changes to the cardiovascular and respiratory systems at rest compared with during exercise



iStock.com/OSTILL

THE RESPIRATORY SYSTEM



The respiratory structures, including the branching of the bronchus and the alveoli

Structure and function

The respiratory system comprises the mouth, nose, airways and lungs. Most of the system is encased and protected by the ribs, sternum and vertebrae. External respiration involves air/gases moving into and out of the lungs, whereas movement of gases from the lungs into the bloodstream is known as **pulmonary diffusion**.

Inspiration and expiration

Humans breathe in actively by contracting the intercostal muscles and the diaphragm. When the intercostal muscles contract, the ribs move upwards and outwards, and at the same time the diaphragm contracts downwards. These actions increase the size of the thoracic cavity and the space within the lungs, causing the pressure within the lungs (intrapulmonary pressure) to decrease to less than that of air outside the body. Gases always move from areas of higher pressure to lower pressure, so air moves into the lungs quickly. This is known as inspiration.

Expiration, on the other hand, is passive and occurs in response to the intercostal and diaphragm muscles relaxing. When this happens, the ribs drop and the diaphragm adopts its relaxed dome-like shape in the thoracic cavity. The space inside the lungs decreases, while air pressure increases until it exceeds that of air outside the body and air is exhaled or expired.

The amount of air inhaled and exhaled per breath is known as the tidal volume (TV). Men generally have a larger lung capacity than women, so their resting tidal volumes tend to be greater. The average tidal volume for men is 600 mL, and the average for women is 500 mL.

Pulmonary ventilation (or minute ventilation) refers to the volume of air moved into and out of the respiratory tract each minute. This can be calculated from:

$$\text{Minute ventilation } (V_E) = \text{respiratory rate x tidal volume}$$

$$\text{At rest, minute ventilation} = 12 \text{ breaths/min x } 0.5 \text{ L/breath} = 6.0 \text{ L/min.}$$

FYI

Just as a stroke volume tends to peak sub-maximally, tidal volume does the same. As oxygen demands increase, greater amounts are delivered from the lungs by increasing the respiratory or breathing rate.

Weblink

QUICKVID

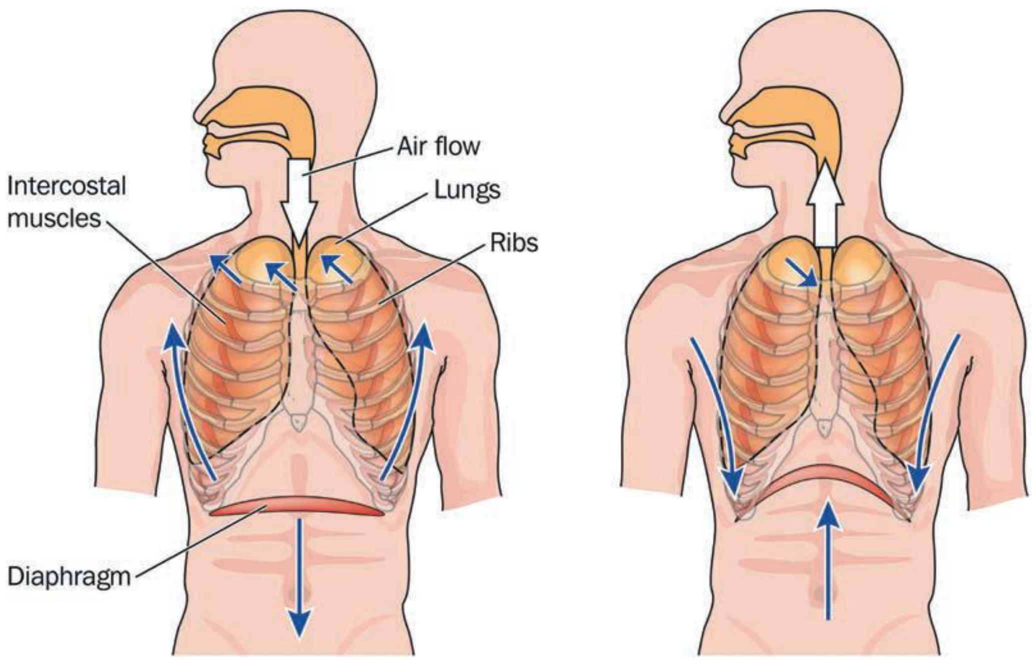
Take a couple of minutes to watch this video by Health Education and Training (2013) that summarises inspiration and expiration and associated pressure changes. Link via http://vcepe12.nelsonnet.com.au.

TABLE 6.2 Immediate changes to respiration as a result of exercise at different intensities for an adult female

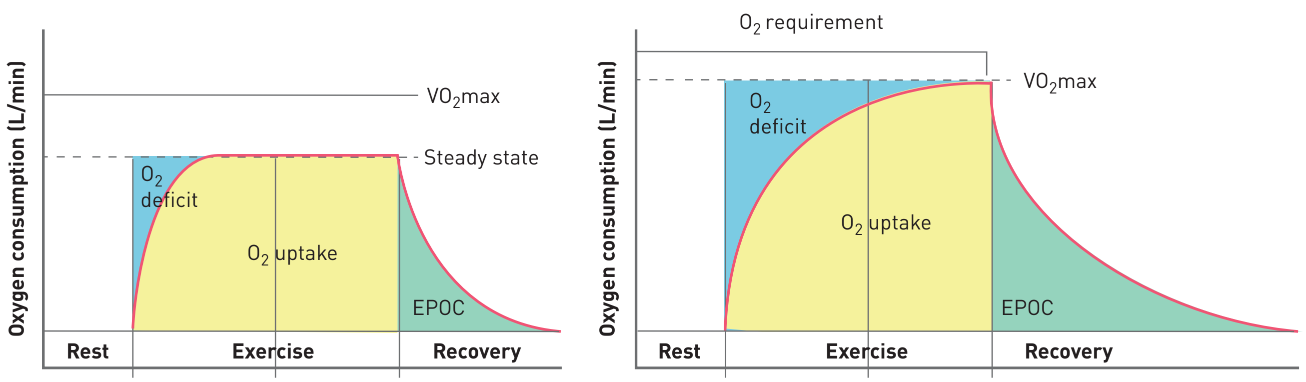
State	Respiratory rate (breaths/min)	Tidal volume (L/ breath)	Minute ventilation (L/min)
Rest	12	0.5	6.0
40–50% max HR exercise	25	2.5	62.5
85–95% max HR exercise	60	2.5	150.0

During exercise, the frequency and depth of breathing increases in order to supply more oxygen to working muscles. At the commencement of exercise and also when workloads are increased, the demand for oxygen exceeds the body's ability to supply it and a period of **oxygen deficit** occurs. If an athlete works submaximally, oxygen demand will level off and they will experience **steady state**. This occurs when oxygen supply can meet oxygen demand and is commonly experienced when jogging or walking at a steady pace.

Shutterstock.com/Blamb



During inhalation (left), air flows into the lungs due to increased lung volume following contraction of diaphragm and intercostal muscles. During exhalation (right), air is expelled from the lungs due to the relaxation of the diaphragm and intercostal muscles.



Oxygen consumption at rest, submaximal and maximal exercise intensities and associated recovery. a) Low to moderate-intensity exercise; b) maximal intensity exercise
Source: W. McArdle, F. Katch, V. Katch, *Exercise Physiology: Energy, Nutrition and Human Performance*, 6th edn, Lippincott Williams & Wilkins, Chicago, 2007

When exercise intensity increases, a point is reached where oxygen supply can no longer meet demand and another deficit occurs. At highest intensities a point is reached where the maximum amount of oxygen that can be taken in, transported and utilised – known as **VO_2 maximum** – is reached. This intense exercise cannot be sustained for extended periods as the body will not be able to supply sufficient oxygen to meet these high demands and fatigue will soon set in.

When exercise, training or competition ceases, oxygen demands drop and oxygen consumption levels gradually return to resting levels. This post-exercise period where oxygen consumption remains above resting levels is known as oxygen debt or excess post-exercise oxygen consumption (**EPOC**). Athletes with high aerobic capacity, such as those training for endurance events, will see a faster return to resting levels of oxygen consumption compared to others who have lower levels of aerobic training and associated adaptations.

How does the brain control breathing?

Breathing is controlled by a respiratory control centre located in your brain stem that constantly monitors the levels of oxygen and carbon dioxide in the bloodstream and adjusts breathing rates to maintain balance and **homeostasis** in the body. When a person is at steady state (rest or exercise) the right amount of oxygen is transferred to their blood when they inhale, and the right amount of carbon dioxide is exchanged and exits the blood when they exhale.

When a person performs activities that require additional oxygen, the oxygen levels in their blood decrease, while carbon dioxide levels increase. The respiratory control centre of the brain senses that the levels are incorrect and increases both the heart rate and breathing rate to make up the difference. This is also supported by oxygen and carbon dioxide sensors located in the aorta, which monitor concentration levels of these gases as blood leaves the heart.

As the activity stops, the respiratory control centre slows the heart and breathing rate back down to maintain homeostasis in the bloodstream.

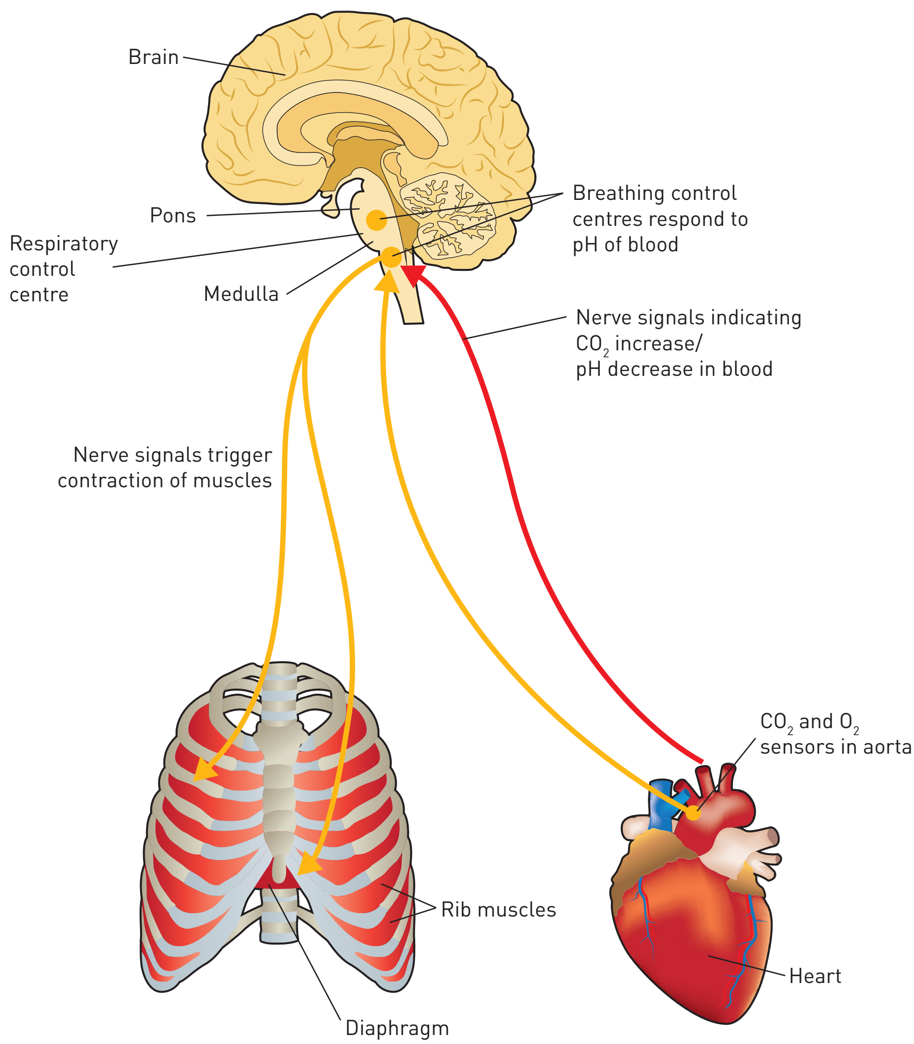
FYI

The build-up of carbon dioxide makes the blood acidic, and this, more than lack of oxygen, is what prompts the respiratory control centre to signal the lungs to increase breathing rates.

QUICKVID

This short video will reinforce some key knowledge about the respiratory system, especially control of breathing. Link via http://vcepe12.nelsonnet.com.au.

Weblink



The respiratory control centre and aortic sensors monitor CO_2 and O_2 levels to ensure that the body's demands can be met quickly.

FYI

Hyperventilation causes a drop in CO_2 below normal levels, lowering blood and oxygen supply to vital organs due to CO_2-induced vasoconstriction, which can cause tissue oxygen levels to drop dangerously low, leading to fainting.

CHAPTER CHECK-UP

1. Briefly discuss how the diaphragm and intercostal muscles work together to bring about inspiration and expiration.
2. Explain how being 'winded' affects the mechanics of breathing.
3. Most athletes perform a warm-up prior to competing. Briefly discuss how this improves oxygen uptake when they start their activity and how this decreases oxygen deficits.
4. Under what sporting circumstances would athletes deliberately try to keep their oxygen consumption above resting levels for as long as possible during recovery?

Transfer and transport of gases

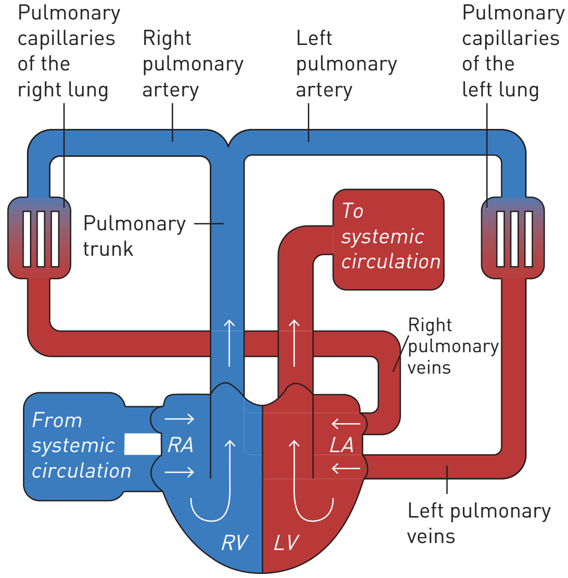
Pulmonary diffusion is the gaseous exchange that occurs at the lungs. This has two main functions:

» to provide the blood with oxygen before the blood is transported to muscles and other cells within the body

» to remove carbon dioxide from the blood returning from the muscles and other cells.

At the alveoli a two-way exchange occurs, in which oxygen moves from the alveoli into the blood and carbon dioxide moves from the blood to the alveoli. The pulmonary capillaries surrounding the alveoli contain blood that is oxygen poor and therefore has a low oxygen pressure because it has been used by working muscles. This pressure difference causes oxygen to move from the alveoli into the blood. At the same time, carbon dioxide is present at a higher pressure and concentration than in the pulmonary capillaries, so it moves from the blood into the alveoli, to then be expired.

You will recall that blood supplying the lungs and alveoli makes up part of the pulmonary circuit – see the diagram at right. The carbon dioxide removed from the blood and transferred into the alveoli is exhaled with each breath. The oxygen-rich blood in the capillaries continues flowing back to the heart, and this blood is then pumped to the rest of the body to provide muscles and tissues with vital amounts of oxygen. In this way, the respiratory system partners with the cardiovascular system to transport oxygen from the lungs to the working muscles and to remove carbon dioxide and other wastes from the muscles, transporting them to the lungs and liver.



A diagram of the pulmonary and systemic circuits. Notice how the pulmonary circuit only involves flows to and from the lungs.

QUICKVID

Look at this video showing gaseous exchange and structures of the respiratory system. Link via http://vcepe12.nelsonnet.com.au.

Weblink

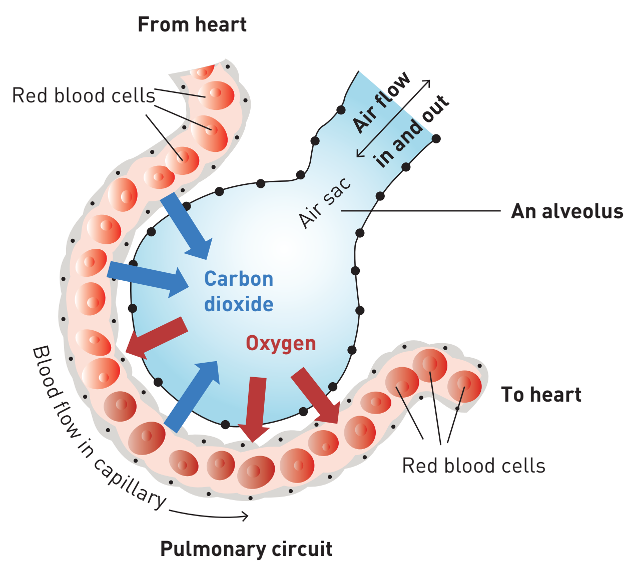
Most oxygen is transported in combination with haemoglobin (Hb) by the red blood cells. When oxygen and haemoglobin combine, they form oxyhaemoglobin.

haemoglobin + oxygen → oxyhaemoglobin

$$\text{Hb} + O_2 \rightarrow \text{HbO}_2$$

This means the amount of oxygen that can be transported depends on haemoglobin levels, which may be increased along with blood volumes in response to long-term aerobic training. Haemoglobin levels can also be increased by illegal means such as the use of blood doping or EPO (erythropoietin; see chapter 8).

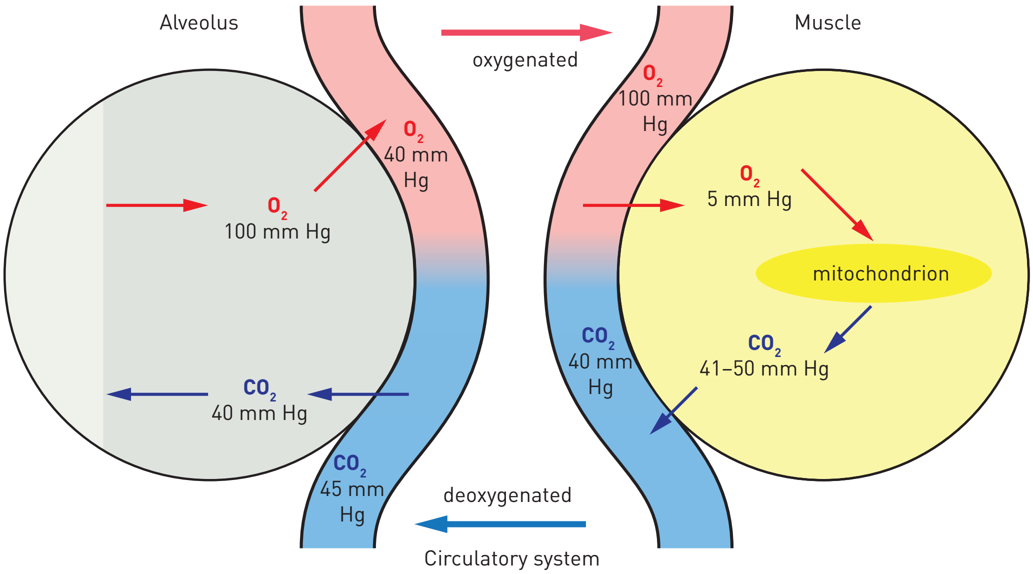
Only 20 per cent of the carbon dioxide produced at cells and muscles is transported via haemoglobin. Most of it (70 per cent) travels in the blood as a bicarbonate ion, and is non-gaseous, and a small amount (7 per cent) is dissolved in blood plasma. Once again, carbon dioxide is removed via concentration and pressure gradients, and it moves from areas of high pressure and concentration, such as the tissues/muscles, to the blood, which transports it to the alveoli so it can then be expired.



Blood flow through a capillary surrounding an alveolus. CO_2 is given off and O_2 is taken up.

FYI

Each molecule of haemoglobin can combine with four molecules of oxygen, and every 100 mL of blood can transport approximately 20 mL of oxygen.



Gaseous exchange at the lungs and muscles sees oxygen and carbon dioxide move from areas of high pressure to areas of lower pressure. These essentially move in opposite directions, and are thus 'exchanged'.

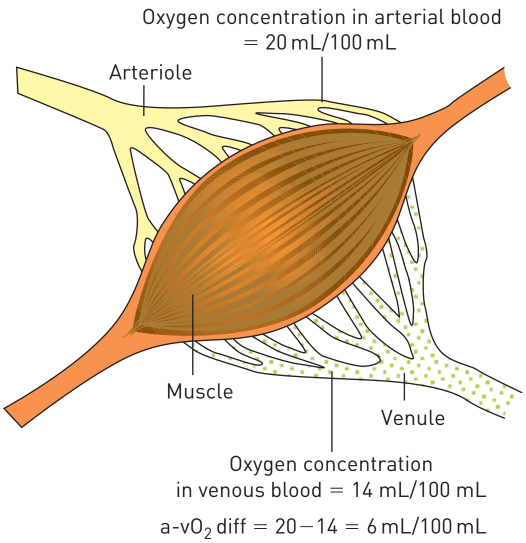
Arteriovenous oxygen difference

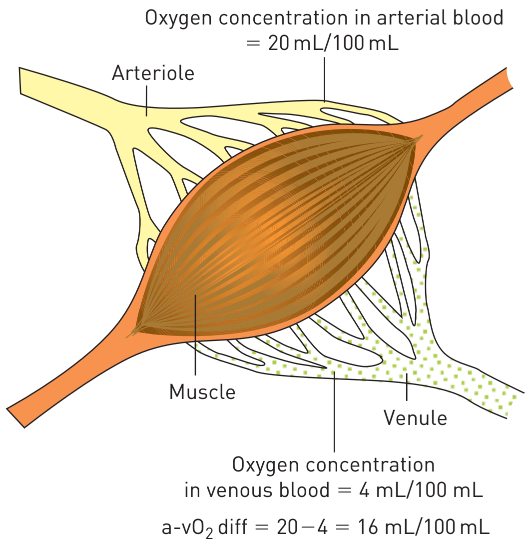
The arteriovenous oxygen difference (a-vO_2 diff) is an indication of the difference in oxygen concentration between arterial and venous blood. At rest, the a-vO_2 diff is approximately 5 mL of oxygen per 100 mL of blood – this reveals the amount of oxygen exchanged or used. Once again, blood arriving at the muscles in the arterioles is higher in oxygen than in the capillaries, so it moves into the capillaries and then the muscle cells by attaching to **myoglobin**.

At rest, the blood retains a large amount of oxygen, about 15 mL per 100 mL of blood, which it keeps in reserve for when demand suddenly spikes, such as when exercise intensity increases. As the muscles extract more oxygen from blood flowing through them, the a-vO_2 diff will also increase.

TABLE 6.4 Arteriovenous oxygen difference in various people

State	a-vO_2 diff (mL/100 mL blood)		
	Untrained	Trained	Triathlete
Rest	4.5	5.0	5.2
Moderate exercise	8.0	8.5	8.7
Maximal exercise	13.5	14.0	17.5





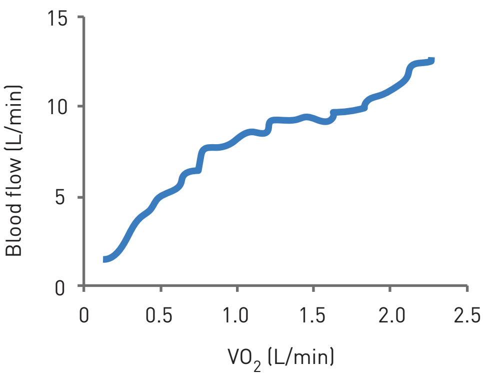
Oxygen extraction/usage by a muscle while jogging (left) and sprinting (right)

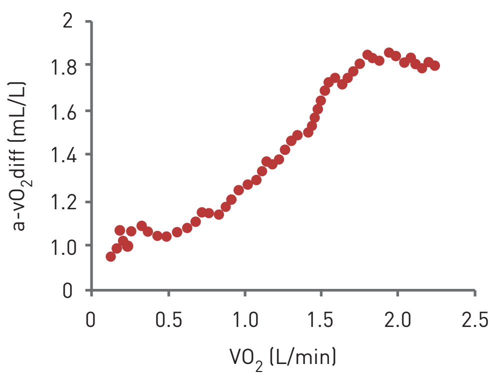
QUICKVID

This video clip shows how oxygen is transported from the lungs to cells and muscles and looks at the role haemoglobin plays in this process. Link via http://vcepe12.nelsonnet.com.au.

Weblink

The following two graphs reveal both the blood flow and arteriovenous oxygen difference in response to increasing workloads. Subjects had both these variables measured while running on a treadmill that was programmed to increase its speed every minute. The running speed corresponded to the volume of oxygen consumed, and this has been used to indicate workload.





The relationship between blood flow (left) and oxygen use (right) during graduated exercise

DATA ANALYSIS

1. Describe any trends that are evident when comparing oxygen consumption, arteriovenous oxygen difference and blood flow.
2. Why does the a-vO_2 diff plateau towards the end of the test while blood flow continues to increase linearly?
3. If the a-vO_2 diff graph represents the response of an untrained 20-year-old male who can get to level 5 on the beep test, draw a new set of axes to show the response of a trained 20-year-old male who can get to level 14 on the beep test. Assume both are running at the same incremental pace throughout the test.
4. As a-vO_2 diff increases throughout the test, what must be happening to gas exchange between the alveoli and capillaries at the lungs as well as the muscle cells and surrounding capillaries? Explain why you believe this to be different from resting conditions.

Weblink

QUICKVID

This excellent video clip clearly explains a-vO_2 diff, how it is calculated, and how it varies under different exercise conditions. Link via http://vcepe12.nelsonnet.com.au.

LABORATORY

ACUTE RESPONSES TO EXERCISE AT THE CARDIOVASCULAR AND RESPIRATORY LEVELS

AIM

To investigate any relationship between exercise intensity and both heart and respiratory rates.

EQUIPMENT

Bench, metronome, heart rate monitor

METHOD

1. Form groups of three students. One student will perform bench steps while the other members of their group record heart rates and respiratory rates (rise and fall of chest or number of breaths per minute). The roles should be swapped so everyone can experience what occurs during varied exercise intensities.
2. Students should keep up with the metronome, completing one minute of bench steps for each of the following rates:
   - **a** Rate 1 – 30 beats/min
   - **b** Rate 2 – 45 beats/min
   - **c** Rate 3 – 60 beats/min
   - **d** Rate 4 – 90 beats/min

   The student performing the task should step up on one beat of the metronome and step down on the next beat.
3. One partner records the heart rate and another records the respiratory rate for the last 10 seconds of each minute.
4. Use a table similar to the following to record your results. You can find this table on the student website at http://www.nelsonnet.com.au, using your login code.

Scaffold

	Heart rate	Respiratory rate
Rest		
30 beats/min		
45 beats/min		
60 beats/min		
90 beats/min		

5. Share your results with at least two other groups and plot your results on a clearly labelled graph.

DISCUSSION

1. What is the relationship between exercise intensity and heart rate and respiratory rate?
2. Is there a relationship between respiratory rate and arteriovenous oxygen difference?
3. Account for any differences in the results obtained from different class members (think about gender, training, etc.).

REAL WORLD APPLICATION

Doctors are working with parents to help save the lives of premature babies

SCIENCE PHOTO LIBRARY / JOHN COLE

Many premature babies experience initial respiratory challenges.

by Kellie Connolly, *The Sunday Telegraph*, 11 November 2012

So small he could nestle in your palm, Harrison Clarke was born 98 days too soon. He weighed a fragile 840 grams. Eyes closed, transparent skin, lungs not ready to work by themselves. His parents Jo and Tim were told he had a 60 per cent chance of survival.

He's proven to be a fighter. The pictures you see were taken at five weeks. He's just tipped the kilo mark, but Harrison still needs help. He needs miracles. Every system in his body is being constantly monitored – his breathing, his blood, his heartbeat, and his fluids.

He is X-rayed, weighed, measured and has blood samples taken. There is intervention at every step.

'You keep asking why. Why all the time. Why did this happen to us?' says his mum Jo Clarke.

'We're young and fit. I went to all my appointments and took my vitamins – so why did this happen? I guess you have a really heightened sense of anxiety all the time.'

Jo haemorrhaged when she was 16 weeks pregnant. Bed rest ensured Harrison stayed put for another 10.

His doctors are better equipped than ever to ensure this little man graduates from the Neonatal Intensive Care Unit (NICU) at the Royal Hospital for Women in Randwick in a few months and heads home with his mum and dad.

But there's so much they don't know. Like why might Harrison survive when others born at the same time may not?

'Most babies born at his gestation will have things like chronic lung disease. Will his eye health be OK? Is he going to be blind? Is his hearing going to be

OK? Issues with his feeding. Is he going to be able to swallow and suck and do all those sorts of things? And also brain development? How far behind will he be?' Clarke says.

According to Professor William Tarnow-Mordi, from Westmead Hospital's WINNER Centre for newborn research: 'These days it's not so much a question of survival. What's important is they survive healthy.

'There's a high risk of a baby having some level of disability if they are born very premature and so, in addition to just keeping them alive, we need to protect their brain. Make sure their brain matures so they all have the abilities to live a long and full life. And we have a long way to go to ensure that all of them win not only survival, but healthy, full-quality survival.'

Neonatal paediatrics is a complex, multi-layered practice and, for the first time in Australia, the specialists are asking the parents for help. 'In the field of mothers and newborn research, this is the first time parents have been recognised as associate investigators,' says Tarnow-Mordi. A new multi-centre study led by the University of Sydney has just been given $2.2 million in funding by the National Health and Medical Research Council. The same body recommended a decade ago there be more consumer input in medical trials. It's only now happening in the field of neonatal paediatrics.

The Royal Women's Hospital in Parkville, Melbourne has one of Australia's largest Neonatal Intensive Care Units (NICU). It provides specialist services to babies who need special treatment for critical illnesses straight after birth.

It also has a Special Care Nursery (SCN) that looks after babies who are healthier than babies in the NICU, but still need extra care and monitoring before they are allowed to go home.

Equipment and monitoring in the NICU

It is very important to keep newborn babies warm and comfortable. To keep them at their ideal temperature they will either be in an incubator or in a heated open cot, or have a heated mattress.

Depending on how early they are born, or any conditions associated with being premature, babies may have:

- leads on their chest to monitor their heart and lung function
- sensors on their foot or hand to monitor oxygen levels in the blood
- a blood pressure cuff wrapped around their arm/leg to monitor blood pressure
- breathing support through a ventilator machine and an endotracheal tube (ETT) that delivers warmed and humidified air into the baby's lungs
- a continuous positive airway pressure (C-PAP) machine, which delivers oxygen under pressure and helps keep the lungs expanded, reducing the effort required for a baby to breathe
- a gastric tube (through the mouth or nose) into the stomach to feed the baby until it can suck
- a narrow tube and needle in their hand or foot to provide intravenous (IV) fluids
- an intravenous pump (drip) used to give fluids, nourishment or medication
- a temperature probe to monitor their skin temperature and adjust incubator/cot temperatures
- a catheter in the umbilical cord to assist with delivery of medication and food, and to take blood samples
- bright phototherapy/ultraviolet lights used to treat jaundice.

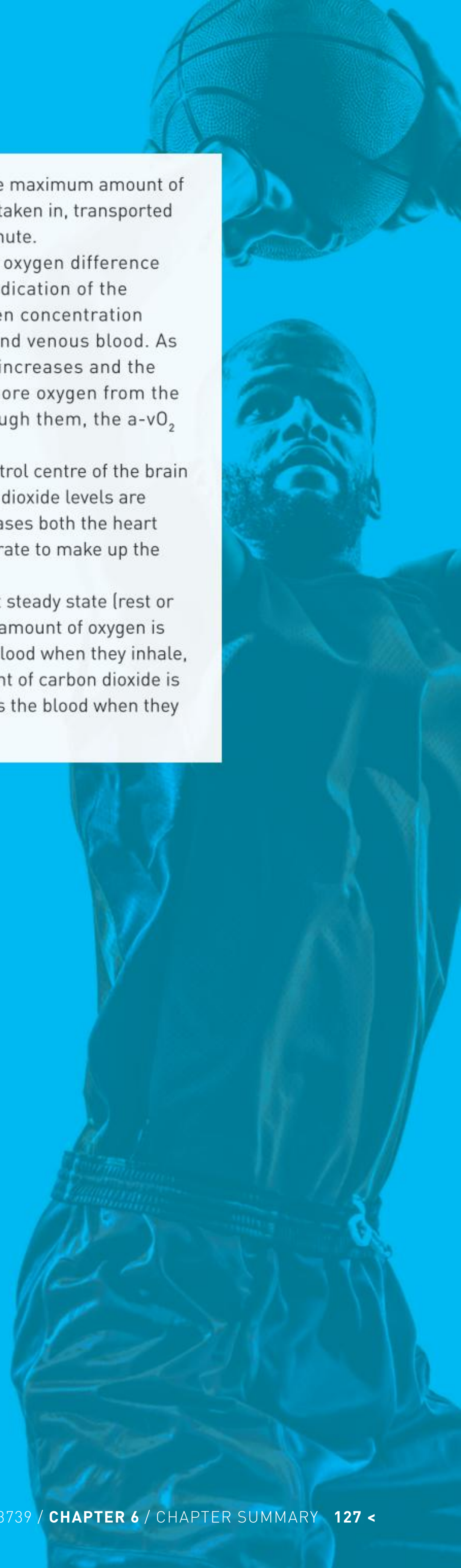
Questions

Consider the following:

1 Being born prematurely might result in some ongoing respiratory problems. What effect would poorly developed alveoli have on performance if the person wanted to compete in an endurance event such as a triathlon?
2 Many adults use a C-PAP (continuous positive airway pressure) machine when they go to sleep at night. What medical conditions might require them to use this technology, and how does the C-PAP machine assist them during their sleep?
3 Pulse oximeters can quickly detect the saturation/oxygen levels in the blood, and can provide a reading by simply placing an instrument over the index finger. Using your knowledge of the cardiovascular and respiratory systems, provide two different 'problems' with each system that would result in low levels of oxygen being present in the blood.

CHAPTER SUMMARY

- Inspiration (inhaling) is an active process in which the ribs lift upwards and outwards, the intercostal muscles contract and the chest cavity expands as the diaphragm simultaneously contracts and lowers. Expiration (exhaling) is a passive process that occurs when the respiratory muscles relax and air is forced out of the lungs.
- Oxygen leaves the alveoli and enters the blood through diffusion. It is transported as oxyhaemoglobin.
- Gaseous exchange occurs all around the body as a result of concentration and pressure differences. Gases move from areas of high levels to those of low levels.
- The amount of air inhaled and exhaled per breath is known as the tidal volume (TV). During exercise, tidal volume increases. If a person works submaximally, this increase will level off and the athlete will experience steady state. This occurs when oxygen supply meets oxygen demand.
- VO_2 maximum is the maximum amount of oxygen that can be taken in, transported and used in one minute.
- The arteriovenous oxygen difference (a-vO_2 diff) is an indication of the difference in oxygen concentration between arterial and venous blood. As exercise intensity increases and the muscles extract more oxygen from the blood flowing through them, the a-vO_2 diff will increase.
- The respiratory control centre of the brain senses that carbon dioxide levels are incorrect and increases both the heart rate and breathing rate to make up the difference.
- When a person is at steady state (rest or exercise), the right amount of oxygen is transferred to the blood when they inhale, and the right amount of carbon dioxide is exchanged and exits the blood when they exhale.



CHAPTER REVIEW

Multiple-choice questions

1 During inspiration, the diaphragm:
  A lifts upwards while the intercostals relax
  B contracts downwards while the intercostals contract
  C lifts upwards while the intercostals contract outwards
  D contracts upwards while the intercostals lift upwards.

2 Gaseous exchange at the lungs occurs because of:
  A pressure differences
  B concentration differences
  C active breathing
  D passive breathing.

3 A person will return to resting levels of oxygen consumption more quickly after an activity if they:
  A have higher levels of oxygen consumption during the activity
  B perform an active recovery
  C have undertaken aerobic training
  D breathe into a paper bag and inhale their own CO_2.

4 While running a marathon, when runners face an uphill section of the course, their a-vO_2 diff will:
  A remain unchanged
  B increase
  C decrease
  D plateau.

5 Endurance athletes, compared to untrained people, tend to have
  A larger tidal volumes
  B greater respiratory rates
  C higher core temperatures
  D smaller minute ventilation.

Short-answer questions

6 Why is the arteriovenous oxygen difference greater when someone is jogging than when they are walking?

7 Joggers often jog on the spot while they wait for pedestrian lights to change. Suggest a reason for this. Your answer must focus on heart and respiratory rates.

8 Explain how it is possible for athletes to achieve multiple 'steady states' while running a marathon.

9 Draw a diagram to show the movement of gases between the systemic capillaries and the muscles they surround. Clearly show the movement of oxygen and carbon dioxide into and out of the muscles.

10 Draw a simple flow chart or diagram to demonstrate an understanding of the movement of blood between the heart and the lungs. Draw oxygenated blood as red and deoxygenated blood as blue, and use arrows to show direction of flow.

11 Endurance athletes end up with more alveoli as a result of their training. Discuss how this adaptation would contribute to improved performances in endurance events.

Investigations

12 Describe the effect asthma sprays have on the respiratory system and athletic performance. You may need to carry out some research to answer this question.

13 Draw a graph (X = Distance and Y = Heart rate) clearly showing the following.
  - A 50-year-old woman completes a 15 km run as part of her fun-run training.
  - She wears a heart rate monitor to record changes in her heart rate and records a resting heart rate of 65 bpm.
  - She knows that 120 bpm means she is working aerobically.
  - It takes her 1 km before she reaches a steady state at 75 per cent of heart rate max.
  - The 15 km run takes place around her neighbourhood and her intensity throughout the run remains fairly constant.
  - As part of her training, she increases her intensity for the last 1 km and sprints for the last 200 m, then completes an active recovery for 1 km.

  a Clearly indicate when the runner is in 'oxygen deficit' – what does this mean?
  b What is the maximal heart rate reached (during the final sprint) and how did you calculate this?
  c What happens to the arteriovenous oxygen difference during steady state?

CHAPTER 7

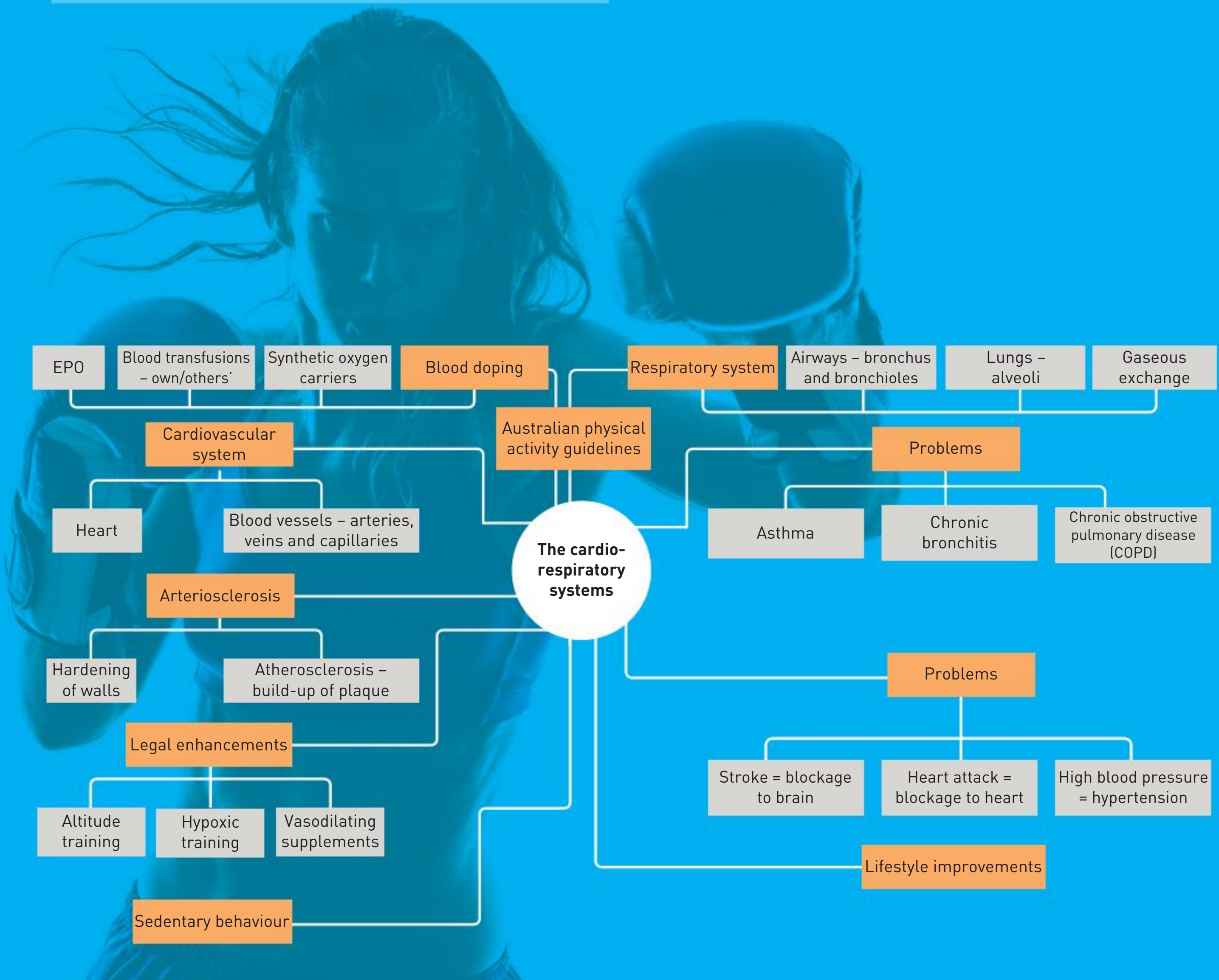
FACTORS AFFECTING THE CARDIORESPIRATORY SYSTEM

Key knowledge

- physiological, social, cultural and environmental enablers and barriers of cardiovascular health (such as atherosclerosis, coronary heart disease, high cholesterol levels, hypertension and stroke) and respiratory health (such as chronic obstructive pulmonary disease)
- the role of physical activity, sport and exercise to enhance the capacity and functioning of the cardiovascular and respiratory systems

Key skills

- assess enablers and barriers to cardiorespiratory health and investigate strategies to enhance the capacity and functioning of the cardiorespiratory system



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When a person exercises at high intensity, they feel their heart pounding, and sometimes it may feel as if their lungs are about to burst. This is because both the cardiovascular and respiratory systems are working hard to take up and supply large amounts of oxygen to working muscles. These acute responses are temporary and these variables return to resting levels after exercise has stopped.

Some people struggle to take up and transport oxygen even under moderate exercise intensities. As soon as they try to work harder, they experience pain because their deteriorated cardiovascular and respiratory systems simply cannot keep up. Poor choices regarding diet and exercise often lead to lifelong chronic diseases such as:

» diabetes
» cardiovascular disease
» osteoporosis
» arthritis
» obesity
» **chronic obstructive pulmonary disease (COPD)**
» inflammatory bowel disease
» central nervous system degenerative diseases
» various cancers.

Cardiovascular diseases include commonly reported problems associated with **atherosclerosis**, coronary heart disease, **hypertension** and stroke. Cardiovascular diseases and chronic obstructive pulmonary disease contribute significantly to **morbidity** and **mortality**, and also place a heavy economic burden on the healthcare system at state, national and global levels. These lifestyle diseases can be minimised or prevented, for the most part, by making lifestyle changes.

FYI

Every hour, five Australians die from heart disease, stroke and blood vessel disease, collectively known as cardiovascular disease. Many others live with a disability after having a heart attack or stroke (Australian Heart Foundation).

FYI

Angina is a chest pain caused when plaque blocks arteries supplying the heart. Sudden plaque rupture and clotting causes the heart muscle/cells to die. This is diagnosed as a heart attack, or myocardial infarction.

PHYSIOLOGICAL CAUSES OF CARDIOVASCULAR DISEASE

Atherosclerosis

Arteries are blood vessels that take blood, oxygen and nutrients from the heart and carry them around the body. They are lined by a thin layer of cells (endothelium) that keep them toned and smooth, which helps blood flow. Arteries are normally flexible and elastic, but over time, their walls can harden. **Arteriosclerosis** occurs when the arteries harden and become thick, sometimes restricting blood flow to vital organs and tissues.

Atherosclerosis is a specific type of arteriosclerosis. Atherosclerosis is characterised by the build-up of fats, **cholesterol** and other substances (plaques) in and on arterial walls, which can decrease arterial flexibility as well as restricting blood flow. High blood pressure, smoking and high-cholesterol diets are the main causes linked with damage to the endothelium. This damage allows cholesterol to enter the arterial wall, and an associated influx of white blood cells attempts to digest the cholesterol. With time, the cholesterol and white blood cells form a mass that becomes a plaque in the wall of the artery. As atherosclerosis progresses, that mass/plaque increases in size.

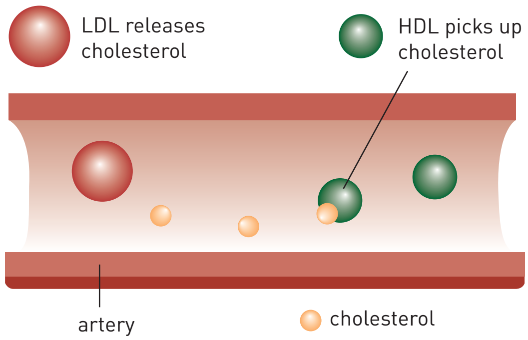
Plaque from atherosclerosis usually has one of the following outcomes:

» It continues to build in a slow, controlled way in and on the arterial wall. Eventually, it restricts blood flow and causes significant blockages to the blood's normal path. The sufferer tends to experience pain around that site.
» More seriously, the plaque can suddenly rupture, resulting in a blood clot inside the artery. If this occurs in arteries supplying the brain, it causes a stroke. A heart attack results when this blockage/clot occurs in the arteries supplying the heart itself.

Cholesterol

There are two different types of cholesterol in foods – a good type (HDL) and a bad type (LDL), which is associated with atherosclerosis. LDL delivers cholesterol to the cells that need it. However, when LDL levels become too high, some of it collects inside artery walls and forms a hard plaque, which can result in atherosclerosis.

HDL acts like a street sweeper, picking up unused cholesterol from artery walls and returning it to the liver, where it is eliminated. When LDL levels become too high, HDL can't keep up and atherosclerosis results.



The two types of cholesterol in the arteries – 'good' (HDL) and 'bad' (LDL)

TABLE 7.1 Cholesterol classifications

Classification	Total cholesterol (mg/dL)	Description
Desirable	<200	Optimum level for reduced risk of heart disease
Borderline	200–240	Levels are higher than they should be; seek medical advice on how to lower them
High risk	>240	Levels are too high; increased risk of developing heart disease or complications from heart disease. Consult your doctor immediately. Guidelines for how much physical activity to do may not help reduce the risks of sitting too much. Health benefits are greatest for people who sit less, AND move more.

Saturated fats are often referred to as 'bad fats' – they are not considered essential for good health, and have been linked with an increased risk of heart disease and high cholesterol levels in the body. Saturated fat is a type of fat that is solid at room temperature. It is mainly found in animal products, but can be found in some plant sources.

Animal-based sources of saturated fat include:

» dairy foods, such as butter, cream, ghee, regular-fat milk and cheese
» meat, such as fatty cuts of beef, pork and lamb, processed meats like salami, sausages and the skin on chicken
» lard.

Plant-derived sources of saturated fat include:

» palm oil
» cooking margarine and copha
» coconut oil, milk and cream.

Saturated fats are also commonly found in many manufactured and packaged foods, such as:

» fatty snack foods
» deep-fried takeaway foods
» cakes
» biscuits
» pastries and pies.

Source: Reprinted with permission of the Dietitians Association of Australia. For current advice and guidelines please go to www.daa.asn.au.

FYI

Atherosclerosis and arteriosclerosis are different conditions:

- Arteriosclerosis is the stiffening or hardening of the artery walls, sometimes also linked to high salt diets.
- Atherosclerosis is the narrowing of the artery because of plaque build-up. Atherosclerosis is a specific type of arteriosclerosis.

Saturated fats are one of the main causes of high blood cholesterol levels. The Heart Foundation has found that increasing amounts of saturated fats in your diet will increase the level of 'bad cholesterol' in your blood and decrease the level of 'good cholesterol'.

Coronary heart disease

Coronary heart disease occurs when fatty deposits build up in the walls of the arteries that supply the heart itself, resulting in reduced oxygen and nutrient supply. This sometimes manifests as acute pain (angina) or, more seriously, results in a heart attack. The more blood vessels that are blocked/obstructed, the greater the area of the heart that will be affected.

INVESTIGATION

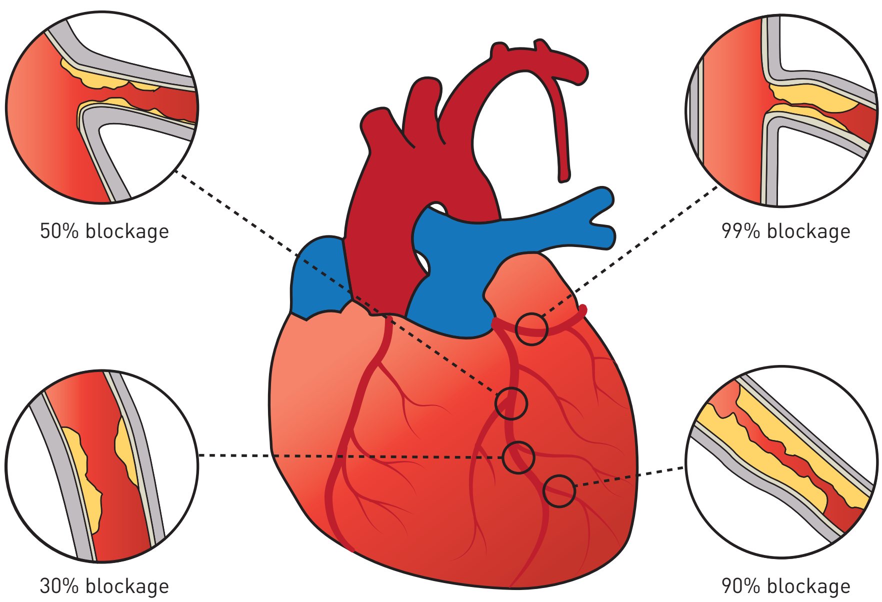
PLANNING A HEALTHY DIET WITH GOOD LDLS

Write down your food consumption (breakfast, lunch, dinner and snacks) for a typical Monday–Friday period. Classify each of the foods consumed (including drinks) as containing either LDL or HDL cholesterol. For each LDL listed, suggest a healthier alternative – ideally, something that is high in HDLs.

Weblink

INVESTIGATION

The American Heart Association website has information about cholesterol and coronary artery disease and can be accessed via http://vcepe12.nelsonnet.com.au. It will provide you with a better understanding of your own cholesterol score, how cholesterol causes arterial diseases and some of the drugs used to counteract high levels of arterial cholesterol.



Different levels of blockage in arteries caused by build-up of plaque. The greater the build-up, the greater the likelihood of a blockage becomes.

In 1953, a group of researchers found that bus conductors in London, who spent their working hours walking the length of the double-decker buses as well as climbing the stairs, experienced half the coronary heart disease (CHD) mortality rates of their driver counterparts, who spent their days sitting behind the wheel. These researchers hypothesised that it was the physical activity in their work that protected the conductors from developing CHD. This was the first study that linked physical activity with the positive health outcomes.

But was physical activity the only contributing factor? The researchers also noted that conductors were smaller in size. Did drivers smoke more than conductors? How did their diets compare? Did genetics play a part? Since this initial study, many others have been conducted, all coming to the same conclusion: regular physical activity or cardiorespiratory fitness decreases the risk of cardiovascular diseases and CHD.

Shutterstock.com / Michal Rosak

Bus conductors with different levels of occupational activity showed different levels of coronary heart disease.

Hypertension

Hypertension is commonly referred to as high blood pressure. It is the most frequently managed condition seen by doctors in Australia. Blood pressure is the force exerted by the blood against the walls of blood vessels. The force/pressure depends on cardiac output and the resistance of the blood vessels. You should recall from chapter 5 that blood pressure is made up of two readings: a **systolic** reading representing the pressure on arteries as the heart pumps blood out (systole) and a **diastolic** reading taken as the heart relaxes and refills with blood (diastole). Typical measures for blood pressure are systolic = 120 mmHg and diastolic = 80 mmHg. Hypertension is said to occur when blood pressure is higher than 140 mmHg over 90 mmHg (that is, both systolic and diastolic are higher than normal).

FYI

Blood pressure is always expressed as systolic over diastolic pressure, e.g. **120/80 mmHg**.

Ninety per cent of people with high blood pressure have primary hypertension, which has no single clear cause. Multiple factors can combine to contribute to hypertension, such as:

» smoking
» being overweight or obese
» drinking excessive alcohol, especially binge drinking

TABLE 7.2 Blood pressure classifications based on recommendations for adults

Blood pressure	SBP (mmHg)	DBP (mmHg)
Normal	<120	and <80
Prehypertension	120–139	or 80–89
Stage 1 Hypertension	140–159	or 90–99
Stage 2 Hypertension	≥160	or ≥100

Note: SBP = systolic blood pressure; DBP = diastolic blood pressure

Source: National Heart, Lung, and Blood Institute (US)

- lack of exercise /sedentary lifestyle
- unhealthy diet – especially if it's high in salt and saturated fat
- a family history of high blood pressure (genetic predisposition).

The second type of hypertension, secondary hypertension, can link your high blood pressure to a known cause, such as:

- kidney disease
- endocrine disease/ hormone disorders
- narrowing of the aorta or the arteries leading to the kidneys.

Secondary hypertension can also be caused by:

- steroid medicines
- the contraceptive pill
- pregnancy.

All of these factors, either individually or in conjunction with each other (multifactorial), will result in the heart needing to pump harder, resulting in higher blood pressure.

CHAPTER CHECK-UP

1. How does being overweight contribute to hypertension?
2. When arteries supplying the heart itself are badly blocked, a heart attack may result. If blocked arteries are discovered during a regular check-up and ultrasound or MRI, what can surgeons do to improve blood flow and reduce the risk of a heart attack?
3. Provide two reasons why increased blood pressure is often seen in pregnancies, and why this tends to increase as the pregnancy progresses.

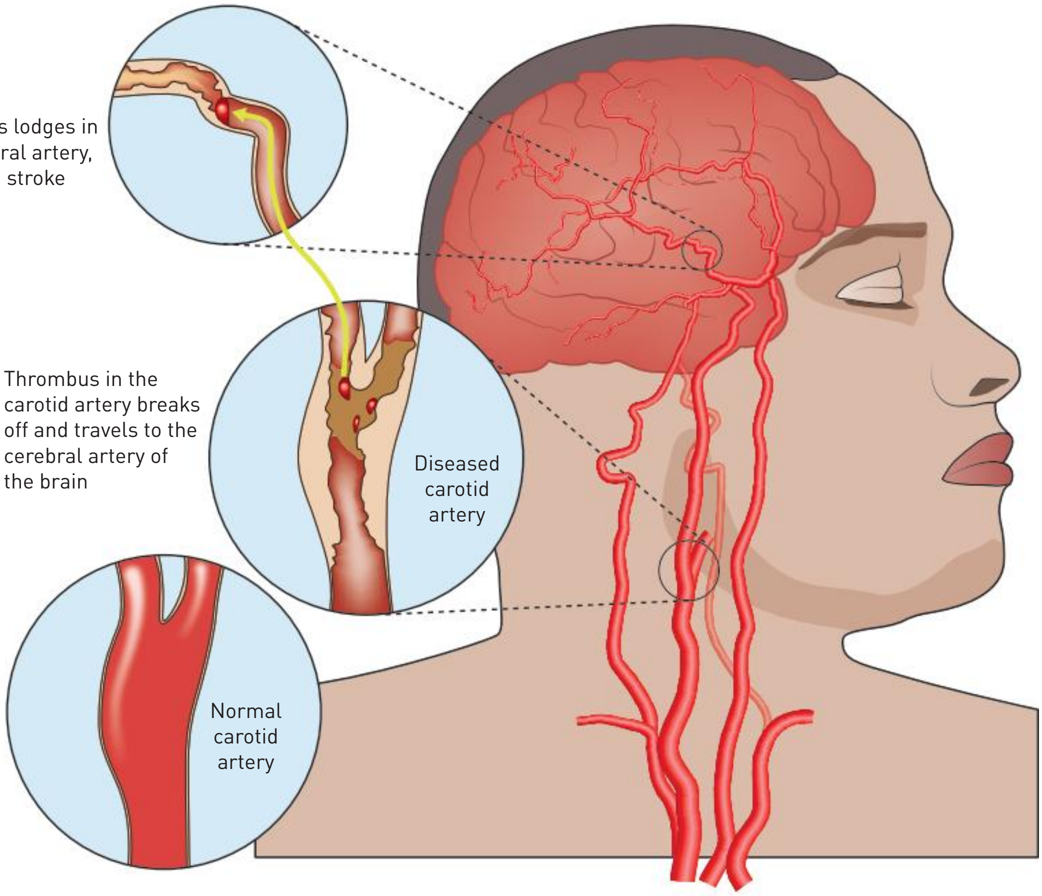
Stroke

A stroke occurs when the blood supply to the brain is interrupted, leading to temporary/permanent disability or death. The longer a stroke victim remains untreated, the greater the chance of brain damage occurring. Getting emergency medical treatment as soon as symptoms of a stroke begin greatly improves the chance of survival and successful rehabilitation.
Using the F.A.S.T. test involves asking these simple questions:

Face Check their face. Has their mouth drooped?
Arms Can they lift both arms?
Speech Is their speech slurred? Do they understand you?
Time Is critical. If you see any of these signs call 000 immediately.

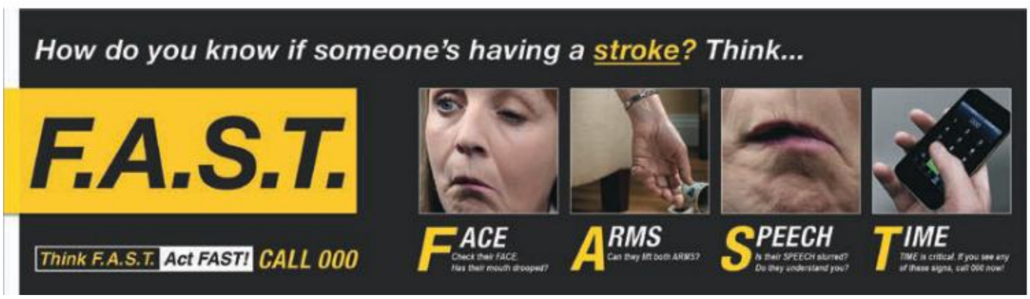
Risk factors in adults

A risk factor is something about your body or behaviour that increases your chance of disease. The more cardiovascular risk factors you have, the more likely you are to be affected by a cardiovascular disease.



A stroke is caused by disrupted blood supply to the brain. As soon as symptoms appear, urgent medical attention is needed.

Supplied with kind permission of the Stroke Foundation



The National Stroke Foundation recommends the F.A.S.T. test as an easy way to remember the most common signs of stroke.

In 2011–12:

- 63 per cent of Australian adults were overweight or obese
- 56 per cent were inactive or insufficiently active
- 16 per cent smoked daily
- 20 per cent exceeded lifetime alcohol risk guidelines
- 32 per cent had high blood pressure (including 22 per cent with uncontrolled high blood pressure)
- 63 per cent had dyslipidaemia (abnormal amounts of lipids such as cholesterol in the blood)
- 3 per cent had impaired fasting glucose (indicating higher than normal blood glucose levels, known as pre-diabetes)
- 66 per cent of adults had three or more risk factors at the same time.
- 10 per cent had five or six risk factors.

Source: Australian Institute of Health and Welfare, 2014

Weblink

PRACTICAL ACTIVITY

YOUR CARDIOVASCULAR RISK

Fill in the Australian absolute cardiovascular disease risk calculator via http://vcepe12.nelsonnet.com.au. First you will need to measure or bring your systolic blood pressure, your total cholesterol, and your HDL cholesterol to plug into the calculator. Then discuss how changing some of your responses would alter your levels of risk.

REAL WORLD APPLICATION

1 in 5 Australians affected by multiple chronic diseases

About half of all Australians have a chronic disease, and around 20% have at least two, according to new data released online today by the Australian Institute of Health and Welfare (AIHW).

The release covers eight chronic diseases: arthritis, asthma, back problems, cancer, chronic obstructive pulmonary disease, cardiovascular disease, diabetes and mental health conditions.

'When two or more diseases occur at the same time, it is referred to as 'comorbidity', said AIHW spokesperson Louise York.

'Sometimes these diseases occur together simply by chance, but often it's because there are some associations between them, such as shared risk factors.'

Ageing is a factor that has a particularly strong association with comorbidity.

'Older people are more vulnerable to developing many diseases, and Australians' increasing life expectancy means a greater chance for multiple conditions to arise,' Ms York said.

Nearly 40% of Australians aged 45 and over have two or more of the eight chronic diseases examined in today's release.

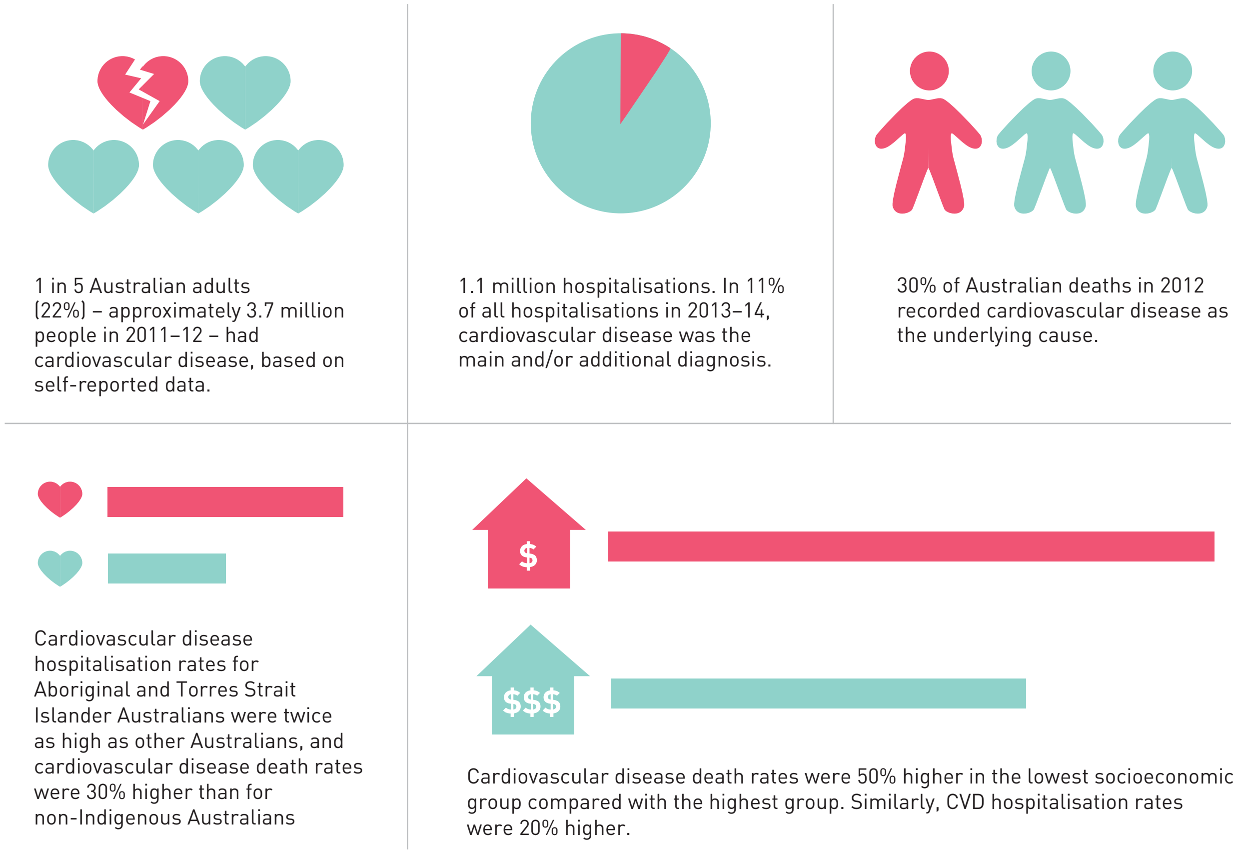
'For this age group, the two most common chronic diseases to occur in combination with any other chronic disease were arthritis and cardiovascular disease,' Ms York said.

'When looking at particular combinations of diseases in this age group, we found that arthritis and cardiovascular disease occurred together most frequently, in 16% of the population, followed by arthritis and back problems (10%) and back problems and cardiovascular disease (8%).'

Source: Australian Institute of Health and Welfare, 2015

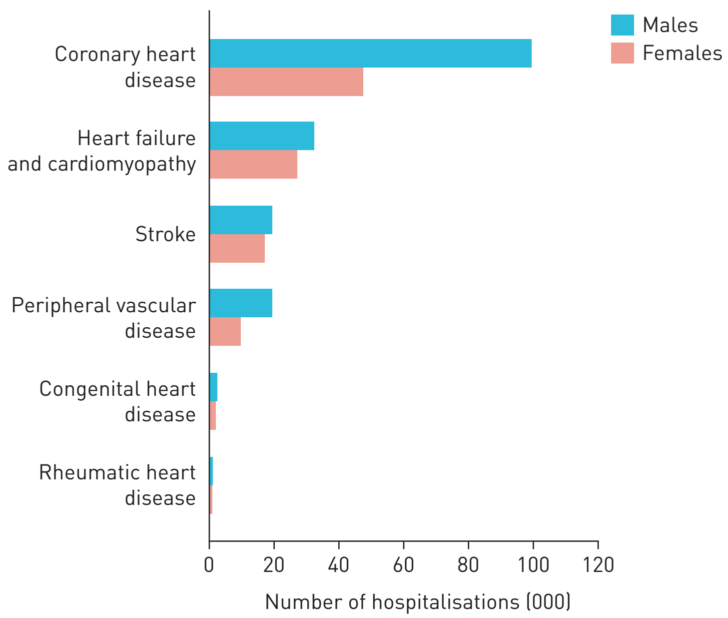
Questions

1. In your own words, explain what 'comorbidity' means.
2. Why do you think arthritis and cardiovascular disease often occur together?
3. How could addressing factors that contribute to cardiovascular disease potentially also lead to decreased incidence of arthritis?
4. Quite often, lifestyle choices made in a person's twenties will affect their health in their forties and beyond. Provide three clear examples demonstrating how this eventuates.



Cardiovascular disease in Australia – a snapshot

Source: Based on Australian Institute of Health and Welfare material



Cardiovascular disease–related hospitalisations (principal diagnosis), by age and sex, 2013–14

Source: Based on AIHW national health morbidity database, 2015

CHAPTER CHECK-UP

1 When someone is suspected of having suffered a stroke, what has happened to them? Why is it critical that medical assistance for suspected stroke victims is sought as soon as possible?
2 When two or more diseases occur at the same time, it is referred to as 'comorbidity'. Which two diseases occurring together greatly increase the risk of cardiovascular disease? Briefly comment on whether some combinations are potentially more dangerous than others.
3 Death rates for cardiovascular disease were 30 per cent higher for Aboriginal and Torres Strait Islander people than for non-Indigenous Australians. Research possible reasons for this and produce a three-paragraph summary outlining these (each factor should take up one paragraph).
4 The graph on page 137 reveals that males are more likely to be hospitalised for cardiovascular disease-related incidents than females of a similar age. Suggest two factors that might explain this trend.

PHYSIOLOGICAL CAUSES OF RESPIRATORY DISEASE

Respiratory conditions affect the airways, including the lungs as well as the trachea and bronchioles that transfer air from the mouth and nose into the lungs. Respiratory conditions can be acute or chronic and can cause ill health, disability and even death in severe cases.

According to the Australian Health Survey, an estimated 6.3 million Australians suffered from a chronic respiratory condition in 2011–12 (ABS, 2012). Respiratory conditions are among the most common problems encountered by general practitioners, with approximately one in five patients presenting with respiratory conditions between 2004 and 2014 (Britt et al., 2014). In 2012, more than 12 500 deaths were linked to a respiratory condition (ABS, 2015). Chronic obstructive pulmonary disease (COPD) is a leading cause of death both in Australia and internationally, and asthma death rates in Australia are high in comparison with many other countries (AIHW; Poulos et al., 2014).

Asthma and chronic obstructive pulmonary disease (COPD) are the two most common chronic **obstructive respiratory diseases**. **Asthma** is a chronic inflammatory disorder of the airways. People with asthma experience episodes of wheezing, breathlessness and chest tightness due to rapid and widespread narrowing of the airways. This limits airflow in the lungs, which can lead to mild or severe shortness of breath that is not fully reversible, even with treatment. COPD is a serious long-term disease that mainly affects older people, and includes conditions such as emphysema and chronic bronchitis. Asthma is five times more prevalent than any other form of COPD in Australia (ABS, 2012).

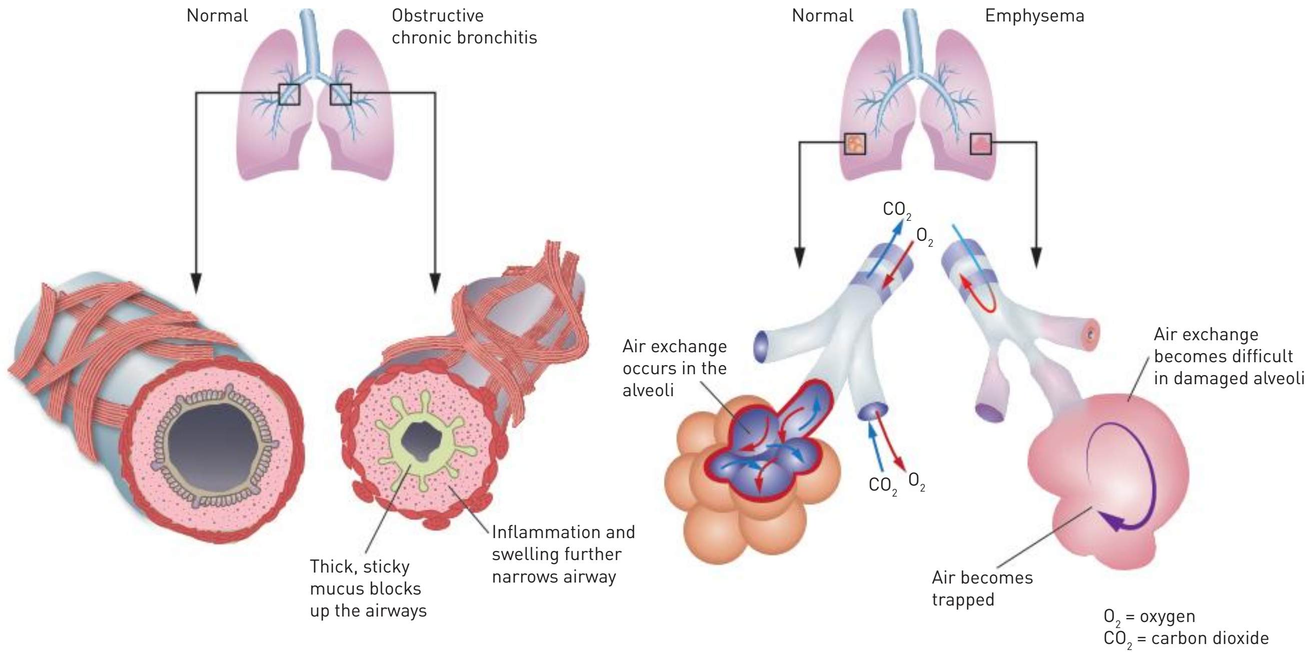
Chronic obstructive pulmonary disease (COPD)

COPD covers a number of lung conditions that are long-term, progressively worsen and cause shortness of breath by reducing the normal flow to the lungs. The most common conditions are emphysema, chronic bronchitis and chronic asthma. Each of these conditions can occur on its own, although many COPD sufferers have a combination of them.

There are two main causes of COPD. Smoking is by far the most damaging, but also the easiest to remove. One in two smokers will develop reduced air supply to their lungs and one in five will develop much more serious lung problems. Long-term environmental exposure to pollution irritants such as chemicals, dust, fumes and even **second-hand smoke** may also contribute to COPD.

Many smokers will develop a condition known as **emphysema**, which results in the bronchi and bronchioles losing their elasticity, causing the airways to narrow. In addition, the alveoli, where gaseous exchange occurs in the lungs, become stretched and eventually destroyed. The combination of having narrowed airways and requiring extra effort to breathe results in a feeling of shortness of breath.

A constant swelling and irritation of the bronchi and bronchioles is often linked to emphysema. This irritation prompts increased mucus secretion, and is often diagnosed as chronic bronchitis. The airway openings are reduced, making it harder for air to enter the lungs. If these orange bands should be pink like the ones on the other diag combined with the symptoms of emphysema, breathing becomes markedly more difficult.



Chronic bronchitis and emphysema cause similar deterioration of the airways, but emphysema also significantly affects the alveoli.

Asthma

Asthma is the most widespread chronic health problem in Australia. About one in ten Australian adults and one in nine or ten children have asthma. Asthma is a common chronic disease of the airways in which the muscles in the bronchus and bronchioles tighten and their lining becomes swollen and inflamed, producing sticky mucus. These changes cause the airways to narrow significantly, making it difficult to breathe.

Most people with asthma only experience symptoms when they inhale a 'trigger' such as pollen, exercise without the right preparation, spend time in colder climates or catch a cold or flu. Asthma can be controlled with the right medication, meaning breathing is only affected occasionally. If asthma is not well treated, however, or is very severe over a long time, the long-term inflammation that occurs can become permanent.

FYI

In Australia, up to one in five people over 40 years old are believed to be affected by COPD. It is currently the fourth most common cause of death in men and the sixth most common in women.

HOW MUCH ACTIVITY IS ENOUGH TO PREVENT CARDIOVASCULAR AND RESPIRATORY DISEASE?

Low levels of physical activity are a major risk factor for ill health and mortality. People who do not do enough physical activity have a greater risk of cardiovascular and cardiorespiratory diseases, colon and breast cancers, type 2 diabetes and osteoporosis. Being physically active improves mental, musculoskeletal and cardiorespiratory health and reduces other risk factors such as overweight, high blood pressure and high blood cholesterol.

Australia's physical activity and sedentary behaviour guidelines (see chapter 10) recommend that Australians be active on most – preferably all – days every week.

Hundreds of studies have shown that sedentary behaviour is often linked to obesity, metabolic syndrome and type 2 diabetes, all of which increase the risk of developing cardiovascular disease. Interestingly, many researchers have found that, even among people active enough to meet the Australian physical activity guidelines, those who spent more time sitting were at increased risk of cardiovascular-linked disease and mortality compared with those who sat less. This suggests that decreasing sedentary behaviour is likely to result in a decreased cardiovascular risk, with the added benefit of increased physical activity.

How can physical activity contribute to improved cardiovascular and respiratory health, both in preventing and treating the associated conditions presented earlier in this chapter?

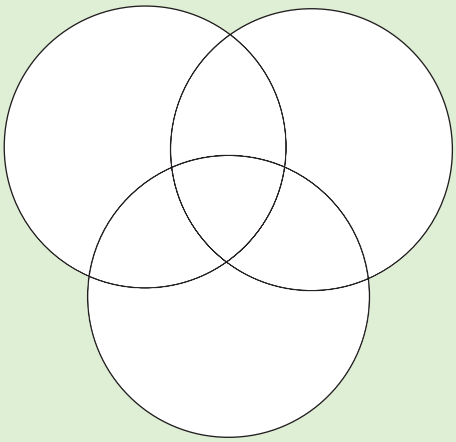
The benefits of physical activity on cardiovascular and cardiorespiratory health are extensively documented. People who do moderate- to vigorous-intensity aerobic activity have a significantly lower risk of cardiovascular and cardiorespiratory disease than inactive people. Regularly active adults have lower rates of cardiovascular disease and stroke, lower blood pressure, better blood cholesterol profiles and greater aerobic capacity. Significant reductions in risk of cardiovascular disease result from weekly activity levels equivalent to150–300 minutes of moderate intensity physical activity or 75–150 minutes of vigorous intensity physical activity, or an equivalent combination of both. Even greater benefits are seen with longer activity times.

Studies have found that physical activity helps people maintain a stable weight over time. People who want to lose a substantial amount of weight (more than 5 per cent of body weight) and people who have lost weight and are trying to keep it off need a high amount of physical activity unless they also reduce their calorie intake. Many people need to do more than 300 minutes of moderate-intensity activity a week to meet weight-control goals.

For health benefits, children aged 5–12 years and young people aged 13–17 years should do at least 60 minutes of moderate- to vigorous-intensity physical activity every day.

CHAPTER CHECK-UP

1 Copy and complete the Venn diagram to show the similarities and differences between asthma, chronic bronchitis and COPD.



2 Some people believe asthmatics should not exercise vigorously in case they trigger an asthma attack. Do you agree? What are some of the problems associated with a sedentary lifestyle?

3 Discuss two situations in which too much physical activity can be harmful.

QUICKVID

Using your code, log in to http:/nelsonnet.com.au and scroll to chapter 7, page 141 to watch the author summarise the main points of factors affecting the cardiorespiratory system.

Video

CHAPTER SUMMARY

- Cardiovascular disease is a term used to describe many different conditions affecting the heart and blood vessels. The most common and serious types of cardiovascular disease in Australia are coronary heart disease, stroke and heart failure.
- Arteriosclerosis occurs when the arteries become thick and harden, sometimes restricting blood flow to your vital organs and tissues.
- Atherosclerosis is a specific type of arteriosclerosis involving the build-up of fats, cholesterol and other substances (plaques) in and on arterial walls, which can decrease arterial flexibility as well as restricting blood flow.
- Plaque from atherosclerosis usually leads to one of the following outcomes:
  - it restricts blood flow and causes significant blockages to blood supply to the heart, resulting in angina
  - it can rupture, causing a blood clot inside the arteries supplying the brain (causing a stroke) or the arteries supplying the heart itself (causing a heart attack).
- There are two different types of cholesterol in foods – 'good' cholesterol (HDL) and 'bad' cholesterol (LDL), which is associated with atherosclerosis.
- Ninety per cent of people with high blood pressure have primary hypertension, which has no single clear cause. There are multiple factors that can combine to contribute to hypertension, such as:
  - smoking
  - being overweight or obese
  - drinking excessive alcohol, especially binge drinking
  - lack of exercise/sedentary lifestyle
  - unhealthy diet – especially if it is high in salt and saturated fat.
- A number of risk factors are known to increase the risk of developing cardiovascular disease, including being overweight and obese, smoking, having high blood pressure or high blood cholesterol, insufficient physical activity, poor nutrition and diabetes. Cardiovascular disease and type 2 diabetes share many risk factors.
- Asthma is a chronic inflammatory disorder of the airways. People with asthma experience episodes of wheezing, breathlessness and chest tightness due to rapid and widespread narrowing of the airways.
- COPD (chronic obstructive pulmonary disease) limits airflow in the lungs, which can lead to mild or severe shortness of breath that is not fully reversible, even with treatment. COPD is a serious long-term disease that mainly affects older people. It includes conditions such as emphysema and chronic bronchitis. Asthma is five times more prevalent than other forms of COPD in Australia.
- Low levels of physical activity are a major risk factor for ill health and mortality. People who do not do sufficient physical activity have a greater risk of cardiovascular and cardiorespiratory diseases, colon and breast cancers, type 2 diabetes and osteoporosis.
- Being physically active improves mental, musculoskeletal and cardiorespiratory health and reduces other risk factors, such as being overweight and having high blood pressure or high blood cholesterol.
- Hundreds of studies have shown that sedentary behaviour is often linked to obesity, metabolic syndrome and type 2 diabetes, which all increase the risk of developing cardiovascular disease. Even among people who are active enough to meet the Australian physical activity guidelines, those spending more time sitting were at increased risk of cardiovascular-linked disease and mortality compared with those who sat less.

CHAPTER REVIEW

Multiple-choice questions

1 Arteriosclerosis is caused by:
   A high-salt diets
   B low-fat diets
   C high-cholesterol diets
   D low-cholesterol diets.

2 A heart attack occurs when:
   A the heart receives a shock and stops beating
   B the heart is forced to beat quickly without a warm-up
   C arteries supplying the heart itself are blocked
   D fat deposits 'strangle' the heart, thus reducing its contractility.

Short-answer questions

3 Consider the findings of the study into cardiovascular diseases among bus drivers and conductors. Comment on the likely incidence of cardiovascular diseases among a school's office staff and its maintenance staff. Justify your answer.

4 It is recommended that young people aged 13–17 years should engage in activities that strengthen muscle and bone on at least three days per week. This focus might be linked to efforts around increasing peak bone mass. Find out more about peak bone mass and then discuss why it has been included in the Australian physical activity guidelines.

CHAPTER 8

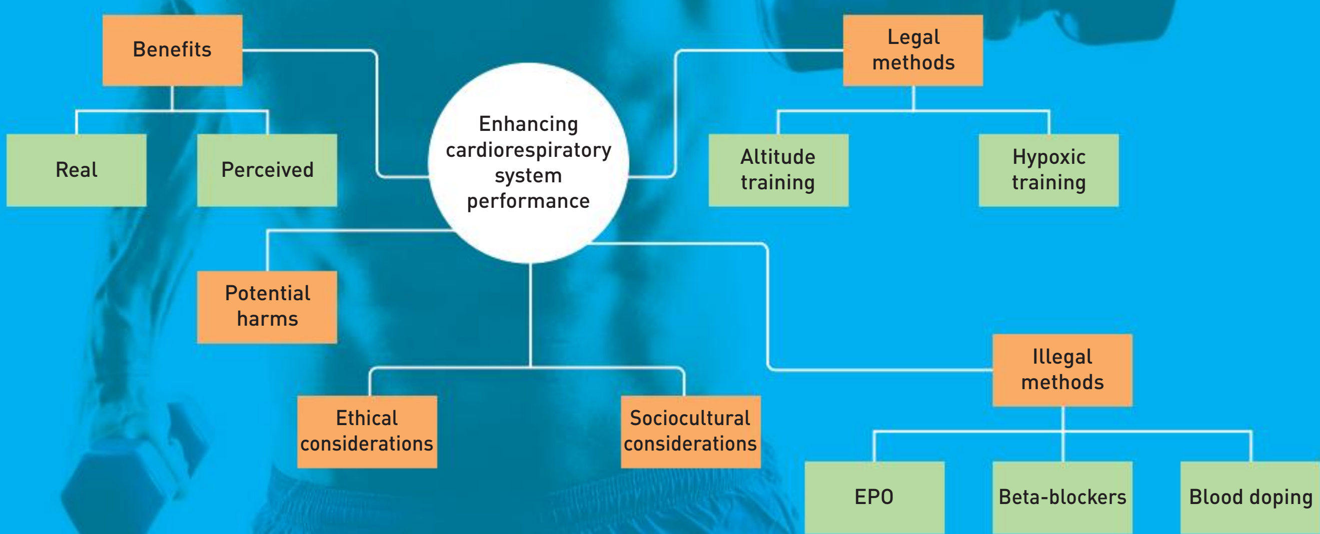
LEGAL AND ILLEGAL METHODS THAT ENHANCE PERFORMANCE OF THE CARDIORESPIRATORY SYSTEM

Key knowledge

- actual and perceived benefits and potential harms to the athlete of legal and illegal substances and methods that enhance performance of the cardiorespiratory system, such as altitude training, erythropoietin (EPO), beta-blockers and blood doping
- ethical and sociocultural considerations associated with the use of illegal practices associated with improving the function of the cardiorespiratory system

Key skills

- critically analyse the physiological effects on the individual of legal and illegal strategies that enhance the performance of the cardiorespiratory system
- discuss the ethical, social and cultural considerations associated with the use of legal and illegal practices associated with improving the function of the cardiorespiratory system



iStock.com/OSTILL

The cardiorespiratory system brings oxygen into the body via the respiratory system and transports it via the cardiovascular system to the cells, which use the oxygen to produce energy via cellular respiration. The cardiovascular and respiratory systems work together to provide specific tissues with oxygen, nutrients and a means to remove waste by-products. The two systems are functionally linked, and are often referred to as the cardiorespiratory system.

Energy must be provided in order for skeletal muscles to contract. The respiratory system plays a key role in this process by delivering oxygen to, and removing carbon dioxide from, the body. The cardiovascular system plays a key role by delivering oxygen to the working muscles.

Chapters 5–7 have provided a comprehensive outline of the structure and functions of the cardiorespiratory system. This chapter will investigate and evaluate a range of performance-enhancing practices, strategies and methods (both legal and illegal) that individuals utilise in order to enhance the performance of the cardiorespiratory system.

To gain a detailed insight into the workings of these practices, it is important to first gain an understanding of why individuals seek to engage in them. What are these individuals seeking to achieve? The answer will vary according to the goal, motivation and purpose of the individual, as well as the level of physical activity being undertaken.

For example, the practices chosen by a recreational runner in their thirties will differ from those chosen by an individual in post-cardiac surgery rehabilitation or by an elite cyclist looking to improve their oxidative enzyme activity and resistance to fatigue. But the end goal will be the same: to enhance the performance of their cardiorespiratory system.

Enhancing the performance of the cardiorespiratory system

Enhancing the performance of the cardiorespiratory system means improving the ability of the circulatory and respiratory systems to supply oxygen and nutrients to the skeletal muscles and remove waste products. Regular exercise can enhance these systems by improving the efficiency of the heart, allowing it to pump more blood with fewer beats, and increasing the number of capillaries that feed the heart, allowing more blood supply to reach the working muscles. Exercise can also benefit the respiratory system by allowing greater amounts of oxygen to be taken in and used by the body. While most individuals are happy to achieve these benefits safely through hard, honest training and a balanced diet, some take short cuts to enhance performance artificially.

So how can the performance of the cardiorespiratory system be enhanced? This chapter will investigate and evaluate a range of performance-enhancing practices, both legal and illegal, that individuals pursue, as well as exploring the ethical considerations and sociocultural influences on these practices.

Legal vs illegal practices

Chapter 4 has outlined current legal and illegal practices that enhance the performance of the musculoskeletal system and the role played by ASADA and WADA, as well as discussing the meaning of ethical considerations and sociocultural considerations.

A legal method or practice is one that enhances performance and does not violate the World Anti-Doping Code, does not threaten the health or safety of the individual and provides a measurable performance enhancement. Legal training methods that enhance the performance of the cardiorespiratory system include altitude training and **hypoxic training**.

An illegal method or practice enhances performance and violates the WADA Code, threatens the health or safety of the individual and provides a measurable performance enhancement. Illegal methods or practices allow an individual to gain an unfair edge or unjust advantage over their competitor. Examples of illegal practices that enhance the cardiorespiratory system include erythropoietin (EPO), beta-blockers and blood doping.

As ASADA points out, 'Some drugs, medications and substances are banned in sport, as are some methods. Athletes competing in sports governed by a World Anti-Doping Code compliant anti-doping policy need to be aware that they cannot just take any drug or medication, or even use certain methods'. (Australian Sports Anti-doping Authority, https://www.asada.gov.au/substances, accessed May 2016.)

To revisit WADA and ASADA's role in performance enhancement in more detail, refer to chapter 4.

LEGAL AND ILLEGAL CARDIORESPIRATORY PERFORMANCE ENHANCERS

Chapter 7 covered factors affecting the cardiorespiratory system and the role of physical activity, sport and exercise in enhancing the capacity and functioning of the cardiorespiratory systems. There are a whole range of other practices that people, typically athletes, might consider – not necessarily to address health concerns, but to gain a competitive edge over their opponents.

Some of these practices are legal and ethical, while others are prohibited because they are unethical, and in many instances compromise the health of the athlete.

Altitude training

Training at high altitude has become increasingly popular in recent years. Exercising at altitude leads to increased ventilation, increased heart rate and decreased stroke volume, and reduced plasma volume.

Altitude training has been used by endurance athletes such as marathon runners, triathletes and road cyclists for more than 50 years. They undertake these methods to improve the amount of oxygen their bodies can take in, transport and utilise, gaining aerobic benefits associated with blood cell changes. Altitude training generally occurs in a natural environment and can be classified as a legal method of performance enhancement. Issues around accessibility may, however, lead to questions of fairness.

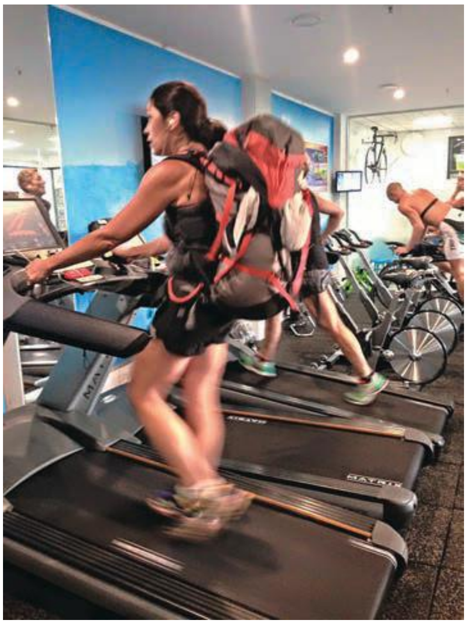


Image courtesy of Altitude Australia, http://altitudeaustralia.com.au

Mountaineer Annie Doyle training at a simulated high altitude chamber for her third attempt at summiting Mount Everest.

There is significantly less oxygen available to the body at altitudes of more than around 2000 metres than at sea level (see Table 8.1 on page 147). High altitudes present significant challenges to normal athletic performance, because the body finds itself in serious oxygen deficit. The human body has a built-in protective mechanism to counter the effects of high altitude. When the brain senses that the body is not receiving normal levels of oxygen, it produces an increased concentration of red blood cells. This increases the ability of blood to transport oxygen to working muscles and tissues.

While the body adjusts to altitude, it is common for the athlete to experience symptoms such as fatigue, breathlessness and headaches. Recently, athletes have been trialling a method known as 'live high, train low'. This tricks the body into believing it is living at high altitude, but allows the athlete to perform better quality training while at the top part of the aerobic training zone for 60+ minutes. The athlete would struggle to reproduce this intensity and duration when training at high altitudes.

Many variations on altitude training can be employed, and the purpose of altitude training will vary according to the individual. For many, the purpose is to improve sea-level performance.

Early altitude training involved an athlete exercising and living at altitude. The main criticism of this practice was that athletes experienced a greatly reduced ability to train hard and recover while at altitude. During the late

1990s, a new model of training emerged, designed to maximise the physiological adaptation from exposure to hypoxia. Ben Levine and Jim Stray-Gunderson proposed a 'live high, train low' (LHTL) altitude training model. The recent development of hypoxic tents and facilities has made the LHTL model more accessible to a greater cross-section of the community, by reducing the need to travel to altitude. Hypoxic training will be discussed later in this chapter. Other models of altitude training include 'sleeping high and training low' and 'train high and live high'.

Research into the effects of altitude training has returned varied findings, and more research is required to determine the best form. What is certain is that performance at altitude is enhanced following acclimatisation and training at moderate to high elevations. It is also clear that training or living for a period of time in a hypoxic environment induces better oxygen extraction, increased oxidative muscle enzymes and decreased blood lactate accumulation. Therefore, performance at altitude is certainly improved after chronic exposure to high elevations.

It is generally agreed that, in order to achieve results, altitude training needs to take place above 2000 m – optimally, at 2500 m – for changes to occur at the blood level. It usually takes an athlete three months of altitude training to achieve a greater oxygen capacity than could be attained at sea level. There is some variation in how long exercise scientists believe the effect will last; many agree that the maximum effect only remains for a period of two to three weeks.

Originally, athletes would travel to places that were considered to be 'at altitude'. The common classifications of altitude zones and their associated oxygen levels appear in Table 8.1 below.

TABLE 8.1 The effective amount of oxygen at different altitudes (metres)

Altitude (metres above sea level)	Effective oxygen (%)	Altitude category
0	20.9	Low
500	19.6	Low
1000	18.4	Medium
1500	17.3	Medium
2000	16.3	Medium
2500	15.3	High
3000	14.4	High
3500	7.5	High
4000	12.7	Very high
4500	11.9	Very high
5000	11.2	Very high
5500	10.5	Extreme
6000	9.9	Extreme
6500	9.3	Extreme
7000	8.7	Extreme
7500	8.2	Extreme

Source: Reproduced with permission of Higher Peak LLC, http://www.higherpeak.com/

INVESTIGATION

Weblink

Watch a video about 'live high, train low' altitude training by following the link at http://vcepe12.nelsonnet.com.au. There are also links to several other websites, with different perspectives. Once the class has investigated all the websites, discuss what you feel altitude training is best for, in terms of cost and effectiveness for particular sports.

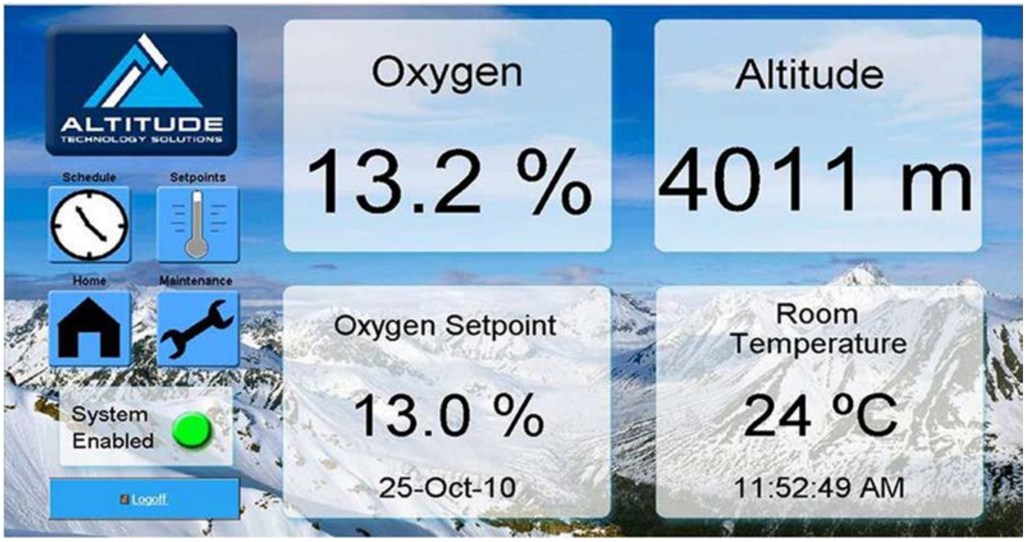


Image courtesy of Altitude Australia, http://altitudeaustralia.com.au

Display showing conditions in a simulated altitude training chamber. At sea level, the air has an oxygen concentration of about 21 per cent; inside the chamber, this decreases to between 16 and 11 per cent, corresponding with oxygen concentrations experienced at altitudes of up to 5000 metres.

REAL WORLD APPLICATION

From the Mountain to the MCG

by Blake McLean, *Australasian Science*, 1 September 2013

Altitude training has been used for decades by endurance athletes in an attempt to improve performance. In recent times this technique has been gaining popularity in professional team sports, perhaps most notably in the AFL. Before this season began no less than six AFL clubs participated in some sort of altitude training camp, and a number of clubs have now also installed simulated altitude, or hypoxic (low oxygen), rooms in an attempt to further enhance performance throughout the year.

However, many are still asking whether altitude training really works and, if so, how does it work? At Collingwood, we are confident that with the right preparation and implementation, altitude training has a positive impact on our athletes. The club has now ventured on eight sojourns to various altitude venues around the world, and has been using hypoxic rooms to implement intermittent hypoxic training (IHT) for more than 5 years …

There are a number of different training techniques available within the realm of what many consider altitude training, with the two most common being traditional altitude training camps and IHT. Despite wide use in the AFL and other team sports, until recently there was no published research on how either of these techniques affect team sport athletes – all of the attention has been on how these techniques impact endurance athletes.

In research published in the *International Journal of Sports Physiology and Performance* we recently reported on how our athletes respond, in terms of physiological changes and running performance, to a 19-day pre-season altitude training camp …

We can measure changes in the oxygen-carrying capacity of the blood by looking at total haemoglobin mass. Haemoglobin is the oxygen-earning protein in red blood cells. Most researchers report a 48% increase in total haemoglobin mass in endurance athletes after living at altitude for 3–4 weeks. Do AFL players respond in the same way? Compared with endurance athletes, AFL players typically have lower haemoglobin mass prior to altitude exposure, and therefore may have an even better opportunity to increase haemoglobin mass than world-class endurance athletes. In our recent publication we reported an average increase in total haemoglobin mass of 3.6% in our players after living

>

for 19 days at moderate altitude. This is similar to the 4% increases commonly reported in endurance athletes after 3 weeks of altitude exposure. We also confirmed that the athletes beginning with the lowest total haemoglobin mass stand to gain the most, in terms of physiological changes, from the altitude camp.

… We [assessed performance] by comparing 21 athletes who travelled to altitude with a group of nine who stayed at home and completed their pre-season training in Melbourne.

All of our athletes were training extremely hard, and as such all of our athletes improved their running performance, which we measure with a 2 km time trial. However, athletes that participated in the altitude training camp had a 2.1 % greater improvement than those who stayed in Melbourne – a very promising result for the overall efficacy of our altitude training camp.

One of the caveats of altitude training camps is that increases in red blood cells generally return to pre-altitude levels about 4 weeks after returning to sea-level, due to self regulatory mechanisms within the body. This is because the athletes are no longer living with less oxygen available, and their bodies are able to sense this and return to the status quo. Therefore, endurance athletes often plan to return from altitude camps just a few weeks prior to their most important competitions, with the goal of 'peaking' to perform at their best during that competition.

Similar timing is not possible for AFL players, as they need to be at their best for 26 weeks of the year, with the most important matches coming at the end of the season. So how can they maintain their improvements from a pre-season altitude camp? The reality is that athletes won't maintain increases in red blood cells upon returning to sea level, unless they continue to live in a hypoxic environment. Dormitories at the Australian Institute of Sport and Victoria University provide this option.

We confirmed that the red blood cells of our group returned to baseline values 4 weeks after returning to Melbourne - just as it has been shown in the past with endurance athletes. The good news is that this group was able to maintain their greater improvements in running performance, which they gained from the altitude camp. This outcome is important for performance.

The underlying thinking is that when athletes return from the altitude camp with an increased physiological (and running) capacity, they are able to train harder during the post-altitude period, allowing for greater training adaptations that allow them to train harder in the following weeks, and so on. Here the athletes are essentially training to train which all athletes are doing during preparatory phases of the season, building each week's work on top of another to gradually improve their performance.

For AFL players, this means getting a boost during their pre-season so they can train harder during the late pre-season and carry these improvements into the season itself. We are confident that these altitude camps give our athletes the edge to take full advantage of the off-season period and optimise their preparation leading into the season.

Questions

1 What findings were made in relation to the Collingwood football players and their haemoglobin mass after training at altitude?
2 How did the Collingwood footballers perform after the altitude camp?
3 What is meant by the comment 'training to train'?
4 What are some of the perceived benefits of IHT?
5 Why are team sport athletes more interested in improving intermittent, high-intensity running?

TEXT ANALYSIS

The 'lactate paradox' describes findings of a low concentration of lactate in blood during exercise after acclimatisation to a high altitude. During acute altitude exposure, blood lactate concentration is higher compared to the sea level value for maximal or submaximal exercise. The paradox occurs with lower levels of blood lactate after acclimatisation, despite a sustained low oxygen environment. Reasons for this vary and are still being researched. Most people elicit a greater blood lactate concentration during acute altitude exposure, and so will not be able to work hard until they have acclimatised, and their blood lactate concentrations have gone down.

Source: JB West, 1986

Explain in your own words, using key terminology, what is meant by the term 'lactate paradox at altitude'.

Hypoxic training

Hypoxia occurs when there is not enough oxygen in the tissues, or low oxygen in relation to metabolic needs. Hypoxic training is a legal cardiorespiratory performance enhancer, and is ethically sound. Hypoxic devices such as hypoxic tents can provide an alternative to altitude training; and, unlike altitude training, they are accessible to all, meaning their use is fair and equitable. By increasing accessibility for those who cannot afford natural altitude training, hypoxic devices may help level the playing field. As with altitude training, further research is required to refine hypoxic training possibilities.

This chapter has previously discussed altitude training, and 'living high and training low'. Hypoxic training is a variation on altitude training. Some coaches and athletes decide to use hypoxic training at sea level using hypoxic chambers, houses or even home-based hypoxic tents. This means the athlete can spend several hours per day (including sleeping) in a low-oxygen environment while continuing to train in their normal environment. This eliminates time needed to acclimatise to higher altitudes. However, it is not as effective as actually spending further time at 'natural' high altitude. Athletes may need to spend as long as 20 hours a day within the artificial hypoxic environment in order to achieve the same result as if they were actually at altitude.

(Source: http://www.drpeterlarkins.com)

Getty Images / The Washington Post

High altitudes can be simulated at sea level by creating hypoxic environments in altitude tents, houses or training areas.

FYI

Scientific studies have shown that through a combination of sleeping in **normobaric hypoxia** every night and moderately working out at altitude two or three times per week, athletes can increase performance by as much as 3 per cent. The proper altitude training program can substantially boost the body's oxygen transport and metabolism systems through enhanced ventilation, naturally increased EPO production and increased **mitochondrial efficiency**. This will allow more efficient energy production both aerobically as well as anaerobically.

Source: http://altitudetraining.com/main/sports/results

Hypoxic training improves oxygen delivery and utilisation, leading to:

» increased VO_2 max
» enhanced power output, speed and aerobic benefits
» improved strength and local muscular endurance
» increased exercise-till-exhaustion (ETE) time
» reduced recovery time after exertion
» stronger intercostal and diaphragm muscles
» decreased resting heart rate and blood pressure
» maintenance of cardiovascular fitness when injured
» diminished overall fatigue.

CHAPTER CHECK-UP

1. Define, and give a specific example of, altitude training.
2. Explain the 'live high, train low' model.
3. What type of athletes would benefit most from altitude training?
4. Explain the term 'hypoxia'.

EPO

Erythropoietin (EPO) is a naturally occurring polypeptide hormone produced in the kidneys that regulates the body's production of red blood cells. It increases red blood cell production by the liver and bones, which in turn increases the amount of oxygen supplied to the muscles.

A synthetic EPO can be used to treat patients with low levels of red blood cells resulting from conditions such as anaemia, kidney disease and various cancers. Athletes seeking to improve their endurance abilities inject EPO to encourage their bodies to produce higher than normal amounts of red blood cells, to enhance performance. The side effects are similar to those of blood doping (see below). EPO thickens the blood, which means that the heart has to work harder to move it around the body. This extra strain on the heart is particularly dangerous at times when the heart rate is low, such as during sleep. The increased thickness, or viscosity, of the blood increases the risk of blood clots, heart attacks and strokes. EPO is on the 2016 WADA list of prohibited substances and methods.

Blood doping

Blood doping is an illegal and unethical method of improving performance by artificially boosting the number of red blood cells in the body, increasing the amount of **haemoglobin** in the blood and thereby delivering more oxygen to the muscles. By boosting the oxygen-carrying capacity of the blood, blood doping improves vO_2 max and endurance capacity and fuels an athlete's muscles by producing larger amounts of aerobic ATP. Potential harms of blood doping include stroke, hypertension, body rejection, infection, autoimmune diseases, heart attack and the risk of contracting blood-borne viruses such as hepatitis B.

Athletes seek to blood dope via:

- blood transfusions
- injections of erythropoietin (EPO)
- injections of synthetic oxygen carriers.

Blood transfusions

Blood transfusions can be of the athlete's own blood (**autologous transfusion**), or from a donor with the same blood type (**homologous transfusion**). Several units of blood (approximately 500 millilitres each) are removed and the red blood cells are harvested, stored for up to six weeks and later reinfused into the veins. Some individuals have been known to reinfuse the blood into their body one to two days prior to competition in an attempt to improve their performance.

Synthetic oxygen carriers

Synthetic oxygen carriers are chemicals that have the ability to carry oxygen and are legally and legitimately used when people need a blood transfusion, but cannot have one because:

- human blood is not available
- there is a high risk of blood infection, or
- there is not enough time to find a match for the person's blood type.

Synthetic oxygen carriers include:

- HBOCs (haemoglobin-based oxygen carriers)
- PFCs (perfluorocarbons).

Athletes use synthetic oxygen carriers to achieve the same performance-enhancing effects as other types of blood doping: increased oxygen in the blood that helps aerobic capacity and production of ATP.

FYI

Tests have been developed to detect the use of synthetic oxygen carriers, EPO and homologous blood transfusions. A test for autologous transfusions is close.

Potential harms of blood doping

Blood doping and using EPO are dangerous practices – those who engage in them risk contracting blood-borne viruses such as hepatitis B. Athletes using blood doping, regardless of the type chosen, all risk developing the same associated problems, including:

- stroke
- hypertension
- body rejection
- infection/transmission of diseases
- autoimmune diseases
- heart attack.

Alamy Stock Photo / ZUMA Press Inc

Lance Armstrong used various forms of blood doping during his cycling career to gain an illegal and unfair advantage over many of his opponents. It has since been discovered that blood doping has been widespread, and is still present, in the world of professional road cycling.

REAL WORLD APPLICATION

What are the dangers of blood doping?

Blood doping is one of the simplest ways to improve your race time. By taking erythropoietin (EPO), a hormone usually produced by the liver and kidneys, you trigger your bone marrow to overproduce red blood cells, in effect boosting oxygen capacity. The result, as seven Tour de France titles show, is a boon for endurance, muscle recovery and overall performance. It's a huge enhancement – and it works fast, too – but what's the downside?

'There are a few pretty substantial risks,' says Dr Philip Friere Skiba, program director of sports medicine at Lutheran General Hospital. The most common is a blood clot that can lead to heart attack, stroke, or even sudden death in your sleep. 'Increasing the blood count makes it more viscous,' says Skiba. 'We call this "sludging", which can slow down your heart rate and cause clots.' To avoid the so-called sludging, you have to keep that heart pumping. There are stories of some doping athletes waking up in the middle of the night and doing jumping jacks to keep it moving. Others, at least anecdotally, weren't so lucky, dying in their sleep.

Years from now, taking EPO to up your red blood cells will likely be considered as archaic as giving yourself a blood transfusion from saved bags of blood (like the first dopers did). Instead, we'll turn to genetic tinkering for more oxygen. One study showed that by imparting such genes to monkeys, researchers could permanently increase the amount of EPO that their bodies created. The problem for these unfortunate animals was the runaway blood cells caused their bodies to turn on the EPO hormone and fight it like a virus. The monkeys eventually died of anaemia (or lack of red blood cells). If we learn how to give that gene an on/off switch, however – something that's exceedingly difficult to do in genetic research today – we could regulate red blood cells for life. This would give you that untraceable edge for all your endurance sports.

Questions:

1 What is the result of taking EPO?
2 What are some of the potential risks of blood doping?
3 Explain 'sludging'.

Beta blockers

Beta blockers, also known as beta-adrenergic blocking agents, are drugs that reduce blood pressure by blocking the effects of the hormone epinephrine (adrenaline). Beta blockers also help blood vessels dilate to improve blood flow, allowing the heart to beat more slowly and less forcefully, ultimately leading to lower blood pressure.

Sports where athletes are likely to take beta blockers include archery, gymnastics, shooting and golf. These athletes require steady hands, increased focus and a relaxed state of mind in order to perform with high levels of coordination and at optimal arousal levels. Beta blockers have been used to reduce tremor and slow the heart rate so that the athlete can fire shots or arrows between heartbeats. In some instances, beta blockers are taken to reduce performance anxiety, and have an arousal-reducing effect.

Beta blockers may be used to treat abnormal heart rhythms and to prevent **tachycardia**, or irregular rhythms such as atrial fibrillation. They can also be useful in treating angina, which occurs when the oxygen demand of the heart exceeds the supply. Beta blockers improve survival rates after a heart attack and are also used to treat high blood pressure and a variety of other cardiovascular conditions.

People with asthma or lung problems such as chronic obstructive pulmonary disease (COPD) typically shouldn't take beta blockers because they can trigger asthma attacks and can narrow airways significantly. Beta blockers are also not recommended for people with diabetes, because they can affect the control of blood sugar. Side effects of beta blockers include hypotension, hypoglycaemia and cardiac failure.

Supplements to enhance the cardiorespiratory system

Some individuals may turn to supplements to enhance their cardiorespiratory system. There are hundreds of supplements that claim to improve cardiovascular or respiratory system function and thus improve performance. However, supplements should only be taken in consultation with a medical practitioner or dietitian. These professionals are qualified to gauge their suitability to individual circumstances.

Metabolic promoters

Metabolic promoters are supplements designed to allow athletes to work at higher intensity more efficiently. By increasing synthesis of ATP in the mitochondria found within muscles, they improve oxygen utilisation by cells. When athletes work above their anaerobic capacity, these supplements help them sustain the effort that little bit longer.

Products containing **adaptogens** such as rhodiola, cordyceps and jiaogulan fall into this category, as well as the amino acids acetyl-L-carnitine and L-citruline malate, which help delay lactic acid accumulation and promote fat metabolism. Resveratrol has also been studied for its ability to increase mitochondrial density.

L-taurine (a non-essential, sulfur-containing amino acid) plays a role in several metabolic processes, such as heart contraction and antioxidant activity. It is necessary for both cardiovascular function and development and skeletal muscle function. In a study conducted with 11 men aged 18–20, it was found that supplementation with L-taurine significantly increased VO_2 max, exercise time to exhaustion, and maximal workload. Additionally, a recent study suggested that L-taurine has fat-burning properties.

Fuel additives

All muscle contractions depend on a source of ATP being broken down and rebuilt. When the body needs to perform maximally in a short period of time, muscles rely on a chemical fuel called creatine phosphate (CP or PC). Creatine supplementation promotes the formation of CP by making sure the phosphates have creatine to pair up with.

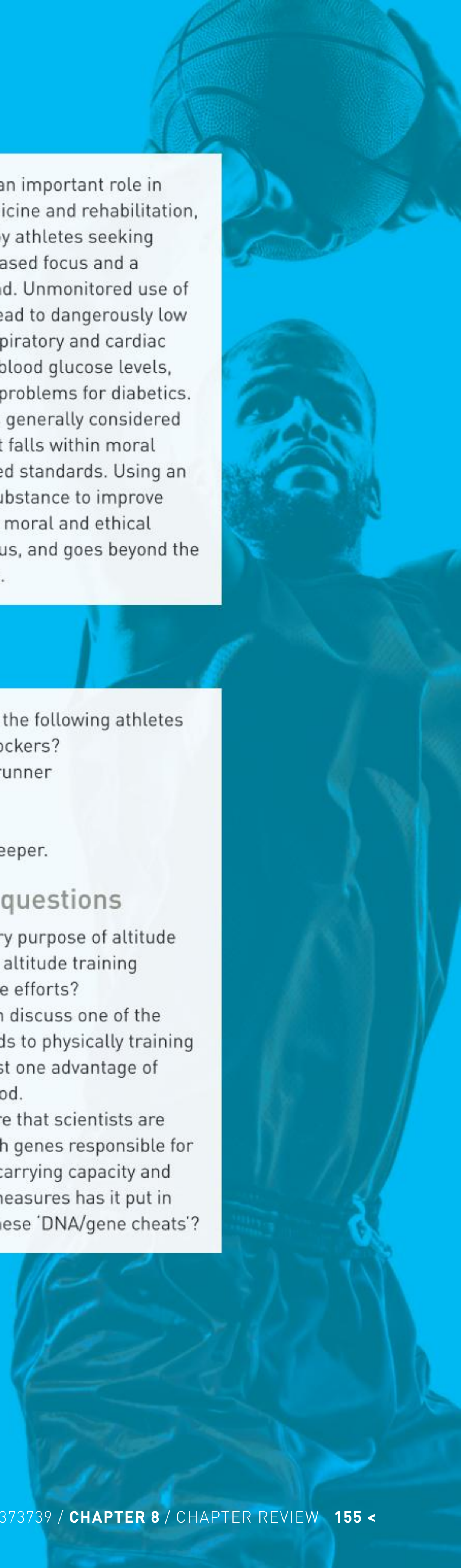
Supplements containing sodium phosphate will promote the generation of creatine phosphate, and thus ATP. Additionally, sodium phosphate loading has been shown to increase aerobic capacity and time to exhaustion by enhancing the ability of red blood cells to deliver oxygen to active muscles. Several studies have also found improvements in endurance performance due to increases in maximal oxygen uptake and **ventilatory threshold**.

Sociocultural and ethical considerations

To revisit the definition of sociocultural and ethical considerations, please refer to chapter 4. Ethical behaviour is generally considered to be behaviour that falls within moral and socially accepted standards. Using an illegal method or substance to improve performance poses moral and ethical questions for all of us, and goes beyond the boundaries of sport. Sport plays an important role in many cultures around the world. Children grow up in specific physical, social, cultural, economic and historical circumstances (their sociocultural context), all of which influence their childhood. Research has shown that children's sociocultural context can have a significant influence on their development.

CHAPTER CHECK-UP

1 Explain why some athletes may use EPO to enhance their performance.
2 Blood transfusions are viewed by some athletes as an alternative to injecting EPO. Explain how the two differ.
3 Why might athletes who are illegally blood doping get up two or three times during the night and either jog or skip for a couple of minutes before returning to sleep?



CHAPTER SUMMARY

- Endurance athletes such as marathon runners, triathletes and road cyclists use altitude training to improve their body's aerobic capacity.
- Some coaches and athletes use hypoxic training at sea-level base by utilising hypoxic chambers, houses or even home-based hypoxic tents to trick the brain into thinking it is at altitude.
- Athletes who seek to blood dope are attempting to increase their oxygen-carrying capacity via illegal:
  - blood transfusions
  - injections of erythropoietin (EPO)
  - injections of synthetic oxygen carriers.
- Beta blockers play an important role in cardiovascular medicine and rehabilitation, but are also taken by athletes seeking steady hands, increased focus and a relaxed state of mind. Unmonitored use of beta blockers can lead to dangerously low blood pressure, respiratory and cardiac arrest, and altered blood glucose levels, which might cause problems for diabetics.
- Ethical behaviour is generally considered to be behaviour that falls within moral and socially accepted standards. Using an illegal method or substance to improve performance poses moral and ethical questions for all of us, and goes beyond the boundaries of sport.

CHAPTER REVIEW

Multiple-choice questions

1 Blood doping occurs when:
- A athletes remove their own blood, store it and then have it reinfused weeks later
- B EPO is injected by endurance athletes, causing more red blood cells to be produced
- C endurance athletes take plasma expanders
- D all of the above occur.

2 Live high, train low training involves:
- A athletes living and training at high altitude
- B athletes living and training at sea level
- C athletes living at high altitude and training at sea level
- D athletes living at sea level and training at high altitude.

3 Typically, which of the following athletes would use beta blockers?
- A a 1500-metre runner
- B an archer
- C a golfer
- D a soccer goalkeeper.

Short-answer questions

4 What is the primary purpose of altitude training? How can altitude training improve endurance efforts?

5 Research and then discuss one of the alternative methods to physically training at altitude. Suggest one advantage of your chosen method.

6 WADA is well aware that scientists are trying to tinker with genes responsible for improved oxygen-carrying capacity and extraction. What measures has it put in place to counter these 'DNA/gene cheats'?

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UNIT 2

PHYSICAL ACTIVITY, SPORT AND SOCIETY

AREA OF STUDY 1

WHAT ARE THE RELATIONSHIPS BETWEEN PHYSICAL ACTIVITY, SPORT, HEALTH AND SOCIETY?

CHAPTER 9

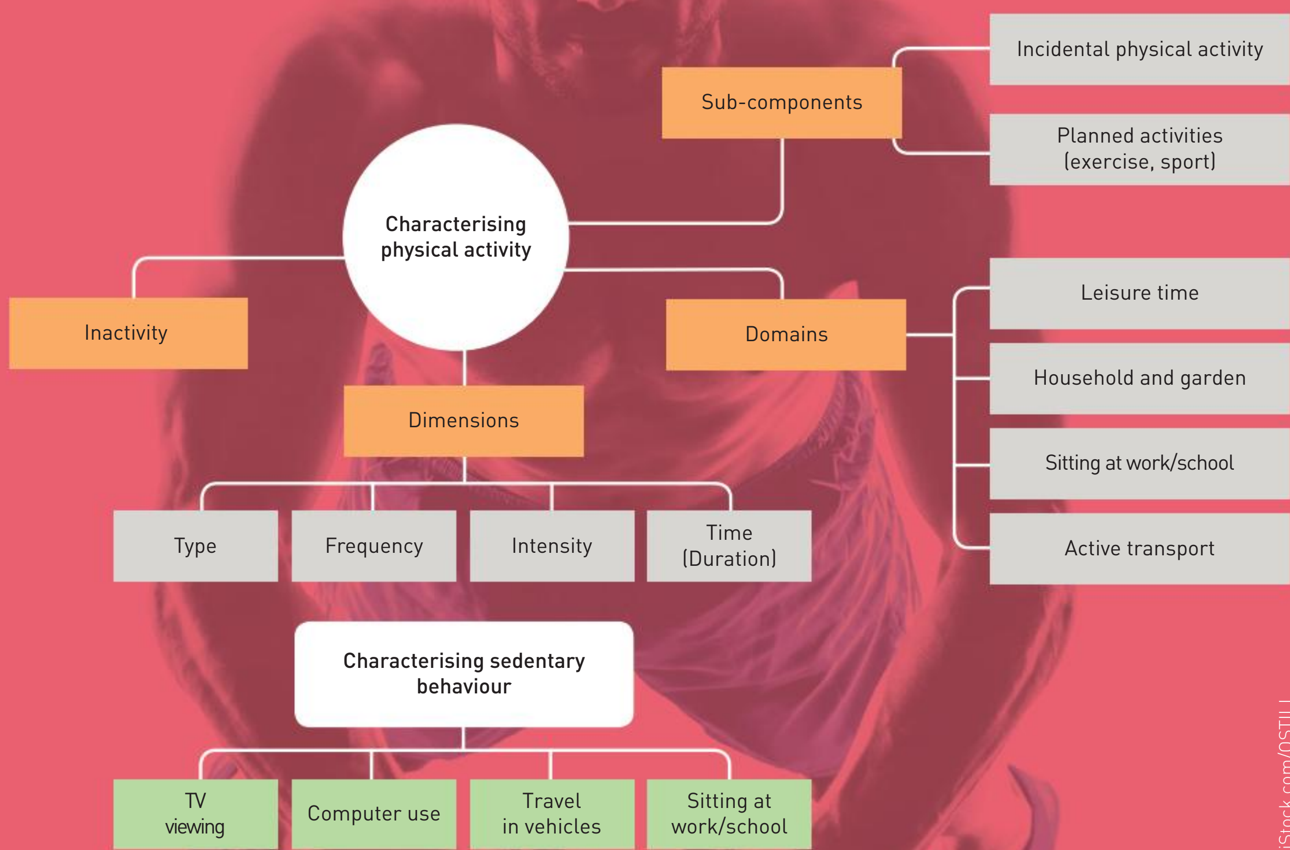
PHYSICAL ACTIVITY CONCEPTS

Key knowledge

- forms of physical activity such as play, games, sports, transportation, chores, exercise and recreational activities
- the concepts of physical activity, physical inactivity and sedentary behaviour
- principles of an individual activity plan, including frequency, intensity, time and type of activity (FITT)

Key skills

- describe and participate in a variety of different forms of physical activity, including a variety of culturally diverse physical activities
- define and identify forms of physical activity, physical inactivity and sedentary behaviour
- apply the principles of frequency, intensity, time and type appropriately to an individual activity plan
- create, implement and evaluate an activity plan for an individual or a specific group to increase physical activity and decrease sedentary behaviour in relation to the guidelines



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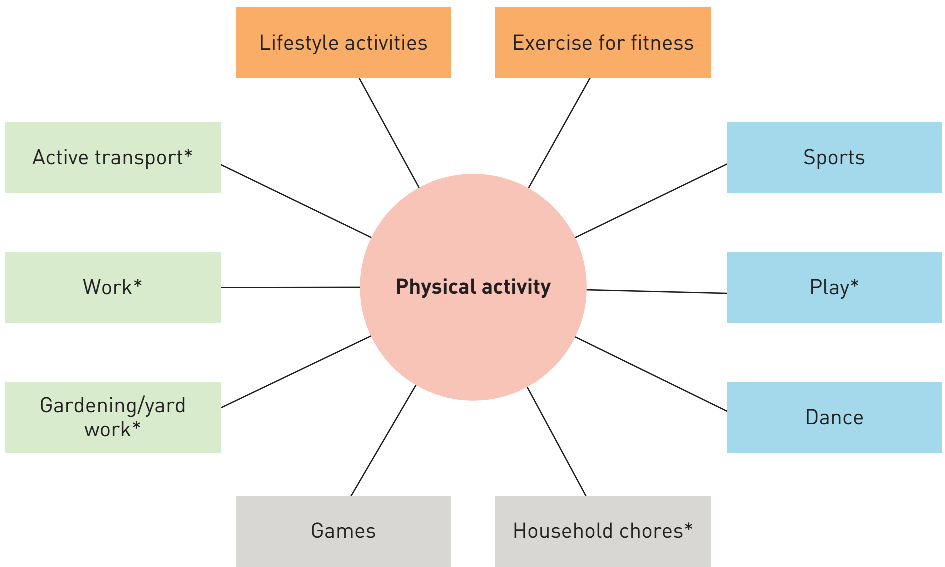
UNDERSTANDING THE NATURE OF PHYSICAL ACTIVITY

Physical activity is generally understood to be any bodily movement requiring the skeletal muscles that expends energy. Some people think **sport** is something different, but it is simply a subcomponent of physical activity. Other subcomponents include exercise, lifestyle activities and games (see below).

Physical activity may also be classified as structured or **incidental**. Structured physical activities tend to be planned, such as participating in organised sport, going to the gym or going for a bike ride. Most people engage in a combination of incidental and structured physical activity that contributes to their overall physical fitness and wellbeing.



Subcategories of physical activity.

*incidental physical activity

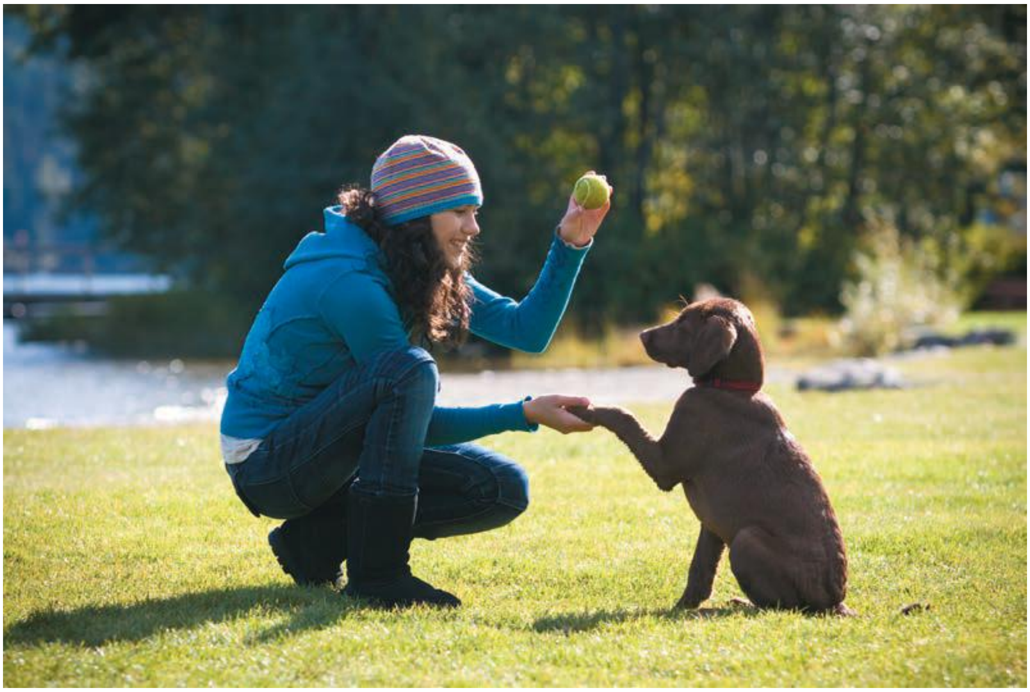
QUICKVID

Watch a short video introduction to Unit 2 Area of Study 1: the relationship between physical activity, sport, health and society. You need to use your code to log in to http:/nelsonnet.com.au and scroll to chapter 9, page 159.

Video

Incidental physical activity

Incidental physical activity is unstructured activity accumulated throughout the course of the day. An example is walking instead of riding or catching public transport, and using the stairs instead of the lift at a shopping centre. Incidental activity can occur during daily activities such as doing the housework, working in the garden or when you **play** with your pets. Often, physical activity is not the primary goal, it's just something that occurs as a consequence of this behaviour. For example, the primary goal may be to go from biology class to the gym for a physical education laboratory class, but in the process, you may walk 250 metres.



iStock.com / tderden

Playing with your pets is a great source of physical activity. Who else can people play with to be active?

TABLE 9.1 Subcategories of physical activity classified as incidental activities

Physical activity subcategory	Description	Examples
Household chores/gardening 	Completing household chores results in higher energy expenditure than being at rest.	Sweeping, vacuuming, scrubbing floors, mopping, hanging out washing, digging, mowing, raking leaves
Active transport 	Any form of human-powered transport to get to and from specific destinations, such as the post office, local shop, work or school, by active mode. This results in much higher energy expenditure than a sedentary alternative, such as travelling in a vehicle.	Walking to the train station; riding a bicycle to work or school; riding a scooter, skateboarding or in-line skating to the local park or shop; non-mechanised wheelchairing

Physical activity subcategory	Description	Examples
Occupational activity 	Some occupations are very active and result in significantly higher energy expenditure than desk jobs. Many tradespeople, labourers, farmers, rangers, etc. are quite active as part of their everyday activities at work.	Carrying bricks on a building site, digging trenches beside a road, removing trees, rounding up cattle on horseback, delivering mail by bicycle
Play 	Play generally consists of no formal rules, may be spontaneous or sporadic in nature, with no set time or defined playing area. Winning is not the priority, so there is a sense of fun, rather than pressure. Anyone can play.	Building a sandcastle; playing tag or chasey; office basketball using scrunched up paper as the ball and a waste-paper basket as the goal; throwing a frisbee or tennis ball; hitting a ball against a wall; juggling

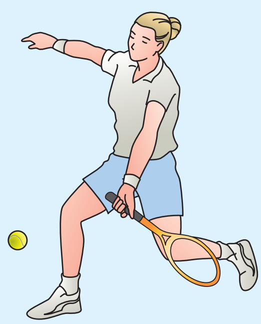
Getty Images / Richard Newstead

The Netherlands is renowned as the active transport capital of the world.

Structured/planned physical activity

Physical education programs often involve exercise and sport – two common subcategories of physical activity that are structured or planned.

TABLE 9.2 Subcategories of physical activity classified as planned activities

Physical activity subcomponent	Description	Examples
Exercise 	Involves planning and structure and requires physical effort to sustain or improve health or fitness. To gain improvements or to maintain fitness outcomes requires purposeful repetition and to be a regular part of a person's weekly routines.	Going to the gym for a workout or to participate in an aerobics class, spin class or Pilates Walking for exercise or going for a bike ride to improve fitness Using dumbbells at home to complete your upper body workout Doing sit-ups and push-ups and stretching
Recreation and leisure 	**Recreational activities** are those activities that stimulate the mind and body, whereas leisure activities are meant to be restful. Some recreational activities, such as fishing, shopping, reading, talking on the phone, or spending time on Facebook, are also considered functional activities. Over the past decade there has been growing interest in extreme sports and high-risk activities such as scuba diving, rafting, snowboarding, base jumping and sky-diving.	Dance, hobbies, games, music, sports, playing computer games (a more active example of this would be playing Nintendo Wii basketball or Wii fit)
Organised sport 	Organised sport is a physical activity that provides active diversion involving bodily exertion and structured competition. For sport to be classified as organised, it generally meets one or several of the following criteria: » Structured or highly organised » Involves skills or set plays » Involves competition and winning is important » Has set rules that must be abided by and the inclusion of officials or umpires to enforce the rules » Involves vigorous physical activity » Requires training and preparation often coordinated by coaches	Intra-school sport (within school), interschool sport (between different schools), community sport, social competitions (e.g. mixed netball or touch football) Club sport at local level Can extend from community club level, to district, state, national or international level Athletes competing in the world championships or the Olympics are competing in organised sport in its highest form of organisation and standard at an international level.

Regular physical activity

Throughout this VCE physical education unit you will refer to physical activity and sedentary behaviour guidelines. Physical activity guidelines, both nationally and internationally, encourage participation in regular physical activity. In fact, you can't meet physical activity guidelines unless you are regularly active. Regular physical activity is activity performed on most days of the week, preferably every day. Chapter 10 provides an outline of the Australian physical activity and sedentary behaviour guidelines. It is important to note that inactivity and sedentary behaviour are not the same thing, even though the two terms are often used interchangeably.


Shutterstock.com / Sorbis

Extreme sports are becoming more popular as recreational pastimes.

Inactivity

Physical inactivity is defined as people undertaking 'insufficient' physical activity to achieve measurable health outcomes. People who do not do sufficient physical activity have a greater risk of cardiovascular disease, colon and breast cancers, type 2 diabetes and osteoporosis. Regular physical activity improves mental and musculoskeletal health and reduces other risk factors such as overweight, high blood pressure and high cholesterol, all of which are discussed in chapter 10. Inactivity means not engaging in any regular physical activity beyond daily activities, or a lack of **moderate-intensity physical activity**.

FYI

The term sedentary is derived from the Latin *sedere*, meaning 'to sit'. Sedentary behaviour incorporates almost all sitting-based activities.

FYI

Although playing computer games is generally considered sedentary behaviour, the amount of energy expended while playing certain Nintendo Wii sports and Wii fit games is between two and three times higher than that expended while watching television (at rest). Although exergaming is not as good for you physically as participating in the actual physical activity itself, something is better than nothing.

Sedentary behaviour

Sedentary behaviour is defined as the amount of time per day spent sitting or lying down (with the exception of sleeping), engaged in non-active activities, such as watching television or playing electronic games, driving a vehicle, working at a computer, reading, etc. Being sedentary means staying in the same place and expending low amounts of energy. While many inactive people spend many hours engaged in sedentary behaviour, highly active people can also be highly sedentary.

Sedentary behaviours include activities that require up to 1.5 METs to perform, where 1 MET (metabolic equivalent) is the amount of energy you expend at rest, and 2 METs is twice the energy expenditure of resting levels. More vigorous physical activity requires proportionately higher oxygen consumption, so activities can be quantified in terms of multiples of the resting oxygen consumption. Higher levels of sedentary behaviour are associated with poorer health outcomes, including an increased risk of type 2 diabetes. Everyone can significantly benefit from minimising time spent sitting each day, and from breaking up periods of time spent being sedentary, as often as possible.

Alamy Stock Photo / Jeff Gilbert

Many research studies have reported that the energy expenditure associated with active gaming is of moderate intensity, equivalent to a brisk walk.

DOMAINS OF PHYSICAL ACTIVITY

Physical activity can take place during leisure time, at work, while performing household chores, gardening or yard work, or as a form of transport.

Leisure-time activity domain

Leisure-time activity is considered any activity that is over and above that which occurs within the workplace. Leisure-time physical activity is performed during recreational, non-working spare time, when a person has the freedom to choose an enjoyable activity or pastime. Later in this book you will learn about physical activity surveys. Most physical activity surveys focus on physical activity performed during leisure time. Examples of leisure-time activities are golf, tennis, walking the dog, basketball and karate.

Household/gardening domain

Chores that you carry out around the house and garden provide an important source of physical activity. These include scrubbing, sweeping, vacuuming, washing windows, raking leaves or grass clippings, digging, mowing and painting. For many older people, this is an essential source of physical activity and provides an opportunity to develop strength, flexibility, balance and muscular endurance.

Occupational domain

This is the physical activity that a person performs regularly as part of their work or occupation. Some people, such as labourers, gardeners, cleaners, personal trainers and physical education teachers, have highly active jobs, whereas others, such as those who have desk jobs, are highly sedentary. Occupational activities can include sweeping, lifting, packing boxes, digging, carrying bricks or wood and tending to animals.

Shutterstock.com / Dmitry Kalinovsky

Tradespeople can accumulate large amounts of occupational physical activity. What are some of the more active occupations?

Active transport domain

Active transport is any form of human-powered transportation used to get to and from specific destinations such as the post box, the shops or church, usually across a reasonable distance, by walking, skating, cycling or the use of public transport. Active transport usually involves travel to a specific destination, rather than walking or cycling for exercise. More people riding bikes to work not only results in many health benefits but also reduces traffic congestion and greenhouse gas emissions, and increases productivity within the workplace.

DIMENSIONS OF PHYSICAL ACTIVITY

Before you can go on to learn about physical activity guidelines and measurement of physical activity in Unit 2, you need a sound understanding of the fundamental dimensions of physical activity. The dimensions of physical activity can be summarised using the acronym FITT, which stands for F = Frequency, I = Intensity, T = Type of activity and T = Time (duration).

Activity type

There are hundreds of types of physical activities that people engage in. These can be classified in terms of the following categories, based on the physical activity pyramid (see page 166):

» lifestyle or lifetime physical activities
» active aerobic activities
» active sports and recreation
» flexibility activities
» strength and muscular endurance activities.

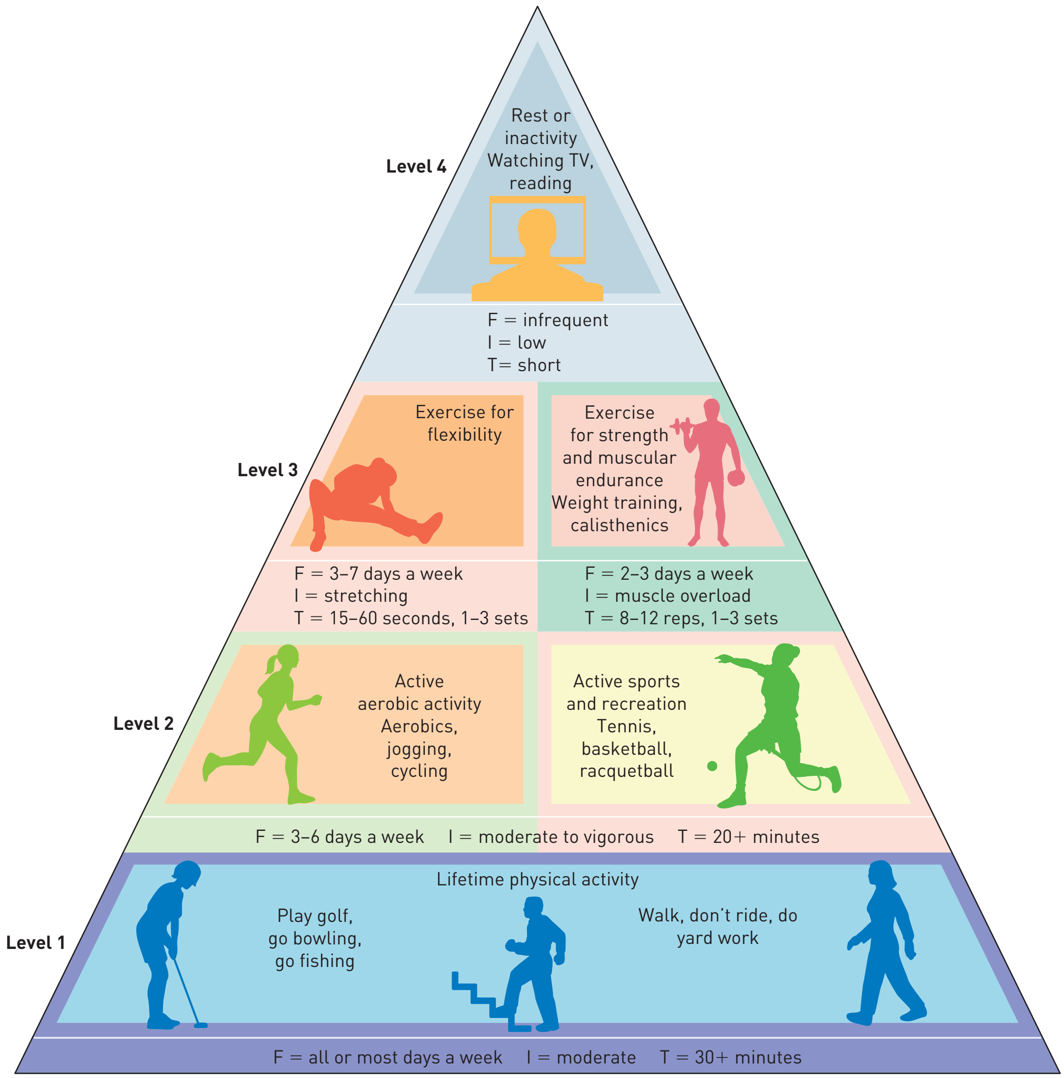
Rest or inactivity is a part of the pyramid but is not a category of physical activity.

FYI

High-quality and contemporary physical education programs place a huge emphasis on lifestyle physical activity programs to engage all students rather than simply focusing on traditional team sports. Only around 30 per cent of adults participate in regular organised sport.

Lifestyle physical activity

Lifestyle (sometimes referred to as lifetime or lifelong) physical activities should be the most common form of daily physical activity. These activities form the base of the physical activity pyramid and should be performed on most days of the week, if not daily. Walking is a lifestyle physical activity and is the most common physical activity people engage in, regardless of the country they live in. Other examples of lifestyle physical activities are gardening, swimming, bike riding, dancing, golf, tennis, kayaking and household chores.



The physical activity pyramid

REAL WORLD APPLICATION

Top fitness trends for 2015

by Sarah Berry, *The Sydney Morning Herald*, 6 January 2015

'The one thing I've learned about exercise is that you need to connect the dots ... you need to work the body as a whole,' the *Biggest Loser* trainer [Steve Willis] says. 'You need to be able to apply what you're doing in real life.'

This might explain the popularity of functional fitness, body weight and mobility-based training.

'There is a definite move towards this type of programming because people are realising it's the most effective style of training for a majority of people, is cheap and versatile, as well as being a lot safer, with more longevity than a lot of the fads,' says Libby Babet of Sydney's agoga and the women's online bufgirl.com.

She points out that as well as being effective, such forms of exercise can be carried out anywhere, anytime, don't require clunky pieces of equipment (if any) and are now accessible to anyone via online programs.

'I've seen mobile apps like Zova and Freeletics launch with incredible success and build their customer bases at an astronomical rate,' she says.

'I think online training is on its way but people are still more motivated with human company,' says Aaron Mckenzie of Origin of Energy, noting that many of the more popular group exercise classes – including CrossFit – fall under the umbrellas of the top trends.

'All of these are using High Intensity Interval circuit style training,' he says. 'Even yoga is becoming more high intensity acro-based.'

As far as future Australian fitness trends are concerned, Mckenzie sees them being influenced by CrossFit, Paleo-based nutrition, organics and meditation.

'Hopefully the military bootcamp style training is on its way out and is replaced with high quality small group training,' he says, with the other experts all agreeing that boutique, small group training classes are on the rise.

Class discussion

1 Discuss why people are drawn to forms of exercise that can be carried out anywhere, anytime, that don't require clunky pieces of equipment (if any), and that are accessible to anyone via online programs.
2 What are the dangers associated with fad physical activities like bootcamp-style training, which tend to involve large groups and one-size-fits-all approaches?

The checklist below outlines the key factors that characterise lifestyle physical activities. Think of 10 activities you engage in regularly and apply the checklist shown to each one. If the activity possesses at least six of the characteristics on the list, it is likely to be an example of a lifestyle physical activity.

Checklist of characteristics of lifestyle physical activities

- ✓ If regularly performed, will result in numerous health benefits
- ✓ Should be performed daily
- ✓ Can easily integrate into everyday life and routines
- ✓ May be considered light activity when you are young but may equate to a moderate intensity when you are older
- ✓ Are easy to perform regardless of fitness or skill level and therefore popular among adults
- ✓ Should expend more energy than being at rest
- ✓ May be performed throughout the lifespan
- ✓ Usually require minimal equipment
- ✓ Can be performed anywhere, anytime, even on holidays
- ✓ Can be performed either alone or with one or two others
- ✓ Are often of light to moderate intensity, moderate-intensity activities being more attractive than vigorous-intensity activities to most people

PRACTICAL ACTIVITY

DOG-WALKING EVENT

Dog-walking is one of the most common leisure-time physical activities. Organise a dog-walking event before or after school for one particular year level. Publicise the event widely and brainstorm all logistics and safety considerations. Ensure owners pick up any mess after their dog, and that all dogs are on a lead and are well-behaved.

As a class, think of some catchy awards to give out. Design a brochure advertising the event and giving information about the health benefits (refer to chapter 10) associated with dog walking.

1 Discuss general benefits of dog walking.
2 Explain why dog walking is classified as a lifelong/lifestyle physical activity.

Shutterstock.com / Daxiao Productions

Bike riding is one of the most common lifestyle physical activities and one of the fastest growing activities in Australia.

CHAPTER CHECK-UP

1 Define the terms 'physical activity', 'exercise', 'sport' and 'play'.
2 Explain the difference between inactivity and sedentary behaviour.
3 Outline three characteristics of lifestyle physical activities.
4 Refer to the physical activity pyramid on page 166 and discuss which activities should be engaged in most and which activities should be performed least during a typical week.

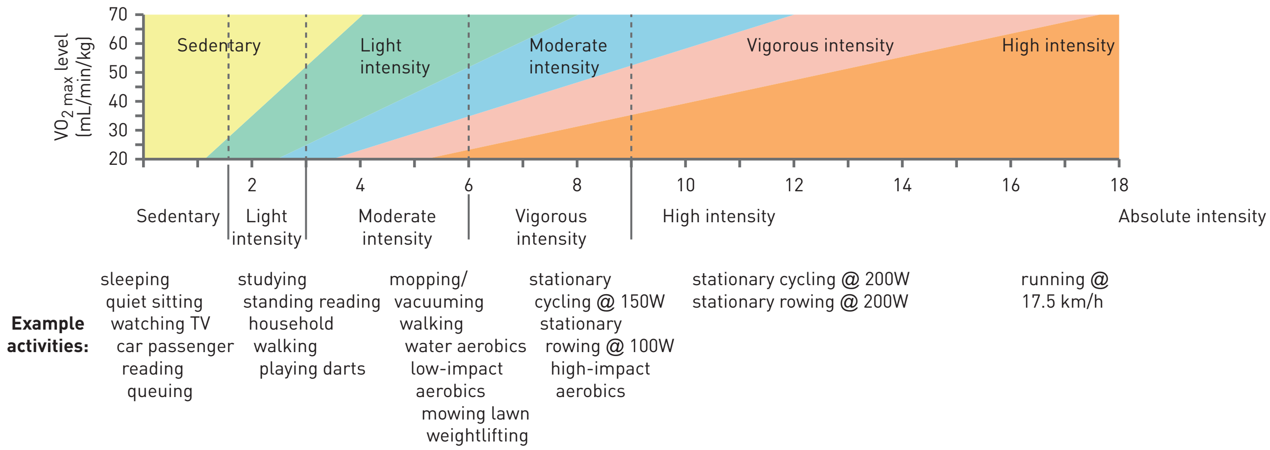
Frequency

The number of times a person engages in physical activity within a given time frame is referred to as frequency. Frequency can also refer to the number of physical activity sessions or bouts during a day. For example, adults can meet the recommended 30 minutes per day by doing three 10-minute bouts of moderate-intensity activity. The adult guidelines recommend that people be active on most days, preferably all days each week.

Intensity

The intensity of an activity refers to how much effort is required to engage in it. Intensity can be classified as sedentary, light, moderate, vigorous and high, depending on how much energy is expended during the activity. The physical activity guidelines focus mainly on **moderate-intensity** and **vigorous-intensity activities**, which are discussed in chapter 10.

Table 9.3 summarises the classifications of physical activity intensity in terms of MET, kcal (or kJ), perceived exertion and proportion of maximum heart rate. When you study measurement of physical activity this table will be an excellent reference.



Physical activity intensities

Reprinted from *Journal of Science and Medicine in Sport*, vol. 13, p. 499. Kevin Norton, Lynda Norton, Daryl Sadgrove, 'Position statement on physical activity and exercise intensity terminology'. © 2009 Sports Medicine Australia.

TABLE 9.3 Classification of physical activity intensities

Intensity classification	Description	Intensity				Example activities
		METs	% VO_2 max	Perceived exertion (Borg)*	% max HR	
Sedentary	Activities that usually involve sitting or lying, which require little movement and low energy expenditure	<1.6	<20	<6	<40	Watching television, reading, sitting in a vehicle, sitting at a computer
Low (light)	The lightest category or activity in terms of perceived and actual exertion and energy expenditure	1.7–2.9	20–39	6–10	40–54	Walking slowly, golf, gardening, household chores
Moderate	Generally consists of sustained rhythmic movements. At this level you should feel some exertion, but still be able to carry out a conversation comfortably.	3–6	40–59	11–14	55–69	Bike riding moderate pace, playing tennis doubles, dancing, weightlifting
Vigorous	Participation at this level leads to a substantial increase in heart and respiratory rates.	7+	60+	15+	70+	Running, swimming laps, squash

* Perceived exertion (Borg) based on category scale (6–20)

Table 9.4 outlines four methods of determining activity intensity. The number of METs required to work at a moderate intensity declines with age. Table 9.5 lists some typical MET vales for males. Values for women are generally 1–2 METs lower than for men.

TABLE 9.4 Methods of determining activity intensity

Method	Description
Talk test	This is a simple test. If you can talk comfortably while being active, you are working at a light or moderate intensity. If you cannot talk comfortably, you are likely to be performing at a vigorous intensity.
Perceived exertion	This a subjective estimate of how hard you feel you are working based on how your body feels. It is not always convenient to take a pulse while exercising, but perceived exertion can be assessed using tests such as the Borg Rating of Perceived Exertion. These scales are simply a perception scale to monitor and interpret the intensity of physical activity, usually an aerobic activity.
Heart rate	There is a direct linear relationship between heart rate and activity intensity. Heart rate, in beats per minute, can be measured manually or by electronic device. To work at a moderate level, heart rate should be 50–70 per cent of **maximum heart rate** (MHR). A 30-year-old should work with heart rate 95–133 bpm to be working within their moderate-intensity target zone.
Metabolic equivalent (MET)	1 MET represents the energy expended at resting levels. 4 METs represents activity expenditure four times that at rest. At rest (1 MET), an average male and female would consume approximately 250 and 200 mL of oxygen per minute, respectively. 1 MET is equal to 3.5 mL of oxygen per kilogram of body weight per minute. It is not feasible to assess how much oxygen an individual's body is using; assigning a MET equivalent can provide an estimate of intensity. The Compendium of Physical Activities provides a list of physical activities and for each assigns the energy expended during each activity by assigning METs.

TABLE 9.5 Energy expended (METs) by males of various ages at different intensities

Age (years)	Energy expended (METs)		
	Moderate	Vigorous	Very hard
20–39	4.8–7.1	7.2–10.1	>10.2
40–64	4.0–5.9	6.0–8.4	>8.5
65–70	3.2–4.7	4.8–6.7	>6.8
80+	2.0–2.9	3.0–4.3	>4.4

Compendium of Physical Activities

The Compendium of Physical Activities gives an estimate of the energy cost of particular activities, providing a standardised means of classifying the METs of different physical activities. Tables 9.6–9.8 present a variety of sporting, household/gardening and occupational physical activities from the Compendium of Physical Activities. Each activity has been assigned a MET value.

TABLE 9.6 Energy expended (METs) for common leisure-time physical activities

Energy expended (METs)	Examples
3.0	Social frisbee; walking the dog; Pilates, general; surfing, body or board
4.0	Table tennis, ping pong; tai chi; volleyball
4.5	Badminton, social singles and doubles; basketball: shooting hoops; tennis: doubles
4.8	Cricket; golf; ballet; modern dance, twist, jazz, tap, jitterbug; stationary rowing
5.0	Skateboarding; softball; baseball; kayaking
5.5	Ballroom, disco, folk, square, line dancing; horse riding; boxing, punching bag
5.8	Swimming: laps, freestyle
6.0	Weightlifting: free weight, Nautilus or universal-type; power lifting; body building; water skiing
6.3	Touch football, flag, general
6.5	Aerobics
6.8	Bike riding for fun (~16–19 km/h)
7.0	Soccer; swimming: laps, freestyle
7.3	Tennis
7.8	Field hockey
8.0	Basketball game; bike riding 19.5–22 km/h; circuit training; lacrosse; running; tennis, singles; ultimate frisbee
9.0	Australian Rules football; orienteering; cross-country running
9.8	Swimming laps, freestyle, fast, vigorous effort
10.0	Rugby; skipping rope; soccer; water polo
10.3	Martial arts, different types, moderate intensity
12.0	Handball; squash
12.3	Skipping rope; rollerblading, inline skating

Adapted from Ainsworth et al., 2011

Shutterstock.com / Ververidis Vasilis

Martial arts are an excellent source of physical activity and players expend large amounts of energy

TABLE 9.7 Energy expended (METs) for common household activities, gardening or yard work

Energy expended (METs)	Examples
2.5	Childcare, infant, general
2.8	Standing, playing with animals, light, only active periods
3.0	Cleaning, heavy or major (e.g. washing car, windows, cleaning garage, vigorous effort)
3.3	House cleaning; vacuuming
3.5	Scrubbing floors, on hands and knees, scrubbing bathroom, bathtub
3.8	Sweeping floors, moderate effort
4.0	Sweeping outside of house; gardening
5.0	Mowing lawn, general, moderate effort

Source: Ainsworth et al., 2011

TABLE 9.8 Energy expended (METs) for common occupational and work-related activities

Energy expended (METs)	Examples
1.3	Sitting: writing, desk work
1.5	Typing, computer
1.8	Sitting in class, general note taking, class discussion
2.3	Standing: light (bartending, store clerk, assembling, filing)
2.5	Police, directing traffic (standing)
4.0	Masseur; Teaching physical education

TABLE 9.8 (continued)

Energy expended (METs)	Examples
4.3	Carpenter
6.0	Building roads: moving debris, driving heavy machinery
7.8	Farmer: bailing hay, cleaning barn, vigorous effort
8.0	Carrying heavy loads, such as bricks; Using heavy tools (not power) such as shovel, pick, spade; Firefighter

Time (duration)

Duration refers to how long a person is active for within a given time period. The physical activity guidelines generally recommend that people engage in a minimum number of minutes daily on most days, depending on their age. It is recommended that people engage in moderate-to-vigorous physical activity for a minimum of 10 minutes at a time. These time periods are often referred as 'bouts' of physical activity or exercise.

TEXT ANALYSIS

CASE STUDY

Dear PE expert,

I read in a magazine the other day that I should be doing at least 30 minutes of moderate-intensity physical activity a day, on most days. I am 30 years old and work in an office, so I don't do much activity as part of my job. I don't like sport or getting too sweaty. Can you give me some tips for incorporating physical activity into my everyday life? Also, how do I know if I am exercising at moderate intensity or not? And how many days is 'most days'?

Kind regards,

Madison

Refer to the letter above and prepare a response to Madison's questions. Ensure you explain at least two ways of classifying moderate-intensity physical activity.

CHAPTER CHECK-UP

1 What is the minimum bout of exercise recommended for health benefits?
2 Identify four methods of determining intensity.
3 Explain what 5 METs refers to.
4 Define vigorous intensity and provide three examples of physical activities generally performed at a vigorous intensity.

PRACTICAL ACTIVITY

LIFESTYLE PHYSICAL ACTIVITY

As a class, participate in a lifestyle physical activity (e.g. Pilates, a bike ride, a power walk, a Zumba class, aqua aerobics, trampolining, or a step or spin class).

1. Identify potential target groups who would benefit from the activity that you participated in. Explain why you have selected each target group.
2. Classify which subcategory of physical activity this activity represents.
3. Describe four characteristics of your chosen physical activity that meet the criteria for a lifestyle physical activity.
4. Outline all safety issues that need to be considered for the designated physical activity.
5. What did you enjoy about this activity? What didn't you enjoy?

REAL WORLD APPLICATION

Nordic walking

Nordic walking is one of the fastest-growing physical activities in Europe. Originating from cross-country skiing in Scandinavia, Nordic walking is a form of fitness walking that is suitable for all ages. Nordic walking can be used as a high-intensity form of cross-training for athletes, recreational fitness or rehabilitation.

The health benefits that can be obtained from Nordic walking include:

- 90 per cent of the body's muscles are activated
- 46 per cent more kilojoules are burnt than in regular walking
- It provides up to 25 per cent greater cardiovascular workout than regular walking
- It results in a decreased load and impact to joints of the lower body
- It provides a more intense workout with less perceived exertion
- It strengthens and tones the upper back, shoulders and arms
- It increases lateral mobility of the spine
- It improves coordination and balance
- It promotes an upright and improved walking posture
- Pain and tension in the neck and shoulders are released.

Questions

As a class, participate in a session of Nordic walking or research this activity. Visit the Nordic Academy Australia website for more information about Nordic walking.

Shutterstock.com / Jacek Chabraszewski

Nordic walking has numerous health benefits

DEVELOPING, IMPLEMENTING AND EVALUATING PERSONALISED PHYSICAL ACTIVITY PLANS

When establishing a personal physical activity plan, a basic goal is to incorporate a variety of movement opportunities, such as:

» maximising incidental physical activity (e.g walking from one classroom to another when the bell rings)
» household chores and yard work in the garden
» occupational physical activity (e.g. physical demands of your job or activity during school time)
» active commuting (e.g. walking, skating or riding to work or school)
» leisure-time physical activity (LTPA) – includes recreational physical activity such as lifestyle physical activity and structured sport or exercise for fitness.

The first step is to complete a basic needs analysis (see Table 9.9).

TABLE 9.9 Needs analysis

Component	Description and examples
Set your goals  Shutterstock.com / Syda Productions	What do you hope to achieve from your personal physical activity plan? e.g. Enhanced feelings of energy and wellbeing, to improve specific fitness components. Be sure to include meeting the physical activity and sedentary behaviour guidelines as well.
Current physical activity level  Shutterstock.com / Amawasri Pakdara	You need to assess your current physical activity habits and sedentary behaviours. You could fill out a survey such as the CLASS survey or an online survey to determine your baseline physical activity level or complete a physical activity journal. Alternatively, you could wear a pedometer for 2–3 days and record your daily steps. Record your daily totals and calculate the average by adding the daily totals together and dividing by the number of days monitored. (This will be addressed in more detail later in the chapter when we talk about implementing your plan.)
Establish your priorities  Alamy Stock Photo /Cultura RM	If you were designing a plan for everyday life, rather than for a specific sport, you would apply the recommendations in the physical activity guidelines for your age and also the physical activity pyramid. Sometimes personal trainers help their clients to establish priorities for health and fitness. If you play a specific sport, your coach or PE teacher may be able to help you to determine which fitness components (health-related and/or sport-related) are important for your sport and even for the position/s you play.

TABLE 9.9 (continued)

Component	Description and examples
Fitness testing  iStock.com / MoMorad	Based on the priorities identified, select the fitness tests that could be used to assess the relevant health-related and sport-related components of fitness. Ensure you select recognised standardised tests that will allow you to compare your results to normative data. Then you can determine your strengths and identify areas in which you would like to improve. There are many fitness test descriptions and much normative data available online. We will study fitness testing in detail in Unit 4 next year.
Tailor to your interests  Shutterstock.com / f9photos	Write down what your interests are, for example: walking, social netball, yoga. You are much more likely to stick to your program if it is (a) tailored to the things you enjoy, (b) in the places you like to hang out and (c) with the people you like to spend time with.
Availability of time and resources  Shutterstock.com / kongsky	You need to create a program that works in with other commitments in your life such as school, work, social events, family expectations and daily chores. The program needs to be based on the resources you have access to. For example, the equipment you have at home, such as bicycles, or the facilities you have access to within your local community, such as parks, facilities and trails.
Appropriate training methods  Shutterstock / Dmitry Melnikov	Are these appropriate for you? Can you access the appropriate facilities? For example, do you need to be able to access a weights room? What training methods will be used? What is the justification for their selection? We will talk in detail about training methods and the application of basic principles of training such as overload and specificity in Unit 4.
Physical state of performer  iStock.com / monkeybusinessimages	Are you injury free? Are the activities selected appropriate for your level of physical activity and fitness? If the person has not been active for a while, a visit to the GP is recommended. It is common practice to complete a Physical Activity Readiness Questionnaire (PAR-Q) (see chapter 3, page 57).

Create and implement a personal physical activity plan

Earlier in this chapter, the dimensions/principles of physical activity (Frequency, Intensity, Time/duration and Type) and context were discussed in detail. Refer to the physical activity and sedentary behaviour guidelines for your age group and design a weekly planner that addresses the recommended:

» frequency of sessions (e.g. most days, every day)
» intensity (e.g. moderate and vigorous intensity)
» time/duration (e.g. 60+ minutes per day)
» type and context (e.g. maximum of 2 hours screen time for entertainment).

Bailey (aged 16 years)
Personal goal: To meet the Australian physical activity guidelines for 13–17 year olds and improve his aerobic capacity

BAILEY'S SAMPLE WEEKLY PHYSICAL ACTIVITY PLAN

	6–9 a.m. (before school)	9 a.m. – 3 p.m. (school hours)	3–10 p.m. (after school)
Monday	Walk to school 10 min		Boxing class YMCA 60 min
Tuesday		Physical Education class 100 min	
Wednesday	Walk to school 10 min		After-school interschool sport (tennis) 90 min
Thursday	Boxing stations 20 min		Walk the dog 45 min
Friday		Physical education class 50 min	Home-based fitness circuit 45 min
Saturday	Push-ups x 30 Sit-ups 3 sets x 25 reps	Bike ride 90 min	
Sunday			Walk the dog 70 min

DATA ANALYSIS

DATA INTERPRETATION

1 Did Bailey meet the physical activity guidelines for a 16 year old? Justify your answer.
2 Create a blank table using the same format and complete a weekly physical activity plan for yourself.

Skillsheet

Shutterstock.com/Himchenko.E

Research consistently shows walking to be the most common physical activity for all age groups. Walking should be part of any able-bodied person's daily routine.

Evaluating a personal physical activity and fitness plan

You can evaluate your personal physical activity plan. There are five basic steps to this process:

1. Setting your goals
2. Establishing your baseline physical activity levels
3. Identifying opportunities to be active
4. Monitoring your progress
5. Comparing with baseline levels and, if activity level has increased/improved, making this the new baseline for future comparisons.

Step 1: Setting your goals

Unit 4 will look at setting goals in greater detail but, generally, goal setting follows the 'SMARTER' acronym. Goals need to be **S**pecific, **M**easurable, **A**cceptable, **R**ealistic, **T**ime phased, **E**xciting and **R**ecorded. Your goals might relate to meeting the physical activity guidelines or improving particular fitness components for the sports you play. Once you set your goals, you will be able to monitor your progress towards achieving them.

Step 2: Establishing your baseline physical activity levels

The only way to determine whether someone has improved, maintained or gone backwards is to monitor their progress. Before commencing a new physical activity program, it is important to establish a starting point, known as the 'baseline' level of your physical activity – just like when starting a new fitness program. Data can be collected before, during and after programs on any of the following factors:

- time spent in light-, moderate- or vigorous-intensity physical activity
- types of physical activities and sedentary behaviour you engage in each day
- whether you meet the guidelines for your age relating to physical activity and sedentary behaviour
- daily steps per day
- basal heart rate – this is generally measured when the person is at rest and relaxed and hasn't exercised or exerted themselves recently
- blood pressure – the pressure exerted by circulating blood upon the walls of blood vessels, which usually refers to the arterial pressure of the systemic circulation. During each heartbeat, blood pressure varies between a maximum (systolic) and a minimum (diastolic) pressure
- hours of sleep per night
- fitness test results for a battery of tests relating to the various health- and sports-related fitness components (you will study these in Unit 4).

Once you have assessed one or several of these factors, analyse your results by comparing them to the recommended value for that factor (e.g. blood pressure).

Step 3 Identifying opportunities to be active

Once you have collected preliminary data on a range of key variables, you can choose appropriate activities to engage in and brainstorm strategies to minimise your sitting time.

Shutterstock.com/CREATISTA

Outdoor boot camps are a type of vigorous activity.

Step 4 Monitoring your progress

There are lots of ways to monitor progress towards set goals. Always use the same technique for measuring activity level. For example, it is not useful to conduct a baseline (pre-program) measurement using a self-report recall survey and then, after 12 weeks, use a pedometer. The two cannot be compared, because they measure different outcomes. A combination of measures can be used, but to measure improvement, identical measures or fitness tests must be used. Table 9.12 displays some sample measures that could be used to monitor progress.

You may need to adjust your personal physical activity plan and program in order to achieve your set goals. You may need to adjust the intensity, duration, frequency or even the type of activities/exercises you do in order to make your program more effective. You may even decide to adjust your set goals, either because you have achieved them or to make them more achievable or more challenging. Ultimately, the main goal is to be as active as possible, and meet the guidelines for your age group. Remember, even doing something small regularly is better than doing nothing at all.

Step 5 Comparing with the baseline data

Compare with baseline levels. If the activity level has increased/improved, this new level then becomes the baseline for future comparisons.

DATA ANALYSIS

ANALYSIS

Complete the right-hand column in the table below by identifying what can be assessed by each measure.

Measures of physical activity and sedentary behaviour

Measure	Format (e.g. electronic)	What does this measure assess?
Diaries and logs	Paper or electronic	
Survey	Paper or electronic	
Pedometers	Digital	
Accelerometers	Digital recording personal devices	
Heart rate monitors	Digital recording personal devices	
Global positioning systems (GPS)	Digital recording personal devices	

Skillsheet

You can also try the two skillsheets for developing your personal plan. Go to http://nelsonnet.com.au and use your login code.

Video

QUICKVID

Watch a video of Professor Jo Salmon talking about understanding sedentary behaviour via http://nelsonnet.com.au, using your login code. Go to chapter 9, page 180.

CHAPTER SUMMARY

- Physical activity is any bodily movement requiring the skeletal muscles that expends energy.
- Subcategories of physical activity include exercise, lifestyle activities and games. Physical activity may also be classified as structured or incidental. Structured physical activities tend to be planned, such as participation in organised sport, or going to the gym or for a bike ride.
- Inactivity is defined as not engaging in any regular physical activity beyond daily activities, or a lack of moderate-intensity physical activity.
- Sedentary behaviour is defined as the amount of time spent sitting or lying down (with the exception of sleeping), engaged in non-invasive activities. Examples include watching television, using a computer or reading.
- 1 MET represents the energy expended at resting levels; 2 METs represents twice the amount of energy expended at rest.
- Sedentary behaviours include activities that require around 1–2 METs.
- Physical activity can take place during leisure time, during work, while performing household chores, gardening or yard work or as a form of transport.
- Lifestyle physical activities should be the most common form of daily physical activity. These activities form the base of the physical activity pyramid and should be performed daily or on most days of the week.

CHAPTER REVIEW

Multiple-choice questions

1 Active transport is defined as:
   A bike riding for exercise
   B any form of human-powered transportation used to get to and from specific destinations
   C walking the dog
   D skateboarding with friends.

2 Leisure-time physical activity is:
   A activity that is over and above that which occurs within the workplace
   B activity you engage in during recess and lunch breaks only
   C physical activity you engage in during holiday breaks only
   D none of the above.

Short-answer questions

3 a Identify four domains of physical activity.
   b Describe the benefits of more people using active transport.

4 a List examples of lifestyle/lifelong physical activities that you engage in.
   b Describe four characteristics of lifestyle physical activities.
   c Explain how an activity may be considered both a lifestyle physical activity and a sport. Include examples in your answer.

5 Explain how a person can still meet the physical activity and sedentary behaviour guidelines while exercising in 10-minute bouts.

6 a Identify three different methods of determining activity intensity.
   b Describe the method you would use to determine the intensity you were working at when you were out on a run.
   c Explain how energy expended (measured in METs) is influenced by age.
   d Based on the Compendium of Physical Activities, how many METs are expended per minute during three of your favourite physical activities?

7 Define sedentary behaviour and provide three examples.

CHAPTER 10

PHYSICAL, SOCIAL, MENTAL AND EMOTIONAL BENEFITS, AND HEALTH RISKS OF INACTIVITY

Key knowledge

- physical, social, mental and emotional benefits of regular participation in physical activity
- the increased health risks associated with being physically inactive, including type 2 diabetes and obesity
- physical activity and sedentary behaviour guidelines for different age groups and population groups

Key skills

- participate in and reflect on a variety of different forms of physical activity, including culturally diverse physical activities
- participate in physical activity, and collect, analyse and reflect on information related to the physical, social, mental and emotional health benefits of physical activity
- explain the health consequences of physical inactivity and sedentary behaviour
- describe the physical activity and sedentary behaviour guidelines for different stages across the lifespan

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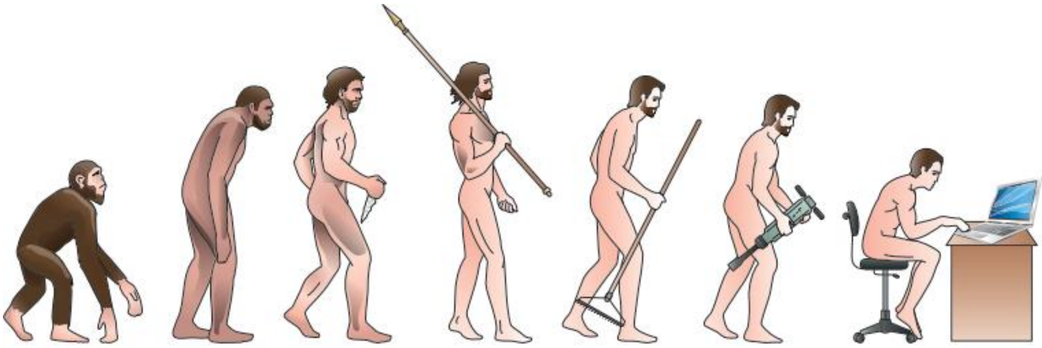
BENEFITS OF PARTICIPATION IN REGULAR PHYSICAL ACTIVITY

The health benefits associated with participation in regular physical activity are well documented (see below). The benefits span physical, social, mental and emotional health. More than 2500 years ago, Hippocrates (an ancient Greek physician) wrote about the health benefits of daily physical activity and is said to have authored the phrase, 'Walking is man's best medicine'.



Human evolution. Human body function has changed from the times of our early ape-like ancestors to the current technological age.

Physical benefits

Improved cardiovascular function

When you are regularly active, your fitness, stamina and energy increase. This is partially due to an increase in the size and strength of your heart muscle. A stronger heart is able to work more efficiently, pumping more blood with each beat. More oxygen is delivered to the brain, and muscles perform more efficiently for longer, therefore delaying fatigue. A more efficient cardiovascular system means you can work harder (i.e. walk or run further and faster) than when you were not as active.

Randy Glasbergen http://www.glasbergen.com/

Regular physical activity is associated with numerous physical, social, mental and emotional health benefits.

Improved strength and endurance

Regular exercise increases the strength and endurance of muscles. Having stronger muscles decreases the risk of injury and reduces lower back problems. Maintaining muscular strength as you age is very important for maintaining mobility and independence and slowing the rate of functional decline. Many older people struggle to open jars or to get up from chairs – these are examples of functional decline. Inactivity results in reduced muscle strength and mass and reduced bone mineral density (BMD), which can lead to reduced functional status, falls and fractures.

Resistance to fatigue

A key benefit of regular physical activity is resistance to fatigue. Increased energy levels mean you have enough energy to get through a typical day at school or work with enough remaining to allow you to enjoy your leisure time without feeling lethargic. Increased energy levels are associated with an improved ability to cope with stress and improved quality of life.

Health benefits of physical activity and fitness

IMPROVED CARDIOVASCULAR FUNCTION

- Stronger heart muscle
- Increased fitness and health
- Lower heart rate
- Better electrical stability of heart
- Decreased sympathetic control of heart
- Increased O_2 to brain
- Reduced blood fat, including low-density lipids (LDLs)
- Increased protective high-density lipids (HDLs)
- Delayed development of atherosclerosis
- Increased work capacity
- Improved peripheral circulation
- Improved coronary circulation
- Resistance to 'emotional storm'
- Reduced risk of heart attack
- Reduced risk of stroke
- Reduced risk of hypertension
- Greater chance of surviving a heart attack
- Increased oxygen-carrying capacity of the blood

IMPROVED STRENGTH AND MUSCULAR ENDURANCE

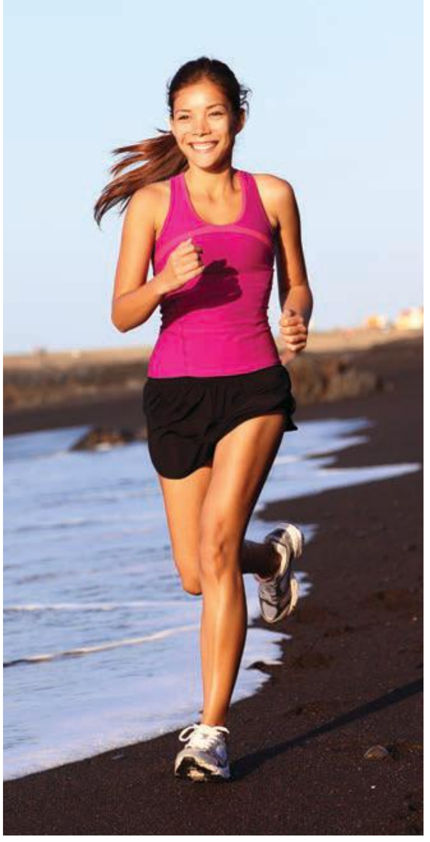
- Increased lean muscle mass and strength
- Greater work efficiency
- Less chance of muscle injury
- Reduced risk of lower back problems
- Improved performance in sports
- Quicker recovery after hard work
- Improved ability to meet emergencies

RESISTANCE TO FATIGUE

- Ability to enjoy leisure
- Improved quality of life
- Improved ability to cope with stress

OTHER HEALTH BENEFITS

- Decreased diabetes risk
- Improved quality of life for diabetics
- Improved metabolic fitness
- Extended lifespan
- Reduced chronic illness
- Decrease in dysfunctional years
- Aids people suffering from arthritis, PMS, asthma, chronic pain, fibromyalgia and impotence
- Improved immune system



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- Reduced risk of menstrual symptoms, constipation and back pain
- Reduced risk of postnatal depression

ENHANCED MENTAL HEALTH AND FUNCTION

- Relief from depression
- Improved sleep habits
- Fewer stress symptoms
- Greater ability to enjoy leisure and work
- Improved brain (cognitive) function
- Improved neuroplasticity of the brain
- Improved concentration

IMPROVED WELLNESS

- Improved quality of life (especially among older adults)
- Leisure time enjoyment
- Improved work capacity
- Ability to meet emergencies
- Improved creative capacity
- Improved independence

OPPORTUNITY FOR SUCCESSFUL EXPERIENCE AND SOCIAL INTERACTIONS

- Improved self-concept
- Opportunity to recognise and accept personal limitations
- Improved sense of wellbeing
- Improved enjoyment of life and ability to have fun
- Improved quality of life

IMPROVED APPEARANCE

- Improved figure/physique
- Improved posture
- Fat control

GREATER LEAN BODY MASS AND LESS BODY FAT

- Greater work efficiency
- Less susceptibility to disease
- Improved appearance
- Less incidence of self-concept problems related to obesity

IMPROVED FLEXIBILITY & CO-ORDINATION

- Greater work efficiency
- Less chance of muscle injury
- Less chance of joint injury
- Decreased chance of lower back problems
- Improved motor co-ordination
- Improved sports performance
- Improved balance and stability

BONE DEVELOPMENT

- Greater peak bone density
- Less chance of osteoporosis

REDUCED CANCER RISK

- Reduced risk of colon and breast cancer
- Possible reduced risk of rectal, testicular, prostate and pancreatic cancers

REDUCED EFFECT OF **ACQUIRED AGEING**

- Improved ability to function in daily life
- Better short-term memory
- Fewer illnesses
- Greater mobility
- Greater independence
- Greater ability to operate an automobile
- Lower risk of dementia

Source: Corbin et al., 2004

Greater lean body mass and less body fat

A high level of physical activity is associated with an increase in lean body mass, made up of muscles, tendons and ligaments, and a decrease in body fat. Healthy weight range guidelines can be misleading; sometimes elite athletes who may have a large amount of lean body mass and low body fat are classified as overweight or obese. Sometimes the way your clothes fit or a body fat assessment is a better indicator of greater lean body mass than using the scales.

Improved flexibility

Being flexible allows you to perform a wide range of movements with a lower risk of muscular and joint injuries. Regular stretching can lead to a greater range of movement and can improve sporting performance and reduce your risk of injury.

TEXT ANALYSIS

BOB'S FITNESS

Bob is 90 years old and still lives independently in his own home. He has never had a driver's license, so has walked or used public transport throughout his life. As a child, he spent a lot of time playing hopscotch and jumping in and out of trees. Bob has never broken any bones, although he has had several falls. His main sources of physical activity are completing household chores, gardening and walking.

1 Discuss why Bob has good bone density. What laid down the foundation for this?
2 Describe why gardening is such a good physical activity for older people.
3 Explain why you think Bob is still capable of living independently at 90 years old.

Bone development

Participating in regular weight-bearing and high-impact activities is essential to maintain strong bones. Childhood and adolescence are key times to develop bone density. During this developmental period activities such as skipping, running and gymnastics are ideal for developing large amounts of the mineral deposits responsible for bone strength. Poor bone mineral density can result in a condition known as osteoporosis, which can lead to fractures, particularly in older people.

PRACTICAL ACTIVITY

As a class, participate in a range of skipping activities using a combination of short and long ropes. Monitor your heart rate:

a before the activity
b during activity
c immediately after the activity
d five minutes after stopping the activity.

Have a class discussion about the potential physical health benefits of skipping.

Social benefits

There are many social benefits associated with participation in physical activity. Playing in a team, going to the gym to do a workout or even walking the dog can mean interacting with other people. Walking groups are very popular as they allow participants to walk, talk and laugh. Interacting with others increases a person's sense of connectedness within a community; the community could be within a suburb, sporting club or school. Socialising when you are active, whether with friends, family, companions, personal trainers, work colleagues or coaches, can:

» increase enjoyment of physical activity
» improve self-concept
» improve quality of life and sense of wellbeing
» enhance engagement
» Increase sense of belonging and attachment
» decrease social isolation
» enhance social networks to buffer against stress and enhance coping.

REAL WORLD APPLICATION

TeamUp

A training buddy can make exercise more enjoyable

TeamUp is a VicHealth initiative that encourages people to connect with others in their local communities to participate in physical activity. The TeamUp app is free and allows people to locate organised physical activities such as bike riding, walking, yoga and swimming. There are activities for all fitness levels and interests.

Not having someone to be active with can be a significant barrier to participation in physical activity. TeamUp helps people overcome this barrier by allowing individuals and sporting organisations to search for activities and events, create new physical activity opportunities, or simply locate a training buddy.

Participation in moderate- or vigorous-intensity physical activity has numerous mental and emotional health benefits

Mental health benefits

Good mental health is the capacity of individuals and groups to interact with one another and their environment in ways that promote subjective wellbeing, optimal development and the use of cognitive affective and relational abilities (Commonwealth Department of Health and Aged Care, 1998).

Over the past decade, there has been growing interest in the positive association between increased physical activity and improved mental health and wellbeing. Research has also shown that active people have greater self-esteem and lower levels of anxiety. Engaging in aerobic activity can also improve the quality of your sleep; good-quality sleep is essential for all aspects of your life.

Increased physical activity is also associated with improved brain function. Just under half (45 per cent) of Australians aged 16–85 years will have a mental health disorder at some point in their life. Findings from the 2014–15 National Health

Survey reported by the Australian Bureau of Statistics (ABS) indicated around one in nine (11.7% or 2.1 million) Australians aged 18 years and over experienced high or very high levels of psychological distress. Women experienced higher levels of psychological distress than men, particularly women in the 18–24 age group.

The latest evidence has shown that physical activity facilitates the **neuroplasticity** of certain brain structures and related cognitive functions. To maintain the neuro-cognitive benefits induced by physical activity, an increase in cardiovascular fitness levels must be maintained. (See chapter 5 for more about the cardiovascular system.)

Emotional health benefits

Emotional health refers to the degree to which you feel emotionally secure, relaxed and able to cope with the demands of everyday life. Being emotionally healthy helps you remain calm under pressure, have a positive self-esteem and be patient with yourself and others. Emotionally healthy people feel safe and secure with their own emotions and feelings and can assertively express them rather than trying to avoid certain feelings or wanting to control them. Of course, emotional health is on a continuum; it fluctuates weekly and daily and can change from moment to moment. Emotional wellness is at the peak of this continuum, when you are very joyful or 'high on life'. Regular physical activity has been consistently shown to be associated with enhanced emotional wellness, by boosting mood, allowing vital energy to flow, and reducing feelings of anxiety and depressive symptoms.

Relationship between physical activity and mental health

Potential biochemical and physiological mechanisms

The potential biochemical and physiological mechanisms include:
» increase in endorphins
» changes associated with an increase in core body temperature
» changes in central serotonergic systems (e.g. increased serotonin)
» increased availability of neurotransmitters
» enhanced blood flow to brain regions involved in emotional regulation
» disruption of the hypothalamic-pituitary-adrenocortical axis, which regulates endocrine response to stress
» improved sleep.

Potential psychological and emotional mechanisms

The potential psychological and emotional mechanisms include:
» distraction or time out from stressful contexts and negative thoughts
» enhanced feelings of control and mastery
» improved self-esteem and physical worth
» behavioural activation.

Participation in regular physical activity provides the following benefits:
» protects against the onset of anxiety disorders and symptoms
» protects against depression symptoms and the onset of major depressive disorder
» reduces feelings of distress (enhances wellbeing)
» enhances self-esteem
» improves psychological wellbeing.

It is thought that physical activity may also have the potential to reduce the risk of **dementia**, although more research is needed. The evidence of the other benefits of physical activity, however, is compelling. As mentioned, people who are regularly active have a reduced risk of heart disease and stroke, both of which are associated with an increased risk of developing dementia. Higher levels of physical activity have been associated with less cognitive decline in older people and slower loss of brain tissue as they age.

REAL WORLD APPLICATION

Exercise for mental health: a no brainer?

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by Cathy Johnson

The physical health benefits of exercise are well researched and understood. But what do we really know about exercise and its effect on our mental health?

'… even though the evidence isn't rock solid, there are other potential benefits and the risk of harm is so minimal, it's a good thing to do,' says Professor Tony Jorm, from the Centre for Mental Health at Melbourne University …

'Exercise is about as low risk as you can get and the side effects are about as minimal as you can get.' … even if it doesn't help your mood or mental state, 'it will potentially help a whole lot of other things'.

Get moving, get happy?

People who make a habit of exercise often say one thing that helps them stick at it is that it simply makes them feel good.

Dr Nicola Burton, senior research fellow in the University of Queensland's school of human movement studies, says '… Even if you don't have depression or anxiety or a serious mental illness … you can enhance your wellbeing and vitality.' Exercise can boost mood, concentration, alertness, and even your propensity to look on the bright side, she says.

Studies that track people over time show taking up physical exercise seems to reduce the risk of developing mental disorders.

A 2011 Dutch study of more than 7000 adults found that doing exercise reduced the risk of developing a mood or anxiety disorder over the following three years, even when controlling for socioeconomic factors and physical illnesses.

Inactivity can be both a cause and consequence of mental illness, says Jorm. 'When people get a problem like depression or severe mental illness, it affects their motivation and enjoyment of life, and that can drive physical activity down. But there's also probably a reciprocal effect, in that when they exercise less, that seems to make [their mental health] matters worse.'

The exercise prescription

Exactly how exercise might boost mood isn't well understood. Some possibilities are that it:

- helps you sleep better
- gives you an improved sense of control, coping ability and self esteem
- provides distraction from negative thoughts and a chance to have new experiences
- offers an opportunity to socialise and get social support if done with others
- changes the levels of chemicals in the brain, such as serotonin, stress hormones and endorphins (substances that can block pain and may also enhance feelings of wellbeing).

There's also no clear evidence on which type of exercise works best, or how much is needed to bring about different effects. Intense exercise may have greater benefits, but it's better to start at a low level and gradually build up than aim too high and risk being turned off, says Jorm. Thirty minutes' brisk walking a few times a week is a good general starting point, he suggests. You don't have to do the 30 minutes all in one go, but it's best if you do it in blocks no shorter than 10 minutes.

For many people with mild depression or anxiety, that 'may be sufficient to produce some improvement in their mood; to stop it worsening so they don't have to go off and get other types of treatment,' he says. 'I think it should be universally used.

'I think there also could be value in increasing the level of activity in the [whole] population as a preventive measure.'

Jorm cycles daily, and rarely uses a car or public transport. He describes himself as 'one of the fortunate people who has a very stable mood. It gives me a positive feeling. I miss it if I don't do it.'

On longer trips, he finds he is flooded with creative thoughts and afterwards notices a definite improvement in his sleep.

Exercise to treat mental illness: What does it help?

The Royal Australian and New Zealand College of Psychiatrists recommends that exercise may complement other treatments for mental illnesses and be used to help recovery, prevent recurrences, and manage the side effects of some medications.

The evidence from randomised controlled trials suggests exercise has a moderate to large effect for people with depression. It is also moderately effective for anxiety.

However, people with severe depression may find it very hard to exercise and even when they can, it needs to be seen as an adjunct to treatment, rather than a treatment on its own, says Dr Caryl Barnes.

For people with psychotic disorders such as bipolar disorder and schizophrenia, it may help improve functioning and physical health.

Exercise has been shown to improve schizophrenia symptoms such as blunted emotions, loss of drive and thinking difficulties. But it is less helpful for delusions and hallucinations.

For some mental health conditions, exercise is actually part of the problem. 'Excessive exercise for someone who's got an anorexic illness can actually be quite harmful,' says Barnes. Increased exercise can sometimes be an early warning sign of a manic phase for those with bipolar disorder. In those cases, continuing to exercise at a high level may serve to 'rev' a person up, and exacerbate the mania, which would not be helpful, she says.

How much and what sort of exercise?

Both aerobic exercise and resistance exercise may be effective.

Three exercise sessions per week, each lasting at least 30 minutes at moderate to vigorous intensity are recommended for a minimum of 8 weeks. Higher doses of exercise may be more effective at improving mental illness but people may be less likely to stick to them.

Physical benefits for those with mental illnesses

People with severe mental illnesses such as schizophrenia die on average 16 to 20 years earlier than the general population – largely because of poor access to medical care, poor diet, little exercise and weight gain related to medication use.

People with depression may also benefit physically from exercise as they are known to be at higher risk of heart disease, although no one's quite sure why.

Questions

1 Outline the point Dr Nicola Burton made about the benefits of regular physical activity to wellbeing.
2 Summarise the key findings of the Dutch study of more than 7000 people.
3 List several potential reasons exercise is believed to boost mood.
4 Increased or excessive exercise can be an early warning sign of what condition or illness?

PRACTICAL ACTIVITY

CLASS DISCUSSION

As a class, discuss how you feel when you have been active and how you feel when you have been mainly sedentary for a few days.

HEALTH RISKS ASSOCIATED WITH INACTIVITY AND SEDENTARY BEHAVIOUR

Chapter 12 looks at enablers and barriers to movement and physical activity. Sedentary death syndrome is a complex condition associated with sedentary living that presents as a series of symptoms, including low cardiovascular fitness, weak skeletal muscles and poor metabolic fitness (high blood sugar and fat levels, obesity and high resting blood pressure).

The remainder of this chapter will focus on the following **hypokinetic** conditions: type 2 diabetes and obesity. See chapter 7 for more information about cardiovascular and respiratory disease.

TABLE 10.1 Risk factors for cardiovascular disease and type 2 diabetes

Risk factor	Cardiovascular disease	Type 2 diabetes	Respiratory disease
Overweight and obesity	yes	yes	no
Physical inactivity	yes	yes	no
Poor diet	yes	yes	no
Tobacco smoking	yes	yes	yes
Excessive alcohol consumption	yes	no	no
High blood pressure	yes	yes	no

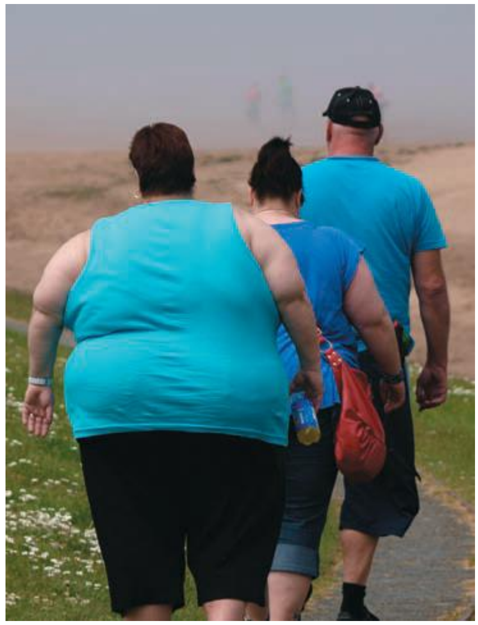
Type 2 diabetes

Diabetes is a disease that results from too much sugar in the blood, which occurs because the body doesn't produce or properly use insulin. Insulin is produced within the pancreas and used by the body to convert sugar and other foodstuffs into energy. Low physical activity levels and poor cardiorespiratory fitness are both predictors of mortality (death) related to type 2 diabetes. While some studies have shown vigorous physical activity has a protective effect against developing type 2 diabetes, other studies have pointed to a progressive protective effect from an increase in total energy expenditure (of all intensities). Other evidence has indicated that a low volume of moderate-intensity physical activity will result in as much improvement in insulin sensitivity (the higher the insulin sensitivity, the better) as a high volume of vigorous-intensity physical activity.

Physical activity is extremely important in the prevention of type 2 diabetes and is commonly prescribed in its treatment. Type 2 diabetes is likely to be a major public health concern in the future.

Obesity

Over the past 30 years, obesity has evolved from a minor public health issue into a global epidemic and a major threat to public health. In Australia, approximately 60 per cent of adults and 30 per cent of young people are either overweight or obese. The World Health Organization (WHO) classifications for adult overweight status are presented in Table 10.2. A body mass index (BMI) of 25 is generally considered the cut-off for being overweight, and 30 is classified as obese. According to the National Health Survey conducted in 2014–15 by the ABS, 63.4 per cent of Australians aged 18 years and over were overweight or obese (11.2 million people). This figure comprised 35.5 per cent overweight (6.3 million people) and 27.9 per cent obese (4.9 million people). A further 35 per cent were of normal weight and 1.6 per cent were underweight. While the prevalence of overweight and obesity increased in Australia between 1995 (56.3 per cent) and 2011–12 (62.8 per cent), there was no significant increase between 2011–12 and 2014–15. Overall, 70.8 per cent of men were overweight or obese in 2014–15, compared with 56.3 per cent of women. (National Health Survey: First Results, 2014–15, cat. no. 4364.0.55.001)


Alamy Stock Photo / Nik Taylor

Everyone, regardless of their weight status, can gain significant health benefits from walking regularly.

There is an association between weight status and physical activity. You expend more energy when you are regularly active and this assists in healthy weight maintenance. However, obesity as a condition is very complex and it would be simplistic to suggest that people become obese solely because they don't do enough physical activity.

The medical complications resulting from obesity are numerous, and include pulmonary diseases, sleep apnoea, liver disease, cirrhosis, gall bladder disease, polycystic ovarian syndrome, coronary heart disease, stroke, cataracts, diabetes, hypertension, cancer and gout.

TABLE 10.2 Classification of adult weight according to the World Health Organization

Classification	BMI (kg/m^2)	Level of risk to health
Underweight	<18.5	Low (there is risk of other health conditions increasing)
Normal range	18.5–24.9	Average
Overweight	25–29.9	Increased
Obese	30+	Increased to very severely increased (40+)

CHAPTER CHECK-UP

1 Describe three physical benefits of participation in regular physical activity.
2 Discuss a social benefit of regular physical activity
3 What is the association between physical activity and the risk of dementia?
4 What is sedentary death syndrome?
5 List five cardiovascular diseases and describe two of them.

Hypertension

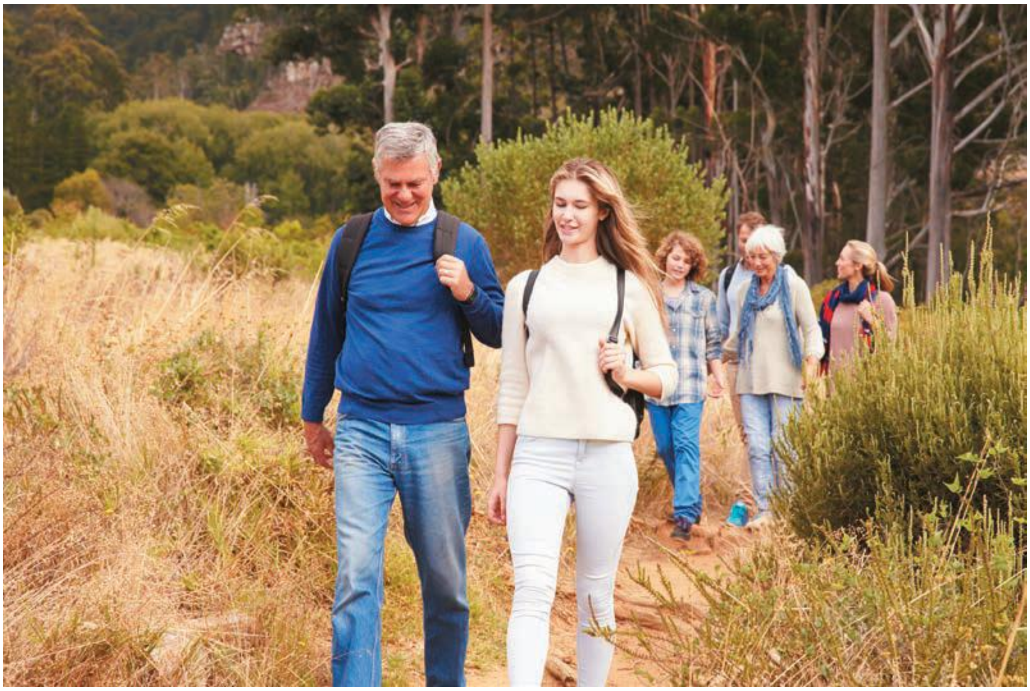
Hypertension is the medical term for high blood pressure. Hypertension is the most frequently managed condition seen by general practitioners in Australia. It is more prevalent in males and is generally treated by regular light- to moderate-intensity physical activity, reduced salt intake, prescribed drugs and stress-management strategies. You studied hypertension in detail in chapter 7, pages 134–5.

High cholesterol levels

Individuals with high total levels of **cholesterol** have a higher risk of coronary heart disease. Regular physical activity can reduce blood lipid profiles, including total cholesterol. Cholesterol classifications are displayed in Table 7.1 on page 132. Low-density lipoprotein (LDL) is a major contributor in the development of atherosclerotic deposits on the inner walls of arteries.

Get off your gluteus maximus!

Research consistently shows that it is not good for your health to sit or lie down for prolonged periods during waking hours. Engaging in prolonged sedentary behaviour significantly increases risk of early death, especially from heart disease. According to the Heart Foundation, sedentary behaviour is also associated with increased risk of being overweight and developing type 2 diabetes and heart disease. Even if you are meeting the Australian guidelines for physical activity, this may not help reduce the risks associated with excessive sitting time. The greatest health benefits are experienced by people who sit less and move more.



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PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR GUIDELINES

Within developed countries, the degree to which the population is involved in physical activity is increasingly considered a significant public **health** issue. Inactivity is the fourth leading cause of death due to non-communicable disease (NCD) worldwide and the cause of more than three million preventable deaths per year (approximately 6 per cent of deaths annually). Governments set national physical activity guidelines and monitor what proportion of the population meets these guidelines. As discussed earlier in this chapter, high levels of sedentary behaviour are dangerous to overall health and have also been linked to chronic disease and obesity.

Most westernised nations have a set of national physical activity guidelines. Australia's physical activity and sedentary behaviour guidelines are presented below. The Australian guidelines were informed by what we know about the relationship between physical activity dimensions (type, frequency, duration and intensity) and health outcome indicators, including the risk of chronic disease and obesity. Australia's physical activity and sedentary behaviour guidelines were based on a rigorous evidence review process that considered:

» the relationship between physical activity (including the amount, frequency, intensity and type of physical activity) and health outcome indicators, including the risk of chronic disease and obesity

» the relationship between sedentary behaviour/sitting time and health outcome indicators, including the risk of chronic disease and obesity.

All infants and children (birth–5 years)*

Physical activity recommendations


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» For health development in infants (birth to 1 year) physical activity – particularly supervised floor-based play in safe environments – should be encouraged from birth.

» Toddlers (1 to 3 years) and pre-schoolers (3 to 5 years) should be physically active every day for at least three hours, spread throughout the day.

Sedentary behaviour recommendations

» Children younger than 2 years should not spend any time watching television or using other electronic media (DVDs, computer and other electronic games).

» In children 2 to 5 years, sitting and watching television and the use of other electronic media (DVDs, computer and other electronic games) should be limited to less than one hour per day.

» Infants, toddlers and pre-schoolers (birth to 5 years) should not be sedentary, restrained, or kept inactive, for more than one hour at a time, with the exception of sleeping.

All children aged 5–12 years who have started school*

Physical activity recommendations

» For health benefits, children aged 5–12 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day.

» Children's physical activity should include a variety of aerobic activities, including some vigorous intensity activity.

» On at least three days per week, children should engage in activities that strengthen muscle and bone.
» To achieve additional health benefits, children should engage in more activity – up to several hours per day.

Sedentary behaviour recommendations

» To reduce health risks, children aged 5–12 years should minimise the time they spend being sedentary every day. To achieve this:
  - Limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day – lower levels are associated with reduced health risks.
  - Break up long periods of sitting as often as possible.

All young people aged 13–17 years

Physical activity recommendations

» For health benefits, young people aged 13–17 years should accumulate at least 60 minutes of moderate to vigorous intensity physical activity every day.
» Young people’s physical activity should include a variety of aerobic activities, including some vigorous intensity activity.
» On at least three days per week, young people should engage in activities that strengthen muscle and bone.
» To achieve additional health benefits, young people should engage in more activity – up to several hours per day.

Sedentary behaviour recommendations

» To reduce health risks, young people aged 13–17 years should minimise the time they spend being sedentary every day. To achieve this:
  - Limit use of electronic media for entertainment (e.g. television, seated electronic games and computer use) to no more than two hours a day – lower levels are associated with reduced health risks.
  - Break up long periods of sitting as often as possible.

All adults aged 18–64 years*

Physical activity recommendations

» Doing any physical activity is better than doing none. If you currently do no physical activity, start by doing some, and gradually build up to the recommended amount.
» Be active on most, preferably all, days every week.
» Accumulate 150 to 300 minutes (2 ½ to 5 hours) of moderate intensity physical activity or 75 to 150 minutes (1 ¼ to 2 ½ hours) of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week.
» Do muscle strengthening activities on at least 2 days each week.

Sedentary behaviour recommendations

» Minimise the amount of time spent in prolonged sitting.
» Break up long periods of sitting as often as possible.

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Adults 65+ years

Physical activity recommendations

» Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities.
» Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility.
» Older people should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days.
» Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity
» Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to.

*irrespective of cultural background, gender or ability

Source: www.health.gov.au

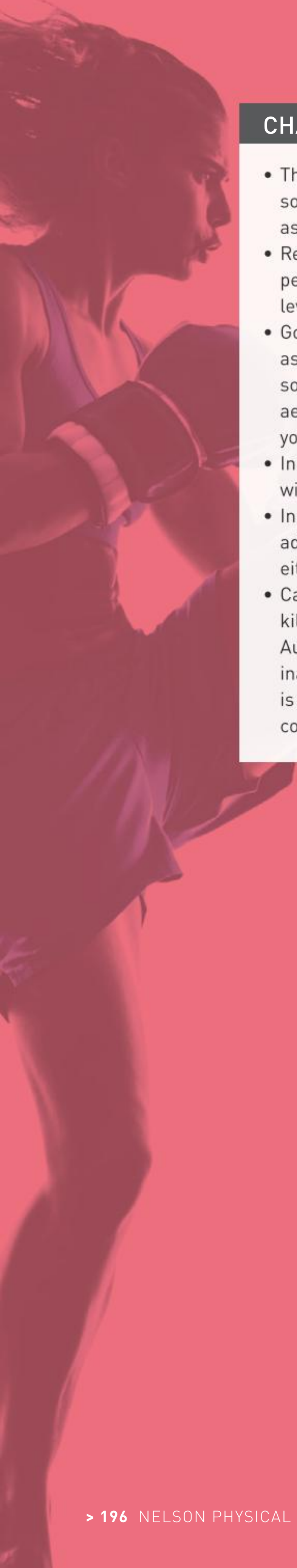
It is important to note that the physical activity guidelines and sedentary behaviour guidelines are independent of each other and measured separately. For example, a teenager could be really active and exceed the 60+ minutes of moderate to vigorous physical activity per day, yet they still might exceed the recommended two-hour maximum for screen time for entertainment.

You will notice that each set of guidelines is made up of recommendations relating to the various dimensions including (a) frequency, (b) intensity, (c) time (duration) and type of activity. It is also important to note that some of the recommendations are quite specific and able to be measured. Other recommendations are less prescriptive and therefore not able to be measured. Chapter 11 will examine how to assess whether someone has met these guidelines, and chapter 13 will explore what proportion of each age group meets these guidelines. It is important to know that guidelines are updated from time to time. Be sure to check the government website to ensure you learn the latest guidelines for each age group.

QUICKVID

Watch a video of Professor Jo Salmon talking about the health risks associated with inactivity and sedentary behaviour via http://nelsonnet.com.au, using your login code. Go to chapter 10, page 195.

Video



CHAPTER SUMMARY

- There are numerous benefits to physical, social, emotional and mental health associated with regular physical activity.
- Research has also shown that active people have greater self-esteem and lower levels of anxiety.
- Good-quality sleep is essential for all aspects of your life at school, at work, socially and during sport. Engaging in aerobic activity can improve the quality of your sleep.
- Increased physical activity is associated with improved brain function.
- In Australia, approximately 60 per cent of adults and 30 per cent of young people are either overweight or obese.
- Cardiovascular diseases are the biggest killers in Australia. One in five deaths in Australia can be attributed to physical inactivity and almost one in five deaths is caused by coronary heart disease and colon cancer.
- Hypertension is the medical term for high blood pressure.
- Generally, the Australian physical activity and sedentary behaviour guidelines are recommendations for all people within the relevant age groupings across the lifespan, irrespective of cultural background, gender or ability.
- Most guidelines are measurable if they include a prescriptive reference to the dimensions of physical activity, including frequency, intensity, time (duration) and type.

CHAPTER REVIEW

Multiple-choice questions

1 Research has shown that active people have:
   A greater self-esteem
   B lower levels of anxiety
   C improved brain function
   D all of the above.

2 What systolic blood pressure is considered normal?
   A 80
   B 120
   C 140
   D 150

Short-answer questions

3 a Describe the benefit of having stronger muscles.
   b Outline what makes up lean body mass.
   c Identify two problems that can result from a reduction in bone density.

4 a What is predicted to be the leading cause of burden of disease by 2030?
   b Define the term 'neuroplasticity'.
   c Identify four potential psychological mechanisms underlying the relationship between physical activity and mental health.

5 a Outline the causes of type 2 diabetes.
   b Describe the association between regular physical activity and type 2 diabetes.
   c Identify the healthy weight range in terms of BMI for adults according to the World Health Organization.

6 a Outline three social benefits to regular physical activity.
   b What percentage of Australian adults are classified overweight?
   c Identify two hypokinetic conditions

7 Identify the normal classification of blood pressure for adults.

8 Explain whether meeting the Australian physical activity guidelines for adults reduces the risks associated with excessive sedentary behaviour.

9 Describe four health benefits of physical activity (include one benefit for each of physical, social, mental and emotional health).

10 If a 4-year-old child plays indoors and outdoors and accumulates 120 minutes of physical activity for the day, have they met the relevant recommendation of the Australian physical activity guidelines for that day?

11 Which of the recommendations of the sedentary behaviour guidelines for adults are measurable?

CHAPTER 11

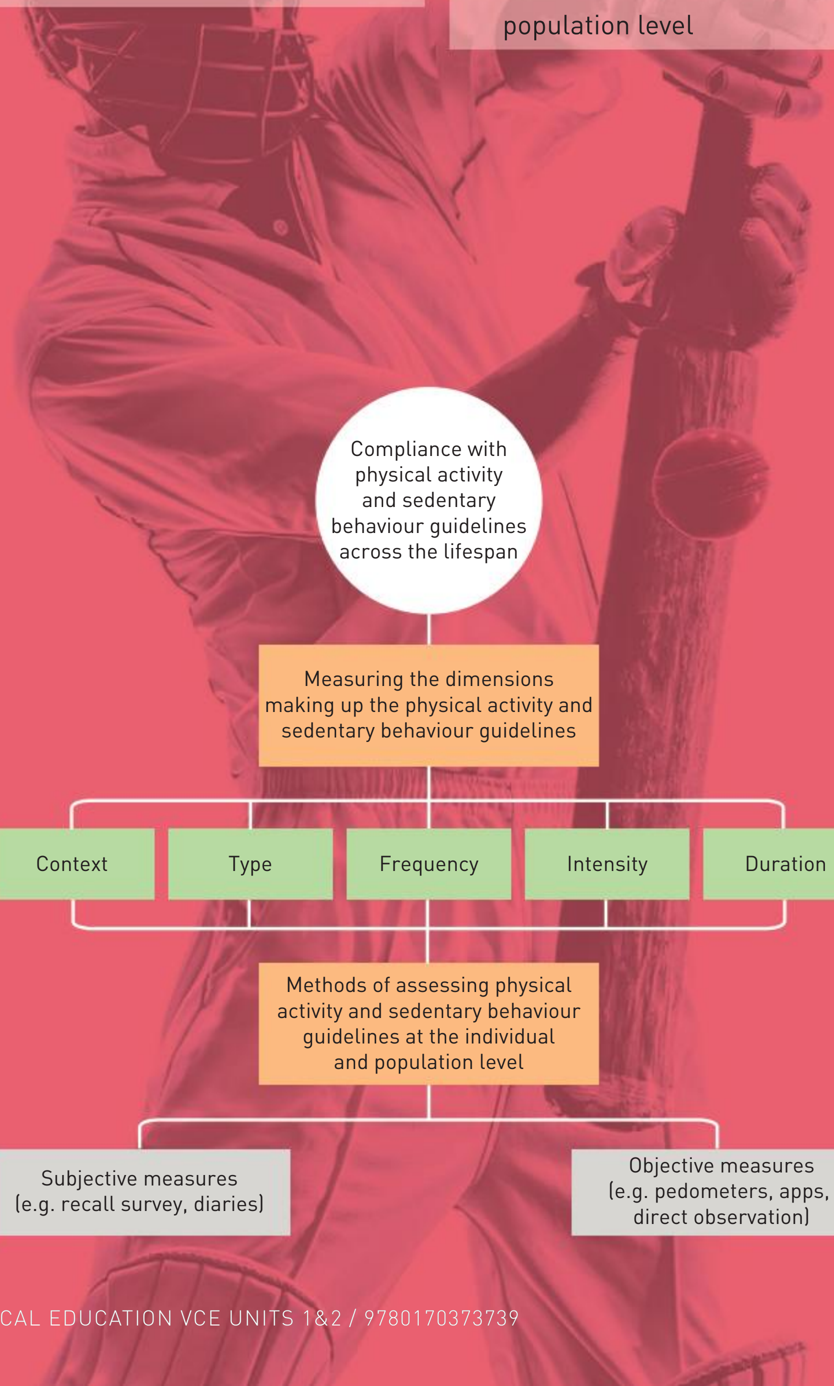
ASSESSMENT OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

Key knowledge

- subjective and objective methods of assessing physical activity and sedentary behaviour such as recall surveys or diaries, pedometry, accelerometry, inclinometry, observation tools (including digital tools such as smart phone and tablet apps) and personal activity trackers

Key skills

- collect, analyse and interpret primary and secondary data related to trends in participation in physical activity
- use appropriate methods to measure and analyse physical activity and sedentary behaviour levels at the individual and population level



Compliance with physical activity and sedentary behaviour guidelines across the lifespan

Measuring the dimensions making up the physical activity and sedentary behaviour guidelines

Context | Type | Frequency | Intensity | Duration

Methods of assessing physical activity and sedentary behaviour guidelines at the individual and population level

Subjective measures (e.g. recall survey, diaries)

Objective measures (e.g. pedometers, apps, direct observation)

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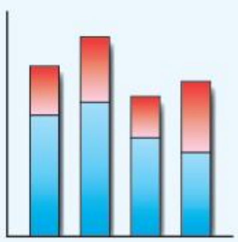
MEASURING PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR AMONG INDIVIDUALS AND POPULATIONS

Measuring physical activity (PA) is more complex than measuring someone's height, weight or fitness. While cardiovascular fitness is an indicator of someone's physical activity level, it is not a direct measure of physical activity behaviour. This chapter will explore the measurement of different dimensions of physical activity and sedentary behaviour (type, frequency, intensity and duration) and the use of several subjective and objective measures at the individual and population levels.

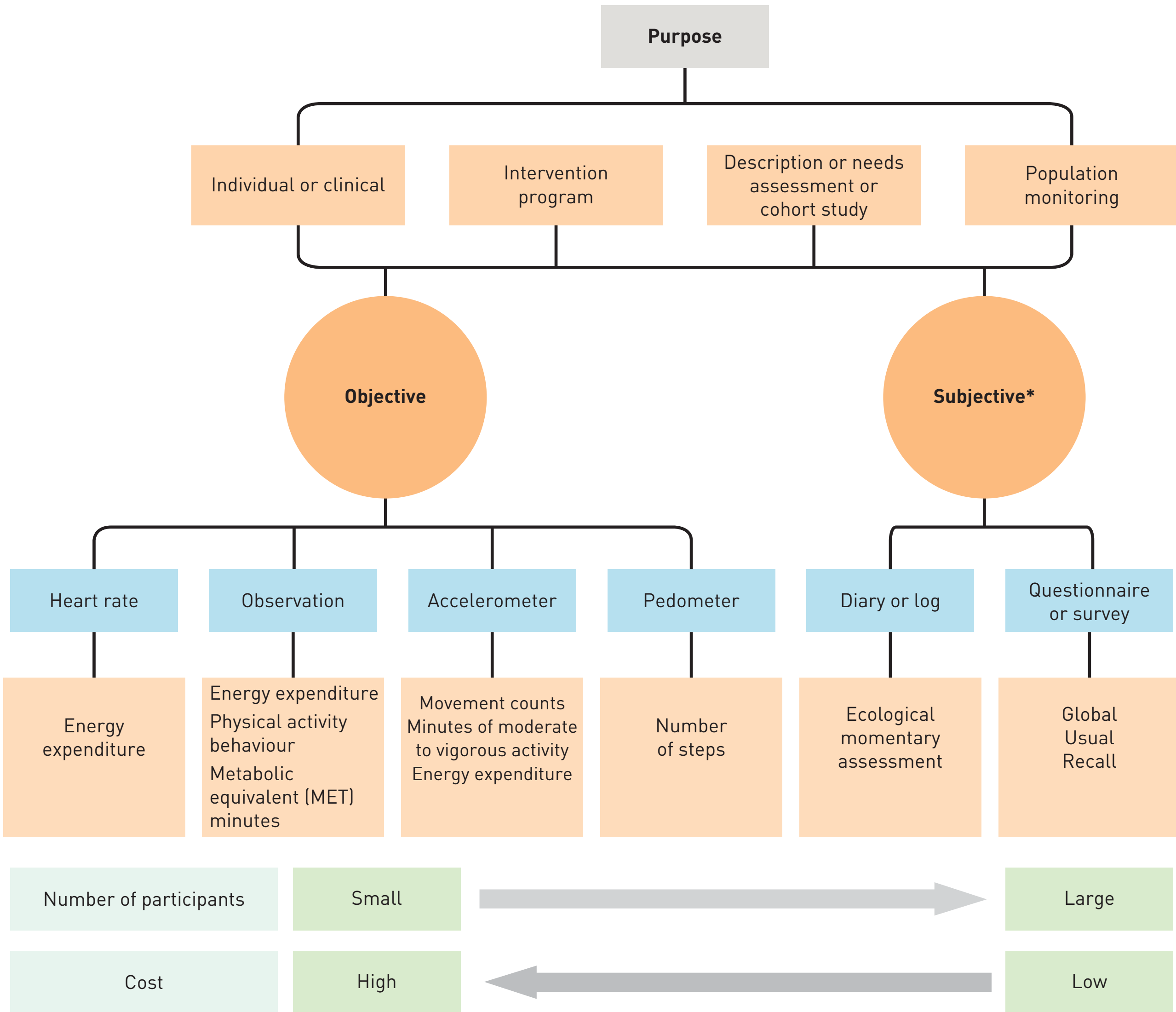
Table 11.1 outlines the main purposes of measuring physical activity at an individual and population level (Sallis & Owen, 1999). One of the most important aims of measuring physical activity is to determine whether an individual, group or population is meeting the physical activity and sedentary behaviour guidelines. Pages 193–195 in chapter 10 summarise the guidelines for physical activity and **sedentary** behaviour for various population subgroups.

TABLE 11.1 Main purposes of measuring physical activity

At the population level 	» To document the frequency and distribution of physical activity in defined population groups » To monitor the achievement of physical activity guidelines and population trends over time » To study the relationship between physical activity and health conditions (for example, cardiovascular risk factors, type 2 diabetes, obesity, cancer and mental health) » To determine the amount or dose of physical activity required to influence specific health parameters » To identify the biological, psychological and environmental factors that influence physical activity » To evaluate the effectiveness of large-scale physical activity intervention programs
At the individual level 	» To detect change in an individual's health and/or behaviour » To determine the effect of any change in physical activity behaviour

Choosing measurement instruments

The choice of assessment method depends on the purpose of the measurement. The tools used during monitoring and surveillance may be very different from those selected to conduct an evaluation. The flow chart on page 200 shows how the measurement used varies according to purpose, number of participants and cost (Dollman et al., 2009). The diagram shows that when the measurement involves a large number of people, low-cost subjective measures are generally used. When more precision is required (in clinical settings with individuals or small numbers of people), objective measures are more likely to be used.



* Parent, teacher, self-reports (>10 years)

Measurement of physical activity

Source: Dollman et al., 2009

Collecting data about physical activity and sedentary behaviour at a population level (that is, community, state or national) requires surveillance. 'Surveillance of population levels of physical activity using a standardized protocol is an important and necessary part of a public health response to current concerns regarding lack of physical activity in many populations. Surveillance of physical activity in populations is most often undertaken using questionnaires, as these are relatively inexpensive and easy to administer compared to objective measurement techniques' (WHO, 2016). Many developed nations have systems in place for monitoring physical activity and sedentary behaviour, along with many other health behaviours.

Evaluation is generally more specific and directly linked to a particular intervention, such as a physical activity program. For example, if the goal of the intervention is to increase the physical activity level of Year 9 girls in your school, several levels of assessment may be planned within the project's evaluation framework.

TABLE 11.2 Levels of evaluation for a school-based physical activity intervention

Level of evaluation	Description	Examples
Formative evaluation	Ongoing assessment of the program activities, with the goal of constantly improving the intervention strategies	Collection of initial, pre-intervention (baseline) data, then regular collection of physical activity data, using a pedometer to track total steps at lunchtime
Process evaluation	Collecting data about the implementation (delivery), e.g. reach of the program, participant satisfaction with program and resources, how the program was implemented	Direct observation to determine whether PE lessons were delivered by the teacher (or interventionist) in the way they were intended
Impact evaluation	Achievement of program goals (immediate effects)	Increased MVPA* during PE lessons, a decrease in the number of girls sitting at lunchtime, and an increase in the number of girls walking in the playground
Outcome evaluation	Outcome evaluation measures the change that has occurred as a result of a program. Achievement of long-term goals rarely assessed, given the long-term nature of the follow-up required to do this.	An observed increase in total physical activity 12 months after intervention; reduction in number of obese girls

* MVPA = moderate- to vigorous-intensity physical activity

Physical activity can be measured directly (for example, the number of times per week a person walks or cycles to work) or indirectly (for example, the number of people per week using a walking and/or cycling path). You will learn more about direct and indirect measures of fitness components in Unit 4.

The only way to determine whether a physical activity program increases a person's physical activity behaviour is to:

» measure their physical activity before the introduction of the program (pre-intervention or baseline testing)
» repeat the assessment during the intervention or using identical measures at the conclusion of the program (post-test or post-intervention)
» repeat the assessment again some time later, such as 12 months after intervention (or post-intervention). This is known as follow-up. Generally a minimum period of 12 weeks of the intervention is necessary to lead to detectable behavioural change over time.

Refer to Table 11.3 for examples of direct and indirect measures of physical activity.

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Active transport is a key source of physical activity. What are some other means of active transport?

Physical activity monitoring in context

It is important to realise that physical activity is rarely measured in isolation. Sometimes the purpose is to identify biological, psychosocial and environmental factors that influence physical activity behaviour. Therefore, in addition to measuring physical activity and sedentary behaviour, questions relating to **correlates** are examined. Table 11.3 presents a conceptual model for assessing physical activity during interventions designed to influence various determinants and health outcomes. You will learn more about these determinants and interventions in the coming chapters.

TABLE 11.3 Conceptual model of PA measures for health promotion (intervention) programs

Program stages (health promotion perspective)	Level of measurement	Stages of PA-relevant measures	Examples of measures
	Program design and conceptual development	Formative evaluation measures	Responses of target group to testing of PA messages or program materials; perception of stakeholders of program's likely success
Program initiated and conducted	Population(s) reached	Process measures; implementation measures	Number or proportion of people attending the program or community events; number or percentage of health professionals participating; program delivered as intended; environmental changes carried out as planned; inter-agency planning/ partnerships materialise and are maintained
Program sustainability	Proximal effects	Individual level measures	Awareness of PA health benefits; cognitive changes such as self-efficacy, intention to be more active, beliefs
		Inter-individual measures	Social supports; enhanced social influences; social environment; social capital (collective efficacy)
	Health promotion impact measures	Individual level measures	PA behavioural changes – increased walking behaviours, increased moderate and vigorous activities; decreased sedentary or screen time; increases in incidental PA, active commuting
		Physical environmental measures	Changes to physical environments completed
		Community level change	Policies developed and implemented; program elements institutionalised in the (health or other) system; program elements self-sustaining without the program initiators on board
Program-derived policy	Long-term outcomes	Health outcomes	Reduced disease incidence or mortality from inactivity-related conditions; improved wellbeing/ quality of life/social capital
Diffusion and dissemination		Other (non-health) outcomes	Environment that better facilitates PA, such as improved public transport, better parks, urban planning, cultural norms and values changed to demand PA infrastructure; sustained policy changes to facilitate PA enhancements; spread of PA, promoting culture and its policy and resources for effective programs to all regions where inactivity is a problem

Source: A Bauman, et al., 'Physical activity measurement: A primer for health promotion', *IUHPE – Promotion & Education*, vol. XIII, no. 2, 2006

MEASURING THE DIMENSIONS OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

Various instruments can measure either one dimension of physical activity and sedentary behaviour or a combination of dimensions. Before looking at specific physical activity measures, it is important to understand the dimensions of physical activity and how they are measured.

Dimensions of physical activity

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Assessing the type and context of physical activity and sedentary behaviour

There are literally hundreds of different types of physical activities that people can engage in. The characteristics of lifestyle physical activities are described in detail in chapter 9. Most people's main sources of physical activity are lifestyle activities such as gardening, walking, golf, swimming, household chores, bike riding, kayaking or tennis. As well as the type of physical activity or sedentary behaviour, the specific context must also be assessed. This might be in a class at school, at work, or at home during recreational time. For example, a computer can be used at home (setting) for educational purposes such as completing homework or for recreational purposes such as communicating on social media.

Many physical activity measures ask respondents about the various types of activity they participate in. This may be for one or more of the following reasons:

» to determine the energy expenditure associated with that particular physical activity by assigning a metabolic equivalent (MET)

» to assess what proportion of physical activity is accumulated within the various domains, such as household and gardening, active transport, occupation or (for youth) school and **leisure-time physical activity**

» to determine the most common activities performed by particular population subgroups, or within a specific context or setting. For example, children in Year 1 participate in very different types of physical activities and sedentary behaviours to those in Year 9. Direct observation measures could be used to determine the most common activities for each year level.

The Children's Leisure Activities Study Survey (CLASS)

The CLASS survey (see page 204) is a self-report for children over 10 years and a proxy-report questionnaire completed by parents for children 10 years and under (Telford 2004). It assesses all dimensions of physical activity (including type, frequency, intensity and duration) performed during a typical week of a school term.

FYI

CLASS was developed in Melbourne in 2000 by Amanda Telford, Professor Jo Salmon and Professor David Crawford at Deakin University. It has since been used to assess young people's physical activity and sedentary behaviour throughout Australia and in more than 25 countries throughout the world.

Children's Leisure Activities Study Survey (CLASS) Children's questionnaire					
Important We are interested in what you do in your leisure time during a typical week. There are no right and wrong answers – **this is not a test**. Please answer all the questions as honestly and accurately as you can – **this is very important.**					
Which of the following PHYSICAL activities do you USUALLY do during a typical WEEK (from the start of the current school term, do NOT include school holidays)?					
During a typical WEEK, what activities do you usually do?	**Do you usually do this activity?**	**MONDAY – FRIDAY**		**SATURDAY & SUNDAY**	
		How many times Monday–Friday?	Total hours/minutes Monday–Friday	How many times Saturday & Sunday?	Total hours/minutes Saturday & Sunday
e.g. Bike riding	*No Yes*	*2*	*40 minutes*	*1*	*15 minutes*
Aerobics	No Yes				
Dance	No Yes				
Calisthenics/gymnastics	No Yes				
Tennis/bat tennis	No Yes				
Aussie rules football	No Yes				
Soccer	No Yes				

Part of the CLASS self-report instrument

Adapted from: Telford 2004

Measuring intensity of physical activity

Table 9.3 (page 169) summarises four commonly used classifications of physical activity intensity: sedentary, low, moderate and vigorous. Not all measures, however, can assess physical activity intensity (see Table 11.5).

Measuring metabolic equivalent (MET) levels

The data collected by many physical activity instruments (for example, self-reported recalls, diaries or logs, proxy-reported recalls, physical activity measures, direct observation) requires the classification of MET scores.

As introduced in chapter 9, a MET score for a particular activity is a comparison between an average person's metabolic rate while at rest and their metabolic rate while engaging in the activity. At rest, one MET is expended. A MET value of 4.0 indicates an intensity four times that of resting levels.

The MET value assigned to a particular activity is based upon the amount of oxygen consumed. At rest, an average male consumes 250 millilitres of oxygen per minute (mL/min), and an average female consumes about 200 mL/min. One MET is the equivalent of 3.5 millilitres of oxygen per kilogram of body weight per minute (mL/kg/min). Because the amount of oxygen a person is actually consuming cannot be easily measured, a MET equivalent can be assigned as an estimate of the intensity of the activity. The Compendium of Physical Activities (Ainsworth et al., 2011) gives typical MET values for a wide range of activities, and some of these were shown in chapter 9. However, it is important to understand that the number of METs expended at each intensity level depends on an individual's age and gender.

Measuring frequency of physical activity and sedentary behaviour

Frequency refers to the number of physical activity **bouts** during a specific time period (for example, per day or per week). The physical activity guidelines recommend adults accumulate 150 to 300 minutes of moderate-intensity physical activity or 75 to 150 minutes of vigorous-intensity physical activity, or a combination of both moderate and vigorous activities, each week. The guidelines encourage adults to be active on 'most, preferably all, days every week' (Australian Department of Health). Here, 'most days' is interpreted as at least five days per week. An individual could accumulate this in different ways: for example, by using three 10-minute bouts per day (3 x 10 min/day x 5 days).

FYI

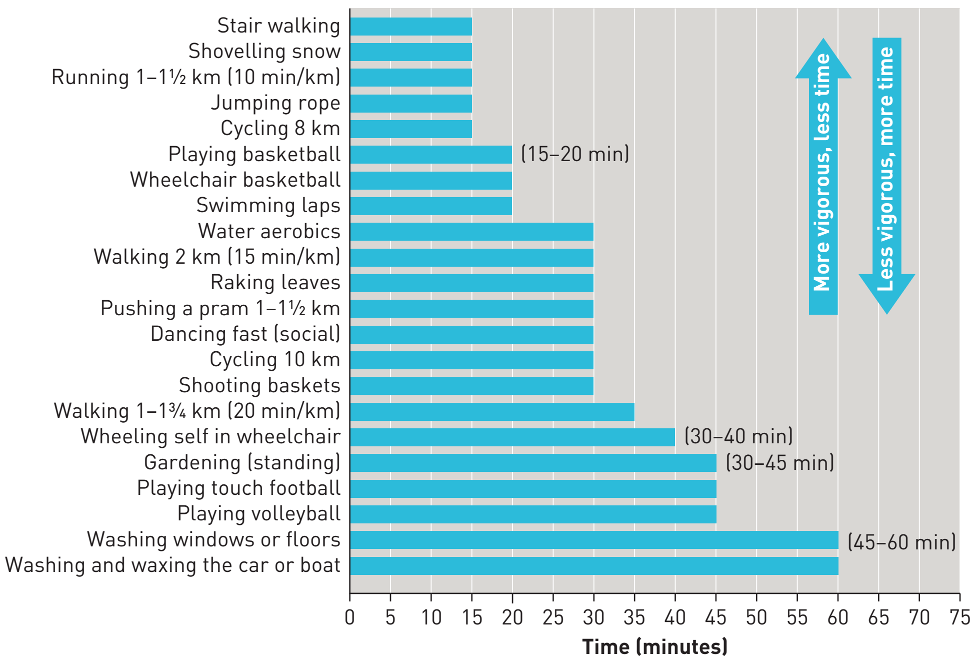
'Weekend warriors' are people who do several hours of physical activity on weekends, but no other activity throughout the week. Although they exceed the recommended weekly minimum time (150 to 300 minutes), they do not meet the required frequency.

Measuring duration (time) of physical activity and sedentary behaviour

The duration of physical activity and sedentary behaviour simply refers to how long a person is engaged in a particular activity. The duration recommended for different population subgroups varies. If an adult was moderately active for 30 minutes per day they would burn approximately 600 kilojoules per day, or about 4000 kilojoules per week. (This is equivalent to about 150 kilocalories per day or 1000 per week.) For other levels of intensity, the time taken to burn this minimum of 600 kJ/day would vary. For example, it would take only 22 minutes at a vigorous intensity.

FYI

The joule is the metric unit for energy, and 1 kilojoule = 1000 joules. To convert kilocalories (kcal) to kilojoules (kJ), multiply by 4.184.



Number of minutes required to burn 600 kilojoules

Source: US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition and Physical Activity, *Promoting Physical Activity: A Guide for Community Action*, Champaign, IL, Human Kinetics, 1999

METHODS USED TO MONITOR PHYSICAL ACTIVITY AT THE INDIVIDUAL AND POPULATION LEVEL

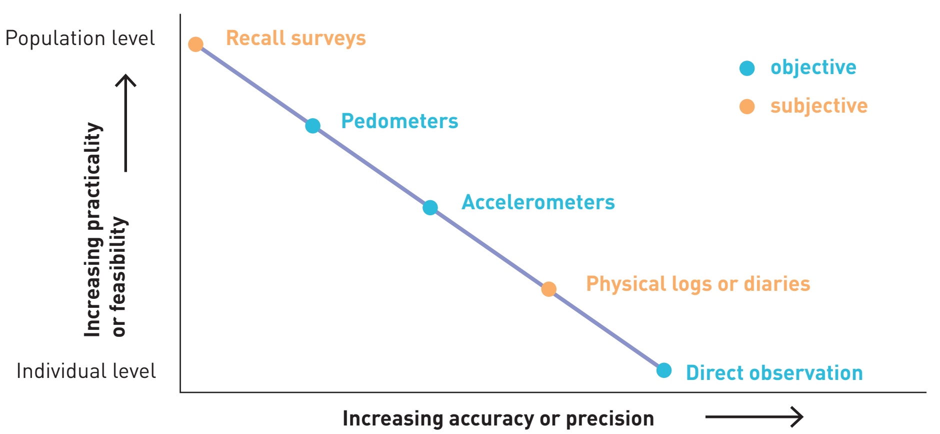
This section describes some of the most commonly used subjective and objective measures of physical activity and sedentary behaviour that can be used at both the individual and population levels. Table 11.5 shows a variety of physical activity instruments, and the graph below highlights the trade-off that exists between practicality (also known as feasibility) and accuracy (or **validity**). Measures offering a high level of precision (such as direct observation and logs or diaries) may not be practical for assessing large numbers of people, when it may be necessary to adopt measures with a lower level of precision.

TABLE 11.5 Instruments used to measure physical activity

Instrument	Measure	Is instrument suitable for assessing:						Expense	Reactivity
		Frequency?	Intensity?	Duration?	Type?	Context?	Energy expenditure?		
Recall survey[1]	Subjective	Yes	Yes	Yes	Yes	Yes	Yes[3]	Low	n/a
Diaries[1]	Subjective	Yes	Yes	Yes	Yes	Yes	Yes[3]	Low	High
Pedometer	Objective	No	No	No	No	No	Yes[2]	Low	Low
Accelerometer	Objective	Yes[2]	Yes[2]	Yes[2]	No	No	Yes[2]	High	Low
Direct observation	Objective	Yes	Yes	Yes	Yes	Yes	Yes[3]	Moderate	High

Notes:

[1] Can be administered by self report or proxy report; [2] Only with certain versions of this type of instrument; [3] If MET values can be assigned to activities



The trade-off between practicality and accuracy

CHAPTER CHECKUP

1 Describe what is meant by physical activity surveillance.
2 Outline the difference between formative and process evaluation.
3 Describe the differences between moderate-intensity and vigorous-intensity physical activity.
4 A person is participating in an activity classified as 5 METs. What does this mean?
5 Explain the trade-off between the accuracy and practicality of a physical activity measure.

TABLE 11.6 Measuring the physical activity guidelines for various age groups

Description of guideline	Self report	Proxy report	Diary	Direct observation	Accelerometer	Pedometer
5–12 year olds						
... accumulate at least 60 minutes of moderate to vigorous physical activity every day.	X*	☺	X*	☺	☺	X
Children's physical activity should include a variety of aerobic activities, including some vigorous intensity activity.	X	☺	X*	☺	☺ Intensity only, cannot capture the type of activities	X
On at least three days per week, children should engage in activities that strengthen muscle and bone.	X*	☺	X*	☺	X	X
13–17 year olds						
... accumulate at least 60 min MVPA every day.	☺	☺	☺	☺	☺	X
... include a variety of aerobic activities, including some vigorous intensity activity.	☺	☺	☺	☺	☺ Intensity only, cannot capture the type of activities	X
On at least three days per week, young people should engage in activities that strengthen muscle and bone.	☺	☺	☺	☺	X	X
18–64 year olds						
Be active on most, preferably all days every week.	☺	☺	☺	☺	☺	X
Accumulate 150–300 minutes of moderate intensity PA or 75–150 minutes of vigorous intensity PA, or an equivalent combination of both moderate and vigorous activities, each week.	☺	☺	☺	☺	☺	X
Do muscle strengthening activities at least two days each week.	☺	☺	☺	☺	X	X

X* Suitable for children aged 10–12 years only

SUBJECTIVE MEASURES OF PHYSICAL ACTIVITY

Some assessments of physical activity rely on a person remembering which activities they participated in, or their perception of the intensity of an activity session. Recall can also be influenced by the opinion and perception of the participant, proxy reporter or researcher. Such assessments are known as subjective measures.

Self-report and proxy-report measures

Self-report measures are the most commonly used subjective measures of physical activity. They include self-administered and interviewer-administered recalls through the use of interviews, questionnaires, diaries or logs. Self-report surveys are completed by the subjects themselves. They always involve some bias, with people often reporting what they think sounds socially acceptable rather than their actual behaviour (known as social desirability bias).

Proxy-report measures involve an individual reporting on behalf of someone else. Typically, proxy reports are completed for someone who is unable to self-report in a reliable or accurate (valid) manner. Proxy reports may be completed for a child by a parent, guardian or teacher. A carer might complete a proxy report on behalf of an elderly person or a person with an intellectual disability. Young children are less able to recall their behaviour than an adolescent or adult because their activity pattern is more variable and harder to remember. Children under the age of 10 years display a huge range in cognitive and linguistic ability, and they may not understand the questions being asked of them, which is also important. Proxy-report methods can be limited by adults being unable to recall children's physical activity. For example, a teacher or childcare worker is unable to constantly monitor every one of the children in their care in terms of their physical activity behaviour, intensity of movement or who they are playing with.

Recall instruments

Recall instruments require respondents to remember which physical activity they engaged in during the previous day, week, month or year. Recalls vary in the way they are administered (self, telephone or interviewer).

The Active Australia Survey (page 211) is an example of an interviewer-administered recall survey that requires the respondent to recall their physical activity during the past week. This survey can be administered either over the telephone or online, in person or in written form, and is designed for use with adults.

A major strength of self-report instruments is their ability to assess physical activity across multiple domains (leisure, household, transport and occupation). However, self-reports have numerous limitations that reduce their accuracy. Social desirability bias occurs when people provide what they believe is the desired response rather than their actual behaviour in their response. This may lead to over-reporting of physical activity. Recalling behaviour is a complex task: children under the age of 10 years and some elderly people, in particular, are likely to have limited capacity to recall specific details due to cognitive and/or memory limitations.

Global Physical Activity Questionnaire (GPAQ)

This questionnaire is a recall instrument designed to assess physical activity patterns. It was developed by the World Health Organization (WHO) for physical activity surveillance in all countries, especially developing countries. The GPAQ collects data about physical activity participation in three domains or settings, including physical activity at work, recreational activity and travel to and from places. The 16-item GPAQ questionnaire also assesses sedentary behaviour. The GPAQ is usually administered by an interviewer, either face to face or over the telephone.

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GPAQ can be used to assess physical activity in developing countries.

INVESTIGATION

Click on the GPAQ link via http://vcepe12.nelsonnet.com.au to see a question-by-question guide for interviewers administering the Global Physical Activity Questionnaire. You could use the online version on your student website at http://nelsonnet.com.au, using your login code, or print it out from there. To help you administer the questionnaire to an adult and determine whether or not they met the physical activity guidelines for a given week.

Weblink

Scaffold

INVESTIGATION

Visit the WHO website via http://vcepe12.nelsonnet.com.au for more information about the IPAQ (see below). Use this instrument to interview someone (over 18 years) to determine whether they met the physical activity guidelines for a given week.

Weblink

International Physical Activity Questionnaire

A team of researchers from around the world met in Geneva in 1998 to develop an international measure of physical activity. During the development of the instrument, extensive reliability and validation testing was undertaken across 12 countries (including Australia). What resulted was a reliable and valid instrument suitable for use in a variety of settings, in different languages, to measure physical activity prevalence at a population level nationally.

There are four versions of the International Physical Activity Questionnaire (IPAQ), including long and short versions; each comes in a telephone or self-administered format. The long version asks about each of the five activity domains separately, whereas the short version consists of four generic items. The main aim of these questionnaires is to provide a common instrument that can be used internationally. In non-English speaking countries, translated versions of the instrument are used. A common instrument means that international comparisons of physical activity can be made. Both the short and long version of the IPAQ are designed for use with young and middle-aged adults (15–69 years).

The short version of IPAQ is commonly used because it is much quicker for respondents to complete. Data from the short version cannot be compared with data from the long version because they measure different things. The short IPAQ has been shown to be as valid and reliable as the long version, and is much quicker to use.

TABLE 11.7 Key characteristics of subjective measures for measuring physical activity

Characteristic	Self report recall/usual	Proxy report (parent/guardian)	Proxy report (teacher)	Diaries/logs
Population (age)	10–18 years 18+ years	3–9 years	5–9 years	10–18 years 18+ years
Sample size	Small to large			
Dimensions assessed	Type, frequency, intensity, duration (varies from measure to measure)			
Method/delivery mode	Questionnaire (pen and paper format and electronic formats, e.g. online survey) or interview (telephone, face to face)			Pen and paper and electronic formats Periodic recording of activities in range of 1 minute to several hours
Assessment time frame	Typically one-off assessment covering a 'usual' week, previous week or previous 1–3 days			Typical 7 days to capture habitual physical activity
Data output	Type (behaviour) – organised vs non-organised Frequency (times per week), Intensity (estimated METs based on adult compendium) Duration (minutes)			
Assessment of physical activity guidelines	Usually can, but will vary from instrument to instrument			
Associated with reactivity	No	No	No	Yes (high)
Technical error	Large	Large	Large	Moderate
Cost	Low	Low	Low	Low
Sources of error and limitations on dimension of physical activity captured	» Poor respondent memory and/or motivation » Susceptibility to socially desirable responses » Underestimation of incidental activities » Low sensitivity to change » Individual variation in intensity within the same activities	Care giver is not necessarily within a couple of metres the whole day and may not know exactly what the child is engaged in. For example, a parent will not be able to accurately report on the child's activity during school hours.		Potential for participant reactivity
Additional considerations	» Computer availability for electronic administration varies among schools. » Literacy levels among respondents can vary widely. » Lists of physical activity cues need to be culturally appropriate.			
Tips to improve compliance and/or data quality	In class – circulate to keep students on task	Check responses with respondent	Check responses with respondent	Send reminders to complete diary entries, e.g. via text or email

Adapted from Dollman et al., 2009

The long version of the IPAQ assesses the vigorous and moderate activities that a person has done in the last seven days. The five parts (domains) to the survey include physical activity that is related to:

» employment
» transport

» housework, house maintenance and caring for family
» recreation, sport and leisure
» time spent sitting.

The most common limitation associated with the IPAQ is over-reporting. It has been suggested that IPAQ interviewers need to be made aware of the maximum acceptable hours so they can probe and clarify with the respondent when an extreme value is given (Rzewnicki et al., 2003). For example, if someone reports that they do 60 hours of vigorous-intensity physical activity per week, the interviewer might clarify whether they meant 60 minutes instead.

PRACTICAL ACTIVITY

THE ACTIVE AUSTRALIA SURVEY: WRITTEN REPORT

1 Using the eight questions below, interview between one and three adults (18 years and over), either in person or over the telephone. The survey should take no longer than 15 minutes. If you access http://nelsonnet.com.au with your login code, there is a blank questionnaire you can fill in online or print out.

Scaffold

2 Using the data you collected, calculate (for each person) the total frequency and total duration (minutes) per week of:
   a walking continuously
   b vigorous gardening or yard work
   c vigorous physical activity (excluding gardening)
   d moderate physical activity.
3 Construct a graph depicting the frequency per week of each category of activity for all three adults, and another graph showing the duration.
4 Discuss your findings. Describe the major source of each individual's weekly physical activity, and calculate whether each individual managed to accumulate enough physical activity to meet the physical activity guidelines for adults (150–300 minutes of moderate-intensity physical activity across most days. Any time reported in vigorous-intensity activity is multiplied by two for this calculation.)

THE ACTIVE AUSTRALIA SURVEY: QUESTIONS

1 In the last week, how many times did you walk continuously, for at least 10 minutes, for recreation, exercise or to get to and from places? (Record number of times.)
2 What do you estimate was the total time that you spent walking in this way in the last week (keep in mind this is continuous walking)? (Record minutes or hours.)
3 In the last week, how many times did you do any vigorous gardening, or heavy work around the yard, that made you breathe harder or puff and pant? (Record number of times.)
4 What do you estimate was the total time you spent doing vigorous gardening or heavy work around the yard in the last week? (Record minutes or hours.)
5 In the last week, how many times did you do any vigorous physical activity that made you breathe harder or puff and pant (e.g. jogging, cycling, aerobics, competitive tennis)? (Record number of times.)
6 What do you estimate was the total time that you spent doing this vigorous physical activity in the last week? (Record minutes or hours.)
7 In the last week, how many times did you do any other moderate physical activity that you have not already mentioned (e.g. gentle swimming, social tennis, golf)? (Record number of times.)
8 What do you estimate was the total time that you spent doing these activities in the last week? (Record minutes or hours.)

Adapted from Australian Institute of Health and Welfare. Licensed under CC BY 3.0 AU

Diaries

Diaries provide rich and detailed information about several dimensions of physical activity (type, frequency, intensity and duration) and require participants to document their physical activity level at the same time each day. Diaries are used to capture all sources of physical activity within a specified time frame (for example, every 30 minutes).

Activity diaries are limited by the participants' ability to follow instructions and remember to document their activities. Perhaps the largest problem and/or opportunity associated with the use of diaries or logs is **reactivity**: many people change their behaviour because it is being monitored. Research shows that writing down health behaviours is a very powerful behavioural change strategy. Chapters 14 and 15 will discuss physical activity promotion strategies.

Multi-Activity Recall for Children and Adolescents (MARCA)

One of the largest national surveys of young Australians' physical activity, known as the National Children's Nutrition and Physical Activity survey, assessed the activity of more than 4000 children and adolescents. A combination of subjective and objective measures were used, including a time diary recall instrument known as multi-activity recall for children and adolescents (MARCA).

Weblink

INVESTIGATION

Click on the link via http://vcepe12.nelsonnet.com.au to learn more about Multi-Activity Recall for Children and Adolescents.

Summary of subjective measures

Table 11.8 provides a summary of the dimensions and domains each subjective measure can assess, along with information about their capacity to assess physical activity in relation to physical activity and sedentary behaviour guidelines.

TABLE 11.8 Assessment of physical activity dimensions, guidelines and domains using subjective measures

Measure		GPAQ	IPAQ[1]	AAS	MARCA[1]	CLASS[1]
Dimensions	Type[2]	✗	✗	✗	✓	✓
	Frequency	✓	✓	✓	✓	✓
	Duration	✓	✓	✓	✓	✓
	Intensity	✓	✓	✓	✓	✓
METs energy expenditure		✓	✓	✓	✓	✓
Physical activity guidelines for children/youth	Physical activity	n/a	n/a	n/a	✓	✓
	Sedentary behaviour	n/a	n/a	n/a	✓	✓
Physical activity guidelines for adults		✓	✓	✓	n/a	n/a
Sedentary behaviour		✓	✓	✓	n/a	n/a
Contextual data		n/a	n/a	n/a	✓	✗
Total physical activity		✓	✓	✓	✓	✓

TABLE 11.8 (continued)

Measure		GPAQ	IPAQ[1]	AAS	MARCA[1]	CLASS[1]
Domains	Leisure time	✓	×	✓	✓	×
	Occupation/school	✓	×	×	✓	×
	Household/gardening	✓	×	✓	✓	×
	Active transport	✓	×	×	✓	×

Notes:
[1] IPAQ, MARCA and CLASS can measure PA across various domains but IPAQ and CLASS cannot measure specific dimensions within each domain.
[2] Type means specific behaviours, such as tennis, weight-training or swimming.
n/a = not applicable
AAS = Active Australia Survey (see page 211)

Advantages of using subjective measures

» Can capture both quantitative and qualitative information
» Can be administered quickly and easily
» Cost-effective for large-scale studies
» Usually low burden on participants
» Have the potential to predict energy expenditure from daily physical activities when compared to the Compendium of Physical Activities (see Table 9.6 on page 171)

Disadvantages of using subjective measures

» Not suitable for assessing children under age 10 or very old adults, due to **cognitive** limitations
» Reliability and validity problems associated with over-reporting due to social desirability bias, memory limitations or misinterpretation of physical activities in different populations
» Interviewer may be needed to obtain accurate data

OBJECTIVE MEASURES OF PHYSICAL ACTIVITY

Physical activity assessments using either direct observation or a device such as a pedometer or accelerometer are examples of objective measures. Objective measures remove the disadvantages associated with subjective measures.

Direct observation

Direct observation involves watching people's behaviours within specific settings (such as parks, schools or physical education classes) and recording activities and events of interest. Direct observation is a highly time-intensive technique, both in terms of training observers and collecting data. However, this technique provides rich, detailed and accurate information about several dimensions of physical activity.

Trained observers watch participants using a real-time sampling technique, which involves documenting aspects of physical activity for a specific time interval (for example, two minutes) followed by a brief break (for example, 30 seconds). Computer software programs have been developed to assist researchers in using time-sampling techniques, storing data and completing analyses quickly. This process allows for the collection of both quantitative

Amanda Telford

Shutterstock.com / Alexey Boldin

Getty Images / Simon McGill

Examples of objective measures used in physical activity monitoring and assessment

data (for example, the number of minutes a child is engaged in running activities during recess) and qualitative contextual data – for example, which classmates children play with during various activities at recess (who), what behaviours they are engaging in (what), what part of the school yard the students are in (where), and at what point during the break the activity is occurring (when).

Direct observation is most commonly used to assess physical activity among children but can also be used with adults. Commonly used instruments include the System for Observing Play and Leisure Activity in Youth (SOPLAY), the System for Observing Fitness Instruction Time (SOFIT) and the System for Observing Play and Recreation in Communities (SOPARC). All three instruments were developed by Professor Tom McKenzie and colleagues at San Diego State University in the United States.

TABLE 11.9 Using direct observation to assess physical activity

Advantages	Disadvantages
» Captures excellent quantitative and qualitative information » Allows for the collection of contextual information (including environmental conditions, the presence of significant others or the availability of physical activity cues such as toys or equipment) » Useful in a variety of community and school-based settings » Computer software makes data collection and analysis simpler than in the past	» Difficult to use with large populations » Intrusive » Highly labour-intensive and time-consuming » Only allows specific physical activity behaviours to be observed » The presence of an observer or cameras may bias the behaviour of those being observed (reactivity) » Training to establish between-observer and within-observer reliability is time-intensive

System for Observing Play and Leisure Activity in Youth (SOPLAY)

The methods of assessing physical activity described so far in this chapter were designed to measure physical activity in individuals only. SOPLAY can be used to assess the physical activity of groups of people. It was designed to assess physical activity in school settings, recording the number of students and their physical activity levels during play and leisure opportunities in a specified activity area (target area). SOPLAY uses time-sampling techniques in which systematic scans of individuals and contextual factors are made within designated and clearly defined areas. It allows for comparisons to be made across different schools or within the same school over different time periods (for example, before school, during lunchtime and after school).

INVESTIGATION

Click on the link via http://vcepe12.nelsonnet.com.au to learn more about the System for Observing Play and Leisure Activity in Youth (SOPLAY).

Weblink

SOPLAY recording procedures

Here is an example of a recording procedure you could use with an adapted version of the SOPLAY instrument while observing a specific target area.

1 On the observation form on the Nelson PE website (http://www.nelsonnet.net.au) enter the date, start time and area being scanned (observed). You will need your login code.
2 Circle **N** (no) or **Y** (yes) for each of the following contextual variables (conditions):
   » **A** = Area is accessible (for example, not locked).
   » **U** = Area is usable for physical activity (for example, not excessively wet or windy).
   » **S** = Area is supervised by a teacher or adult on yard duty. (The supervisor must be directly in the target area and available to respond to student emergencies, but does not have to be coaching or umpiring.)
   » **O** = There is organised physical activity (scheduled and led by the school, such as a sports training session, fitness session or sporting competition).
   » **E** = Equipment (such as balls, skipping ropes) is provided by the school or coaches. Do not circle Y if the equipment is permanent (such as basketball rings).
3 Scan the entire target area for girls. Count and record the numbers of girls who are currently sedentary, walking, very active or playing an active sport.
4 Classify the predominant type of activity occurring in the target area using the activity codes on the SOPLAY data recording form.

   Then repeat steps 3 and 4 for boys. Always scan left to right. Observe each student in the area once. If a student reappears in the scan area, do not record a second time. Do not backtrack to count new students entering the scan area.

Scaffold

SOPLAY observation form

Date: _____/_____/_____			Observer: ______________	Period: BS LU AS (circle)
Start time	**Area**	**Condition** A U S O E	**Girls** S W V	**Boys** S W V
____ : ____	1	N N N N N Y Y Y Y Y	__ __ __	__ __ __
____ : ____	2	N N N N N Y Y Y Y Y	__ __ __	__ __ __

Form codes:	Activity codes:
BS = Before school LU = Lunchtime AS = After school A = Accessible area U = Usable area S = Supervised area O = Organised activity E = Equipment provided S = Sedentary W = Walking V = Very active	0 = No identifiable activity 1 = Aerobics 2 = Baseball or softball 3 = Basketball 4 = Dance 5 = Football 6 = Gymnastics 7 = Martial arts 8 = Racquet sports 9 = Soccer 10 = Swimming 11 = Volleyball 12 = Weight training 13 = Other playground games 14 = None of the above

LABORATORY REPORT

USING SOPLAY TO OBSERVE PHYSICAL ACTIVITY

Refer to the SOPLAY recording procedures and the observation form above.

1 Using a school map, divide the school into different areas for observation. You might even complete this exercise within a nearby primary school if you have approval from the principal. Determine who will observe each of the target areas.

2 Using the SOPLAY recording procedures, record physical activity data onto the data recording form.

3 Complete a scan of the selected target areas during different time periods (for example, before school, during lunchtime and after school).

4 Compare the data with that collected for other target areas. In which areas does most of the physical activity occur? Does this vary by gender? Present your results in table or graph form.

5 Throughout a typical school day, when did most of the physical activity occur (that is, before school, during lunchtime or after school)? Provide examples using evidence from your data collection.

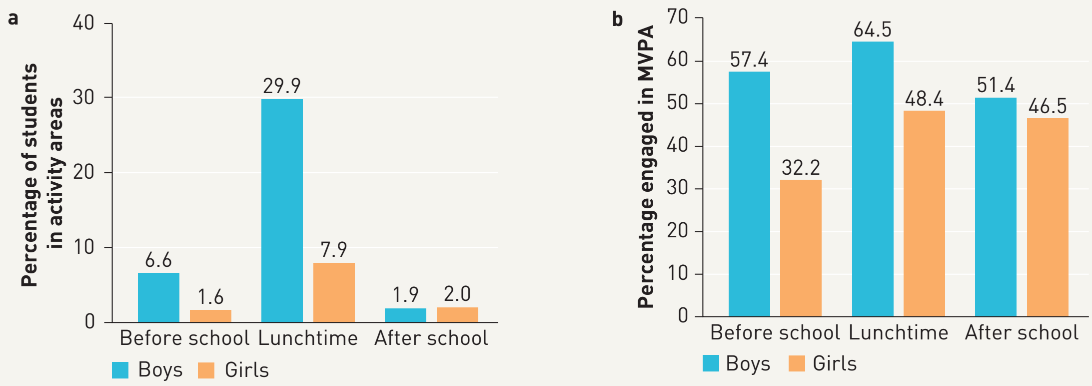
6 List the most common activities observed in each of the target areas.

7 Outline where and when organised activity occurred. Include contextual information in your response (conditions such as whether the area was under supervision, the equipment available and so on).

8 Which subgroup appears to be the most sedentary, based on your data collection? What strategies would you suggest to encourage these individuals to be more active? (Describe the when, where, what and why, and suggest how they could be encouraged to be more active.)

REAL WORLD APPLICATION

Middle school physical activity and nutrition study



Percentage of boys and girls **a** in activity areas, and **b** engaged in moderate to vigorous activity

Adapted from Welk, 2002

The graphs above show data collected from 151 activity areas in 24 middle schools in the United States as part of the Middle School Physical Activity and Nutrition (MSPAN) study, which used SOPLAY. Most of the physical activities observed in the target areas were interschool sports training sessions. The first graph shows the proportion of males and females in physical activity areas before school, during lunchtime and after school over a three-day period. The data shows that very few students visited activity areas. Of those students who did visit activity areas before school and during lunchtime, a higher proportion were male. The second graph shows that male students were more active than female students during all periods.

Questions

1 Discuss why you think male students were more active in the areas observed than female students.
2 Explain why lunchtime periods were associated with the highest levels of moderate- to-vigorous physical activity.

System for Observing Fitness Instruction Time (SOFIT)

The SOFIT tool assesses physical education classes by enabling the researcher to simultaneously collect data on student activity levels, the lesson context, and teacher behavior. The system enables researchers, teachers, and supervisors to make judgments about physical education lessons, particularly as they relate to program goals. The main outcome variable is student physical activity levels, and these can be reported in number of minutes and % lesson time spent in MVPA (moderate-to-vigorous physical activity); VPA (vigorous physical activity); lying down, sitting, standing, and walking; and estimated energy expenditure per lesson (kcal/kg).

Source: Active Living Research, http://activelivingresearch.org/sofit-system-observing-fitness-instruction-time

LABORATORY REPORT

USING SOFIT DURING TCHOUKBALL

Why would SOFIT rather than SOPLAY be used during this setting?

AIM

To introduce students to the use of SOFIT.

EQUIPMENT

You will need handballs, three sets of 12 colour bands and two Tchoukball (rebound) nets. Play takes place on a netball court.

METHOD

In a 50-minute session, half the students participate in Task A and the rest in Task B. After 20 minutes, students swap over to complete the other task.

TASK A: USING SOFIT

Use the following steps to observe two Task B participants. You will be recording student activity and lesson context on a modified SOFIT recording sheet (instructor behaviour categories are omitted for the purpose of this task). The observations for each individual will take a total of four minutes.

1 Select a Task B participant.
2 Observe the participant for 10 seconds. Spend the next 10 seconds filling in the modified SOFIT recording sheet from the NelsonNet website (http://nelsonnet.com.au). You will need your login code. A copy of the sheet is on page 219.
3 Repeat until you have observed the same student 12 times (12 x 20 seconds = 4 minutes).
4 Repeat for another student.

Scaffold

Modified* SOFIT recording sheet

Date: ______ /______ /__________ **School:** ____________________ **Location:** ______________________

Observer: ____________________ **Number of students:** __________ **Number of observations:** _________

Start time: ____________________ **End time:** ___________________ **Lesson length (min):** _____________

Student, gender	Interval	Student activity					Lesson context		
Student 1 (circle) M F	1	1	2	3	4	5	M	S	G
	2	1	2	3	4	5	M	S	G
	3	1	2	3	4	5	M	S	G
	4	1	2	3	4	5	M	S	G
	5	1	2	3	4	5	M	S	G
	6	1	2	3	4	5	M	S	G
	7	1	2	3	4	5	M	S	G
	8	1	2	3	4	5	M	S	G
	9	1	2	3	4	5	M	S	G
	10	1	2	3	4	5	M	S	G
	11	1	2	3	4	5	M	S	G
	12	1	2	3	4	5	M	S	G
Totals									
Student 2 (circle) M F	1	1	2	3	4	5	M	S	G
	2	1	2	3	4	5	M	S	G
	3	1	2	3	4	5	M	S	G
	4	1	2	3	4	5	M	S	G
	5	1	2	3	4	5	M	S	G
	6	1	2	3	4	5	M	S	G
	7	1	2	3	4	5	M	S	G
	8	1	2	3	4	5	M	S	G
	9	1	2	3	4	5	M	S	G
	10	1	2	3	4	5	M	S	G
	11	1	2	3	4	5	M	S	G
	12	1	2	3	4	5	M	S	G
Totals									

Student activity
1 = Lying
2 = Sitting
3 = Standing
4 = Walking
5 = Very active

Lesson context
M = Management
Not involved in knowledge or movement (e.g. splitting into teams, changing equipment, moving from one activity to the next)
Motor content (moving)
S = Skill practice
Activities primarily to improve or practise skills
G = Game play
Application of skills in game or competition

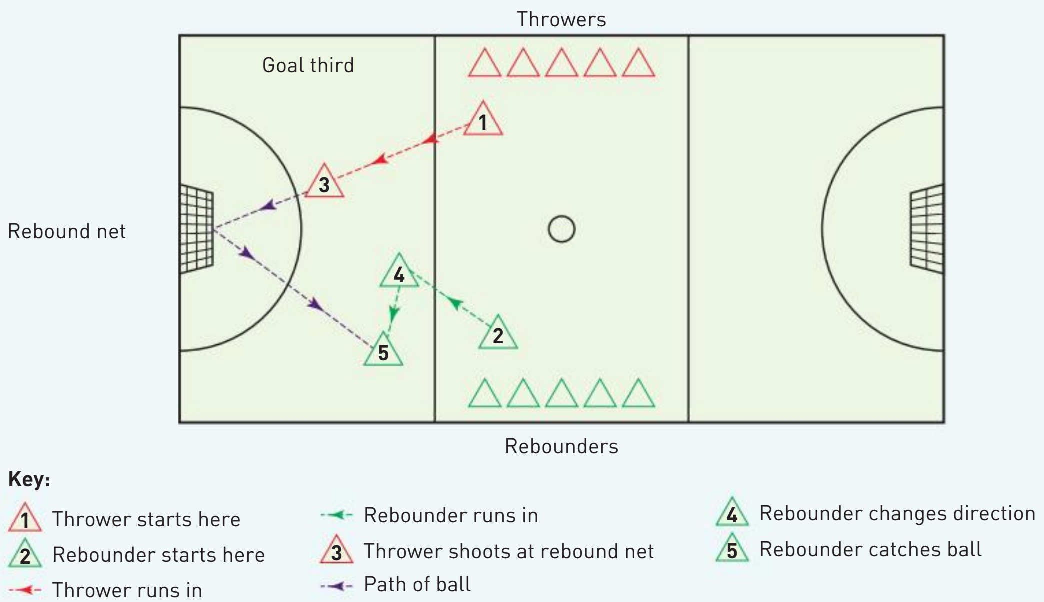
* Note: this modified version omits the instructor behaviour categories altogether

Source: Adapted from TL McKenzie, SOFIT Description and Procedures Manual, May 2015, School of Exercise and Nutritional Sciences, San Diego State University

TASK B: PLAYING A MODIFIED VERSION OF TCHOUKBALL

Participate in a five-minute warm-up (throwing at the rebound nets) and a 10-minute session learning how to play Tchoukball. (Teaching points include: follow through towards the net; throw the ball hard; the lower the ball hits the net, the higher it will rebound in the air; don't make a throw until the pair of players in front of you are safely out of the way.)

1 Participants form two teams of up to 10 students, one at each end of the court. No-one is allowed inside the goal circle at any time.
2 One thrower runs in towards the rebound net, bouncing the ball every two or three steps. (You can hold the ball for only three seconds.) One rebounder runs in at the same time as the thrower.
3 The thrower has a shot at the rebound net from outside the goal circle. To score, the ball must rebound and land outside the goal circle within the goal third. (Alternative rules: the ball must be caught on the full by a teammate outside the goal circle.)
4 The rebounder collects the ball on the rebound and swaps sides to become a thrower. (A shot at goal caught on the full by the opposition team results in a turnover.)



Sample play for Tchoukball

RESULTS

At the bottom of each recording sheet (page 219 or your Nelsonnet website), calculate the total observation time for each column. Remember, each entry on the recording sheet represents 10 seconds of activity. Then fill in a table like the following for each of the students you observed, estimating how many seconds were spent on different student activities and contexts. A blank table is also online, included below the recording sheet. (Lesson context does not need to be recorded in this table.)

Scaffold

Activity or context		Time (seconds)		
		Student 1	Student 2	Total
Student activity	Lying down			
	Sitting			
	Standing			
	Walking			
	Very active			

Motor content	Skill practice			
	Game play			
	Fitness			
	Free play			

DISCUSSION

1 Rank the student activities from the most to least time spent during the observational period.
2 What was the predominant student activity classification?
3 In what motor content mode did the students spend most of their time during this particular physical activity session?
4 How could this instrument be used in school settings to assess physical activity?

System for Observing Play and Recreation in Communities (SOPARC)

SOPARC is a validated direct observation tool for assessing park and recreation areas, including park users' physical activity levels, gender, activity modes/types, and estimated age and ethnicity groupings. It also collects information on park activity area characteristics (e.g., accessibility, usability, supervision, and organisation).

Source: Active Living Research, http://activelivingresearch.org/soparc-system-observing-play-and-recreation-communities

'It's the new iPed. It's a pedometer, a GPS and it has apps that show you the nearest ice cream parlours and dessert shops.'

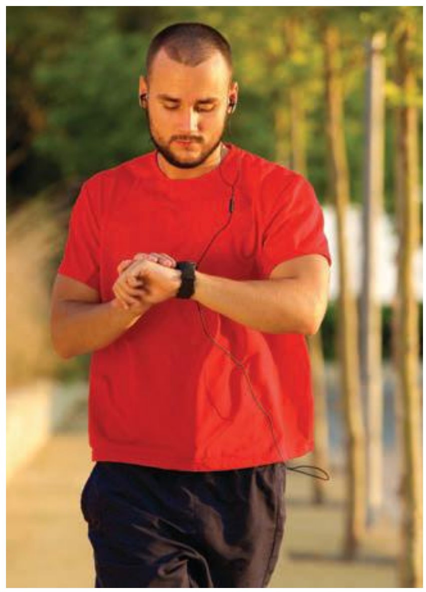
CartoonStock.com / Aaron Bacall

Pedometers

Most personal digital activity trackers contain a pedometer function. Electronic pedometers are low-cost, easy to use and considered to be the simplest form of motion sensor for physical activity assessment. There are many models available on the market, offering a wide variety of functions. In addition to assessing the total number of steps taken, some models can estimate total distance covered (kilometres), energy expenditure (kilojoules or kilocalories) and total movement time (minutes). Pedometers are usually worn on the hip or wrist, and are designed to respond to vertical forces. A step registers in response to the impact of a foot strike. Pedometers will also measure other non-walking activities that involve hip movement, such as going up and down stairs, getting up from a chair or jumping rope.

People who want to achieve health benefits can set a goal of recording 10 000 steps per day on their pedometer. An estimate of the total distance covered can be obtained by programming the individual's stride length into the pedometer, which multiplies it by the number of steps.

Pedometers are potentially the most cost-effective means of bridging the gap between science and practice. They can be worn within a wide range of settings and have enormous potential for increasing an individual's awareness of their physical activity levels. Wearing a device with a pedometer function is one of the most powerful behavioural change strategies, as it can provide the wearer with visible goals, reinforcement via constant monitoring, motivation and increased awareness.



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Why are pedometers so effective in changing physical-activity behaviours?

FYI

For centuries, people have used pedometers to measure distances travelled on foot. Leonardo da Vinci is believed to have invented the pedometer. He was one of the first people to take a scientific approach to understanding how our world works, and produced the first anatomical studies. He also studied flying machines, geometry, mechanics and architecture.

Limitations of pedometers

Pedometers cannot detect stationary activities or isometric exercises, or activities that involve only the arms. However, the main limitation of the pedometer is that it cannot measure the intensity of physical activity. For example, it takes much more energy to walk 100 steps up a flight of stairs than it would to walk 100 steps on the flat. The only way to assess intensity is to compare the time it took the person to reach their step score on various occasions. For example, a person who accumulates 1500 steps in 10 minutes is exercising at a fairly high intensity, while someone who accumulates 1500 steps over 90 minutes is exercising at a low intensity.

Tips for wearing a pedometer

» Many pedometers are not waterproof. Do not place the pedometer in water or allow it to become wet.
» Traditional pedometers are worn in an upright position, sitting on or close to the hip or wrist in a vertical (upright) orientation.
» Wear the pedometer on a belt or armband if possible. Alternatively, wear the pedometer on clothing that has a waistband such as pants or shorts.

TABLE 11.10 Advantages and disadvantages of using a pedometer to assess physical activity

Advantages	Disadvantages
» Inexpensive » Small, lightweight and non-invasive » Easy to administer to large groups » Useful for detecting change (between pre- and post-tests) in the daily average number of steps taken, or to identify changes in rank order among groups » Objectively measures the most common physical activity behaviour (walking) » Appropriate for use in a range of settings (workplaces, the community and schools) » Provides immediate feedback and has the potential to promote behaviour change	» Assesses only one type of physical activity behaviour (walking or running) » Cannot record and store data in real time » Unable to record the magnitude of movement detected (a step is recorded regardless of the intensity or mode during walking, running or jumping) » Provides no information about frequency, intensity or duration of physical activity » Not an appropriate choice for comparing children with different levels of physical maturity because of the influence of body size and speed of locomotion on step count » Although it can provide estimates of energy expenditure, these are based on studies of adults and are not accurate for children

» Always attach the safety strap to your clothing, preferably on a belt loop. This will reduce the chance of losing the pedometer or dropping it.
» When worn correctly, the pedometer logo should be facing away from the body.
» It is normal to hear a noise as if something is moving inside the pedometer. This is the suspended lever arm moving up and down with each step.
» If you wear the pedometer incorrectly it will not count steps accurately. Do not wear it at an angle, place it inside a pocket (where it is likely to slide out of the vertical position) or wear it near your bellybutton.
» If you have a wrist-worn activity tracker with a pedometer function, you can disregard the above tips and simply ensure your device is not too loose on your wrist.

iStock.com / ntmw

LABORATORY REPORT

INTRODUCTION TO PEDOMETRY

AIM

To become familiar with the use of pedometers.

EQUIPMENT

You will need pedometers, cones and a 20-metre tape measure.

TASK A: DETERMINING YOUR STRIDE LENGTH

Your stride length is defined as the distance between the toe of the front foot and the toe of the back foot, when walking. You need to determine your stride length before you can program your average stride length into your pedometer.

The most accurate way to measure stride length is to count the steps it takes to walk a certain distance (measured accurately using a tape measure) and then divide that distance by the number of steps taken.

Stride length = distance ÷ number of steps

For example, if it takes 25 steps to cover 20 metres, then the stride length is:

20 m ÷ 25 = 0.8 m or 80 cm

METHOD

1 Measure out a distance of 20 metres and mark it with a cone at each end.
2 Walk from one cone to the other, counting the number of steps (in your head).
3 Repeat, but at a running pace.
4 Record your results in a table like the one below and calculate your stride length each time.

All the forms in this activity are online via http://nelsonnet.com.au. You will need your login code.

RESULTS

Distance of 20 m	Number of steps	Stride length
Walking		20 m ÷ steps = ___ m = ___ cm
Running		20 m ÷ steps = ___ m = ___ cm

Scaffold

TASK B: COMPARING INTENSITY – WALKING VERSUS RUNNING

To work at a moderate intensity, a person's heart rate should be between 50 and 70 per cent of their maximum heart rate (% max HR). Maximum heart rate (max HR) is age-related and can be estimated in beats per minute (bpm) by:

Max HR (bpm) = 208 – 0.7 x age (years)

For example, the maximum heart rate for a 30-year-old would be approximately:

208 – 0.7 x 30 = 187 bpm

To work at a moderate intensity, the target heart rate for this individual would need to be between 94 and 131 bpm. Working above 70% max HR is considered vigorous intensity.

METHOD

1 Before you start the activity, measure your heart rate and record it in a table (see below).
2 Walk for one minute, wearing a pedometer, then record your heart rate again.
3 Run hard (preferably uphill) or climb stairs for one minute, then measure and record your heart rate again.
4 Calculate the increase in your heart rate from rest to walking, and from walking to running.
5 Calculate the percentage of your maximum heart rate for walking and running.
6 Record whether you were working at a moderate or vigorous intensity level.

Scaffold

RESULTS

	Number of steps taken	HR (bpm)	Increase in HR	% max HR	Intensity
Before activity	n/a		n/a	n/a	n/a
Walking					
Running					

n/a = not applicable

TASK C: ESTIMATING YOUR STEP COUNT

1 Estimate the number of steps you think it will take you to walk around the school oval, and record your estimate in a table like the one below. Reset your pedometer so that the step count is 0. If you are not able to reset, then just record the current step count, so you will be able to calculate the difference later.
2 Walk around the oval and then record your pedometer reading in the table.
3 Without resetting the pedometer, carry out similar steps for the other two walking tasks. Complete the table, including the total number of steps walked.

Scaffold

RESULTS

Walking task	Estimated number of steps	Step count at start of activity	Step count at finish of activity	Actual steps taken for activity
Around the oval				
Around the school buildings				
Around the perimeter of your school campus				

TASK D: ESTIMATING TOTAL DISTANCE COVERED

Some pedometers allow you to enter your stride length and estimate total distance covered in kilometres. Alternatively, you can use the formula:

Distance (km) = stride length (m) x number of steps ÷ 1000

For example, for 3450 steps at a stride length of 80 centimetres (0.8 metres):

Total steps = 3450 x 0.80 = 2760 m or 2.76 km

Find the total number of steps you walked for Task C. Using your walking stride length from Task A, calculate the total distance covered in Task C.

RESULTS

Total steps (Task C)	Walking stride length (Task A)	Estimated distance covered (km)

DISCUSSION

Scaffold

1 Describe what happened to your stride length when you ran 20 metres, compared with when you walked that distance.
2 Compare your estimated step count for various walking tasks with your actual steps (according to the pedometer). For which walking task was the number of steps easiest to estimate, and why?
3 Explain why pedometers are a powerful tool for changing people's awareness of their level of physical activity.
4 Could you use pedometry to determine whether you meet the national physical activity guidelines? Discuss.

Setting a step-count goal

By using a pedometer, is it easy to set a baseline and goals for increasing the number of steps you take per day.

» To determine your baseline (current activity level), wear the pedometer for up to a week and then divide the total number of steps by the number of days to find your current daily average. The more days you record this over, the more accurate your estimate will be.
» Your goal should be to increase your baseline by around 10 per cent. For example, for a baseline of 6000, your goal could be to increase your daily number of steps by 600, every two weeks (see Table 11.11).
Baseline + 10% of baseline = 6000 + 600 = 6600 steps

TABLE 11.11 Step-count goals

Weeks	1 & 2	3 & 4	5 & 6	7 & 8	9 & 10
Goal (steps per day)	6600	7200	7800	8400	9000

Stride-length ready reckoner

Instead of calculating your stride length, you could look it up in Table 11.12.

TABLE 11.12 Number of steps versus stride length for walking a distance of 20 metres

Number of steps	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Stride length (cm)	100	95	91	87	83	80	77	74	71	69	67	65	63	61	59	57

CHAPTER CHECKUP

1 Outline the difference between a recall instrument and a diary.
2 Refer to Table 11.8 (on pages 212–13). Which physical activity measures can be used to assess sedentary behaviour of young people?
3 Describe two disadvantages of the use of direct observation for assessing physical activity.
4 Contrast SOPLAY and SOFIT as direct observation instruments.
5 Explain why pedometers are powerful behavioural change tools.

Accelerometers

Accelerometry techniques enable automatic, continuous and long-term activity measurement within free-living settings rather than just in a laboratory. Accelerometers are sensors that measure the acceleration of objects in motion along referenced axes. These are small, lightweight devices about the size of a matchbox or a 50-cent piece – even smaller in wrist-worn devices. They register body motion, specifically **acceleration** (not speed) and **deceleration** during physical activities.

Accelerometers measure the rate and magnitude at which the body's centre of mass changes during movement. This is generally measured in gravitational acceleration units (g-forces, where 1 g-force equals 9.8 metres per second per second), or in movement counts per minute or during any given epoch. Some accelerometers can respond to gravity to provide tilt sensing. Most smart phone accelerometers sense the movement when you tilt your phone and automatically rotate the screen display for you.

All accelerometers can provide basic data relating to step counts (intensity) and duration that can be used to estimate energy expenditure. The available functions depend on the model of accelerometer, however. For example, depending on the model:

» battery life can range from 60 minutes to 30 days
» data storage capacity can range from a couple of hours to several months.

Reported parameters can range from:

» steps
» **cadence**
» walking speed
» stride length
» distance
» activity count
» sit to stand activities
» upright time
» sedentary time
» stepping time
» **gait** types
» energy expenditure
» activity duration
» sleep duration
» activity intensity.

Accelerometers are usually worn on the hip to measure energy expenditure; however, they also can be worn on limbs – for example, around the wrist or ankle. Many of the latest wearable devices have an accelerometer built in. This technology is able to store large amounts of body-movement data and operates on the assumption that acceleration of the limbs and trunk is associated with whole-body energy expenditure (see the graph on page 228). Uniaxial accelerometers measure motion in a single plane, while biaxial and triaxial accelerometers are able to monitor multiple planes. Accelerometers are equipped with an electronic filter that excludes any movement outside 'normal' human motion, such as sitting in a moving car. Accelerometers record physical activity in movement counts in real time, allowing each minute of monitoring to be sorted by intensity.

Accelerometers can estimate time spent in moderate- to vigorous-intensity physical activity. They can also assess sedentary time and low-intensity activity (typically 50 to 100 counts per minute). In the United States, Patty Freedson developed a series of regression equations that allows physical activity researchers to convert movement counts per minute into different intensities (Wickel, Eisenmann & Welk, 2007). For example, 1.5 METs equates to approximately 77 counts per minute, where 1 MET is equivalent to rest.

REAL WORLD APPLICATION

Interview with Professor Catrine Tudor-Locke

Courtesy of University of Massachusetts Amherst and Professor Catrine Tudor-Locke

Professor Catrine Tudor-Locke is a walking-behaviour researcher from the University of Massachusetts Amherst in the United States of America. Catrine is recognised as a world leader in the use of pedometers to measure and promote physical activity.

Catrine, you are considered one of the world leaders in pedometry. What dimensions of physical activity (type, frequency, duration and intensity) can pedometers measure?

As waist-worn instruments, pedometers are most sensitive to ambulatory movements. These include walking, running, skipping, dancing, etc. Traditionally, pedometers have been used to just count steps taken, and they output an accumulated volume of steps taken over time (for example, a day). But emerging technology is now offering outputs of steps taken above a specified cadence (such as 100 steps per minute) and this presents an opportunity to infer time spent engaging in activities of higher intensity, in line with public health guidelines. Since we know that 30 minutes of activity that is of at least moderate intensity elicits approximately 3000 steps in 30 minutes (and these can be accumulated in multiple 10-minute segments), aiming for this over and above steps accumulated in activities of daily living is a prudent goal.

How have pedometers changed over the past few years?

Leonardo da Vinci is credited with inventing an instrument designed to count steps taken. Gear-driven versions (pre-1980s) were notoriously inaccurate. Modern electronic versions with improved accuracy are commercially available. Not all pedometers are equally accurate, however, and there is no governing body (outside Japan) that sets industry standards, so it is a bit of a buyer beware situation. Manufacturers offer a number of value-added features to their products, such as estimates of distance walked and calories expended, but these estimates are not as accurate as a simple tally of steps taken. Some instruments now offer on-board memories and/or can be downloaded to computers for graphical interfaces. Some pedometers talk, and tell you when they aren't walked enough!

Why are pedometers so popular in program or intervention evaluation?

They are generally affordable, feasible and acceptable. They monitor physical activity in an intuitive, user-friendly metric, and produce output that is readily comparable to other programs and research studies.

Why are pedometers so useful as a behavioural change tool during physical activity interventions?

They fit very well into our understanding of how goal-setting, self-monitoring and feedback are established elements of theory-based program design. They provide a cumulative count of physical activity behaviour that gives the wearer immediate opportunity to alter their behaviour. They are generally small, easy to wear and unobtrusive. People like them!

Questions

1 How have pedometers changed over time?
2 Why are pedometers often used during intervention programs?
3 Explain how a pedometer can enhance behavioural change in terms of physical activity.

iStock.com/Steve Debenport

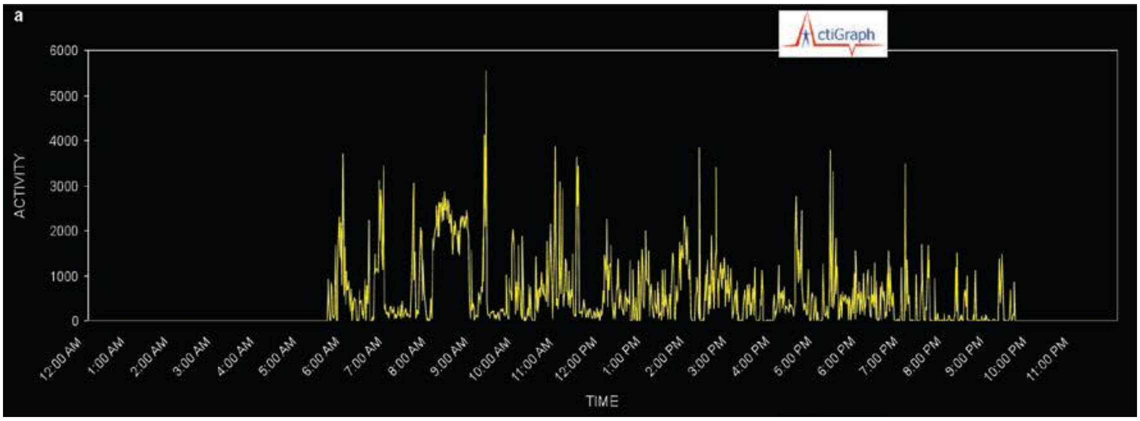
Activity trackers contain accelerometers that track movement in every direction

Weblink

INVESTIGATION

Check out the link on http://vcepe12.nelsonnet.com.au for information about accelerometers. The ActiGraph accelerometer is used in hundreds of universities, sporting organisations and rehabilitation clinics and hospitals in over 40 countries around the world.

Reprinted with permission from ActiGraph, LLC, © 2010



Note: less than 100 cpm = sedentary behaviour; 100–1950 cpm = light-intensity activity; more than 1950 cpm = moderate-to-vigorous activity

Sample of movement count data from an accelerometer

TABLE 11.13 Advantages and disadvantages of using an accelerometer to assess physical activity

Advantages	Disadvantages
» Accelerometers are small, lightweight (40 grams) and non-invasive, although still robust. » They provide an objective indicator of body movement (acceleration). » Accelerometers are a good alternative to self-reporting physical activity by children under 10 years, who often cannot accurately recall their behaviour. » They can be used in the laboratory or on the playing field. » They assess dimensions of intensity, frequency and duration. » They record movement in real time (minute by minute or even by the second). » Data can be stored for extended periods. » Most have an interface to provide participants with feedback. » They can assess physical activity that is difficult to capture (such as children's physical activity, incidental or light-intensity physical activity, sedentary time).	» They are expensive for use with large populations. (Each accelerometer costs between about \$80 and \$3000.) » Older versions are not waterproof, and new versions are not validated for wear during aquatic activities, despite manufacturer advertising. » They are not sensitive to low-impact physical activities, and therefore underestimate movement during cycling and rollerblading, or activities that are mostly upper-body. » Energy expenditure prediction equations are mostly based on laboratory studies; more field-based studies of special populations (such as children) are required. To date, there has been poor agreement as to what cut-points (ranges of movement counts per minute or of *g*-forces) represent different intensities of energy expenditure. » There are subject compliance issues. (People forget to wear them or refuse to wear them after a short period.) » They potentially alter physical activity behaviour and patterns (reactivity). » Energy expenditure may be inaccurately estimated when movement is not horizontal (e.g. when climbing uphill or climbing stairs).

Summary of objective measures

Table 11.14 provides a summary of the dimensions and domains each objective measure can assess, along with information about their capacity to assess physical activity in relation to physical activity guidelines.

TABLE 11.14 Assessment of physical activity dimensions, guidelines and domains using objective measures

Measure		Pedometer[2]	Accelerometer	Direct observation
Dimensions	Type	✗	✗	✓
	Frequency	✗[1]	✓	✓
	Duration	✗	✓	✓
	Intensity	✗	✓	✓
METs energy expenditure		✗	✓	✓
Physical activity guidelines for children/youth	Physical activity	✗	✓	✓
	Sedentary behaviour	✗	✗	✓
Physical activity guidelines for adults		✗	✗[3]	✓

TABLE 11.14 (continued)

Measure		Pedometer[2]	Accelerometer	Direct observation
Sedentary behaviour of adults		✗	✗	✓
Contextual data		✗	✗	✓
Total physical activity		✓	✓	✓
Domains	Leisure time	✗	✗	✓
	Occupation/school	✗	✗	✓
	Household/gardening	✗	✗	✓
	Active transport	✗	✗	✓

Notes:

[1] Measures steps only.

[2] Only some models estimate total activity time of moderate- to vigorous-intensity physical activity.

[3] Cannot assess PA type in relation to strengthening exercises

Appropriate assessment instruments for the target group

When selecting a physical activity measure, it is important to consider the population subgroup being assessed (see Table 11.15). For example, many children under the age of 10 cannot provide a valid (accurate) or reliable (consistent) account of their physical activity behaviour, due to cognitive and memory limitations. While children may not have the cognitive skills to understand the survey items, older people may understand, but may not be able to accurately recall their behaviour due to memory limitations. People with limited understanding of English would have difficulty with a survey or log unless it had been translated.

Accelerometers can be poor measures of physical activity for people with intellectual disabilities because of long hours of sedentary behaviour or slow movements; some models interpret low movement counts or *g*-forces as an indication that the accelerometer is not being worn. As previously discussed, proxy reports (recall surveys, global surveys or diaries or logs) are commonly used to assess physical activity for those groups who are not capable of reporting their own behaviour accurately.

TABLE 11.15 Appropriate measures for assessing physical activity among population subgroups

Subgroup	Self-reported recall survey	Self-reported diary or log	Proxy report	Pedometer	Accelerometer	Direct observation
Children 0–9 years	No	No	☺ ☺ ☺	☺ ☺	☺	☺ ☺ ☺
Children 10–12 years	☺	☺	☺ ☺	☺ ☺	☺ ☺	☺ ☺ ☺
Adolescents	☺ ☺	☺ ☺	☺	☺ ☺	☺ ☺ ☺	☺ ☺ ☺
Adults	☺ ☺ ☺	☺ ☺ ☺	☺	☺ ☺	☺ ☺ ☺	☺ ☺
Older adults 65 years	No	☺ ☺	☺	☺ ☺	☺ ☺	☺

TABLE 11.15 (continued)

Subgroup	Self-reported recall survey	Self-reported diary or log	Proxy report	Pedometer	Accelerometer	Direct observation
People with an intellectual disability	No	☺	☺ ☺ ☺	☺	☺	☺ ☺ ☺
People from a NESB[1]	No[2]	No[2]	☺ ☺	☺	☺	☺ ☺ ☺

Key: No = Not at all appropriate, ☺ = Somewhat appropriate, ☺ ☺ = Appropriate, ☺ ☺ ☺ = Highly appropriate

Notes: [1] NESB = Non-English-speaking background

[2] Only appropriate when translated into the language spoken

REAL WORLD APPLICATION

Interview with Professor Stewart Trost

Image courtesy Queensland University of Technology https://www.qut.edu.au

Stewart Trost is a Professor at QUT

Many people consider Stewart Trost to be one of the world leaders in physical activity measurement, particularly accelerometry.

Why do physical activity researchers often use a combination of measures?

I guess it's because one measure can't provide everything we desire in a measure of activity behaviour. Accelerometers can estimate frequency, duration and intensity, but not type and context. Others suggest that different physical activity measures tap into different aspects of physical activity, and that combining them provides a more optimal assessment. We've made some progress on dual HR and accelerometers, but they still require individual calibration to make them more accurate than single method approaches.

What are the main objective measures you use in your latest research?

The main objective measure that I use is accelerometers. We also use direct observation, which I consider an objective measure when the protocol is sufficiently standardised and the observers are reliable.

What have some of the major advances in accelerometry been over the past few years?

Probably the development of algorithms to predict physical activity intensity. The increase in memory and the access to inexpensive triaxial accelerometer components have been technological innovations. It is almost impossible to buy the components for a uniaxial accelerometer these days. The use of pattern-recognition data-processing techniques is also a major development.

Where is the future of physical activity measurement headed?

Small, easily-worn (like a band-aid) multi-sensor systems that are wireless and use pattern recognition or machine learning data processing techniques to classify activity type and predict energy expenditure is where we are heading. There will also be 'apps' developed for new phones that have accelerometers in them, but they may be more than just measurement tools – more of an intervention for self-monitoring.

Questions

1 Why do researchers use a combination of measures when assessing physical activity?
2 What may future accelerometers look like?

Digital tools

Although subjective methods such as diaries or questionnaires are inexpensive, they are dependent on individual recall and subjective judgements and interpretation, making assessment results inconsistent. The objective techniques already described often use wearable or body-fixed motion sensors and combine a series of functions such as accelerometry and pedometry, GPS, heart rate monitoring etc.

So far, pedometry and accelerometry have been discussed in isolation. During the past decade there were very few devices available to the general public that were considered an accessible and accurate way of assessing physical activity. But technology has moved quickly and today multifunction devices are becoming the norm. Mechanical pedometers or 'step counters' are the simplest wearable sensors to measure physical activity, and are standard in all personal activity trackers, using a spring-loaded mass or other switch mechanism to detect steps.

Multifunction personal activity trackers, which include accelerometry-based wearable motion detectors, can be used for physical activity monitoring and assessment, including posture, movement classification (e.g. sitting versus standing, walking, cycling, etc), estimation of energy expenditure, fall detection and balance control evaluation. Energy estimation and metabolic rates estimated from accelerometers are determined by heat dissipation, skin temperature and conductivity.

Accelerometers can also be integrated into clothing, and wearable accelerometry-based activity monitors can also be integrated with 'health smart homes'. Wearable accelerometers can be synchronised with human monitoring systems designed to monitor important parameters relating to an individual's overall health status.

Smart phones

The popularity of smart phones, with connectivity, advanced computing capabilities and built-in GPS, makes them the ideal device to gauge activity levels, indirectly estimate energy expenditure and monitor human movement. Some devices can be used solely within the smart phone, while others need to be interfaced with other devices, such as a watch or wrist band. Research in the late 1990s established a significant relationship between accelerometry and energy expenditure, and there has been a wearable sensor revolution since.

Physical movements unique to specific physical activities can be identified by some smart phones if mounted between the scapulae (shoulderblades). Some smart phone apps or smart phones can count the number of times a particular muscle group has been exercised (e.g. hamstrings, gluteus maximus, biceps), but this requires the user to strap the phone to their ankle or wrist. The popularity of using smart phones to measure physical activity is limited due to the following issues:

» Location-based sensors that include wi-fi transceivers and GPS can violate personal privacy when tracking a user's location.
» Error associated with inconsistent device orientation and location when carried, e.g. attached to the belt, held to ear, in pocket.
» Complex algorithms are required to identify movements at a lower level of intensity (i.e. lying, sitting, standing, walking up or down stairs, walking on a flat surface).
» Strapping a smart phone to your body can be cumbersome, and is not representative of how people generally carry their smart phones throughout the day.
» Limited battery life is consumed quickly with sensors and apps turned on.
» Data collected using different smart phones is not comparable, as it relies on the use of different sensors and measurement algorithms.
» Many people do not wear or carry their smart phones while at home or at work, so monitoring of physical activity is limited in these settings.
» Quality of heart-rate sensors in smart phones varies.

Emerging technologies

The first wearable monitors were wrist-worn devices designed to monitor vital signs in medical settings. Some also allowed patients to live independently while having their data transmitted to healthcare professionals who monitored them for risk. These devices are now available as an everyday device for healthy living populations. 'Smart' watches/bands and other 'smart' items can communicate with a smart phone in close proximity. These have superseded the use of smart phones for monitoring physical activity.

There are dozens of brands and models available – among the most popular in 2016 were the Apple Watch, Fitbit and Garmin Vivosmart devices. As well as allowing you to play music, check text messages, email and talk on the phone, many of these devices can also assess physical activity in terms of steps, distance, stride length, energy expenditure, sitting time, heart rate, and minutes working at different intensities.

Some models can 'nudge' you towards a specific daily activity goal, such as total steps, distance or energy expenditure, by gradually and progressively overloading your daily targets. Some models allow you to adjust your goals, some send push notifications to your email or social media via apps. Some models determine whether you have met the physical activity and sedentary behaviour guidelines. Some will even alert you when you have been sitting for a certain amount of time, and some will alert you when you reach your daily goal.

Advantages of 'smart' wearable devices

» Non-invasive
» Can estimate energy expenditure
» Can monitor physical activity remotely
» Allow monitoring of physical activity, physiological functions, daily activities and individual behaviours
» Can integrate miniature sensors that can measure heart rate, skin temperature, ECGs and EEGs
» Allow monitoring and processing in real time, 24 hours per day
» Data transmission via wireless networks allows monitoring from external groups such as healthcare professionals
» Can be worn by an individual as an accessory
» Can be integrated with GPS and music to provide motivation

Limitations of wearable devices

At the time of writing these were some of the issues limiting the use of smart wearable devices to measure physical activities:
» Far more research is required to determine the validity of the devices.
» Many devices are not user friendly.
» High-speed networks are not available everywhere.
» Confidentiality of data is not assured – privacy can be breached.
» Data costs of smart phone use can be high.
» The technology is moving so fast it dates very quickly.

SEDENTARY BEHAVIOUR

Sedentary behaviour is completely independent of physical activity behaviour and includes activities that require around 1 to 2 (or less than 1.6) METs to perform (where 1 MET is the amount of energy you expend at rest and 2 METs is twice that). Research has shown a clear association between sedentary behaviour and various health consequences, as discussed in chapter 10. For example, a high level of television viewing has been linked with excess weight, regardless of the viewer's activity level. Someone who is highly active can also be highly sedentary. Sedentary behaviours such as watching television, commuting by car, using a computer or reading are activities that expend low amounts of energy.

CartoonStock.com / Royston Robertson

Are you a couch potato?

Measurement of sedentary behaviour

The main methods for assessing sedentary behaviour are:

» diaries
» accelerometers
» self- or proxy-reported recall surveys
» direct observation
» inclinometers.

Although these methods can all be used to assess the amount of time a person is sedentary, not all can determine whether someone meets the sedentary behaviour guidelines. The sedentary behaviour guidelines for young people specify no more than two hours per day of using screens for entertainment. Although an accelerometer can assess sedentary time, it can't assess contextual data such as what a screen is being used for.

All these methods allow researchers to record the number of minutes or hours spent in sedentary behaviours each day or week, and to assign appropriate METs. Survey instruments usually ask about multiple sedentary behaviours, such as television viewing, computer use (surfing the net and playing computer games) and reading. Although there are dozens of other sedentary behaviours, screen-based activities and reading are among the most common, and give a good indication of overall time spent in sedentary behaviour.

The main objective measures for assessing sedentary behaviour are accelerometers, inclinometers, direct observation and devices.

» **Accelerometers** can detect low-intensity or sedentary behaviour using movement counts or *g*-forces below a certain threshold, although there is little difference between standing and sitting data, despite a difference in energy expenditure.
» **Inclinometers** are electronic devices that can differentiate between standing and sitting. Although traditionally used in construction and vehicle stability testing, some models can be worn on a person's thigh to measure the amount of time they spend sitting. While you

can be considered sedentary when you are standing, the health consequences associated with sitting for many hours are more detrimental than long hours spent standing.

- **Direct observation** can also be used to assess sedentary behaviour. While this method is useful in school or workplace settings, it is not very practical for use in people's homes.
- **Devices** can also be fitted to computer or television screens to measure usage and viewing time. However, these are rarely used in sedentary behaviour research. The fact that a television is on doesn't mean anyone is watching it. Similarly, a person watching television is not necessarily sedentary – they might also be working out on a treadmill, elliptical machine or stationary bicycle. Measurement of physical activity and sedentary behaviour has been made more complex by the popularity of active electronic games such as Nintendo, Wii Sports and Wii Fit.

QUICKVID

Watch a short video of the author explaining the major points of assessment of physical activity and sedentary behaviour. Log in to http://nelsonnet.com.au using your student code, then go to chapter 11, page 235.

Video

Watch a video of Professor Jo Salmon talking about measuring physical activity and sedentary behaviour via http://nelsonnet.com.au, using your login code. Go to chapter 11, page 235.

Video

If you were designing your own survey to measure sedentary behaviour, you could ask how many minutes or hours the person engages in various behaviours while sitting quietly.

CartoonStock.com / Bradford Veley

After fifteen minutes of inactivity, Ed's operating system automatically returns him to sleep mode.

How would you assess the number of minutes Ed is sedentary during work time?

CHAPTER SUMMARY

- The dimensions of physical activity that are commonly measured are activity type, frequency, intensity and duration.
- The method used to assess physical activity will be determined by whether the goal is to measure physical activity within large-scale populations or among individuals.
- Subjective measures of physical activity rely on a person's recall, whereas objective measures employ the use of a device or another person to assess physical activity.
- Proxy reports are usually completed on behalf of a person unable to reliably or accurately self-report, such as very young children, the elderly or the intellectually disabled.
- Not all subjective and objective measures can assess physical activity dimensions across all domains (such as leisure time, house or garden, active transport and work).
- Objective measures are not associated with the limitations of subjective measures such as social desirability bias, recall or cognitive limitations.
- Although accelerometers can assess sedentary time, they cannot capture context, and therefore cannot be used to assess whether a young person has met the sedentary behaviour guidelines.
- Sedentary means staying in the same place for much of the time and expending low amounts of energy. Someone who is highly active can also be highly sedentary (at other times). Sedentary behaviours such as television viewing, computer use and reading can be assessed using measures similar to those used to assess physical activity.

CHAPTER REVIEW

Multiple-choice questions

1 Which of the following is an example of a subjective measure of physical activity?
   A direct observation
   B pedometer
   C keeping a diary
   D accelerometer

2 Which of the following could be used to assess who an adolescent is being active with during a lunch break within a school setting?
   A accelerometer
   B pedometer
   C inclinometer
   D direct observation

Short-answer questions

3 Outline three reasons for measuring physical activity at a population level.

4 How much physical activity per week is recommended for adults?

5 What is the key difference between uniaxial accelerometers and triaxial accelerometers?

6 Explain two advantages of using an accelerometer rather than a recall instrument to measure the physical activity of an eight-year-old child.

7 State one measure that would be highly appropriate to assess the physical activity of a person with an intellectual disability or a person from a non-English-speaking background.

8 Explain how an individual can be highly sedentary and yet still meet the physical activity guidelines.

SOCIOCULTURAL INFLUENCES ON PARTICIPATION IN PHYSICAL ACTIVITY

12 CHAPTER

Key knowledge

- sociocultural influences on participation in physical activity across the lifespan such as historical, social, cultural, environmental, geographic and personal factors
- enablers of, and barriers to, physical activity behaviours including demographic, social, cultural and environmental factors

Key skills

- investigate and determine factors that influence an individual's participation in physical activity across the lifespan
- analyse sociocultural influences on physical activity participation across the lifespan

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Participation in physical activity is important for improving and maintaining both our physical and mental health. Unit 1 looked at how physical activity can prevent diseases such as type 2 diabetes, cardiovascular disease, osteoporosis, obesity and other musculoskeletal and cardiorespiratory injuries and illnesses. Participation in physical activity can also reduce depression, stress and anxiety, improve self-confidence and self-esteem, and increase your energy levels and sleep quality, improving concentration.

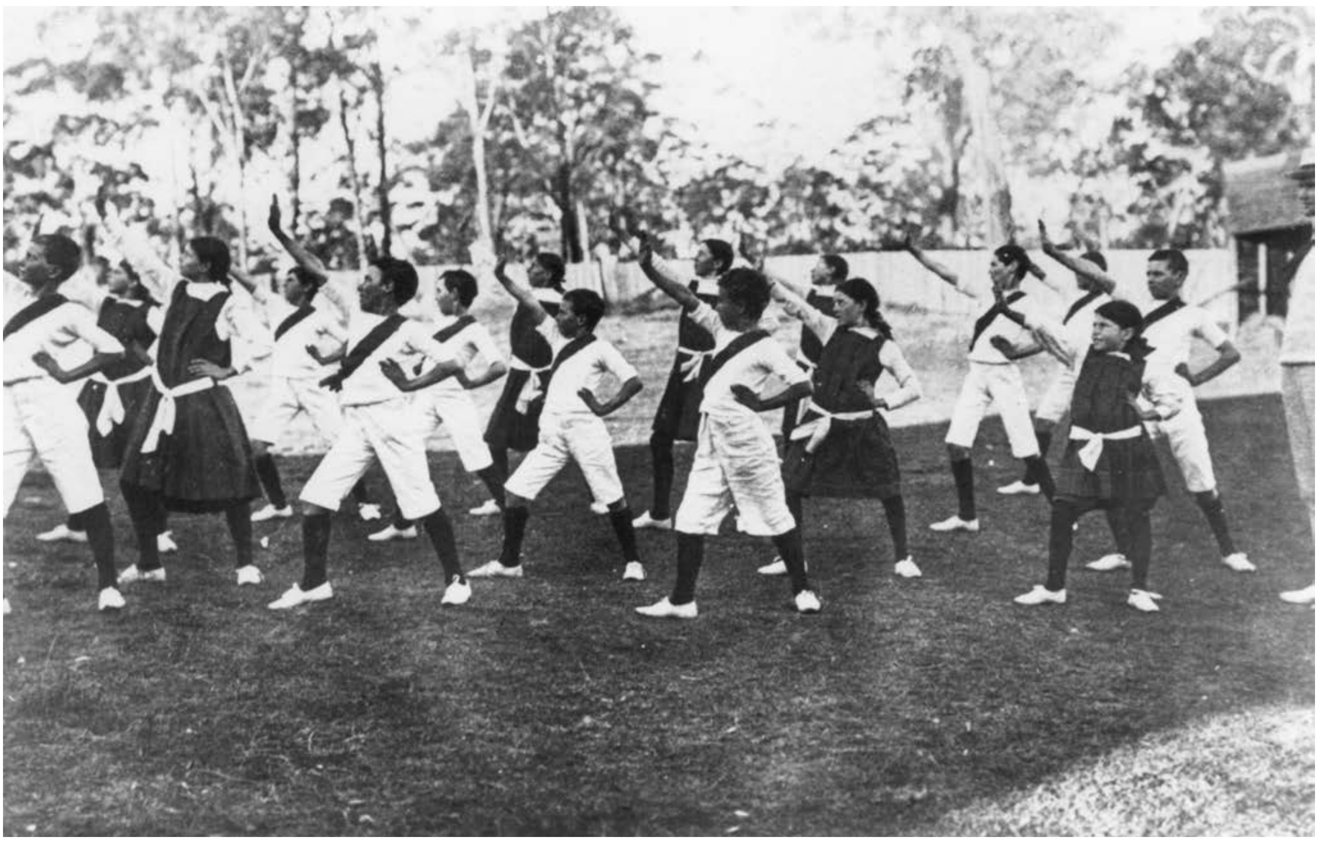
With so many proven benefits, why don't all people participate in regular physical activity? What influences the decision to be physically active? This chapter will look at the influences on, and enablers and barriers to, participation in physical activity.

SOCIOCULTURAL INFLUENCES ON PARTICIPATION

Sociocultural influences on participation in physical activity include historical influences, individual factors and social influences.

Historical influences

Australia's national identity is intertwined with sport and being physically active. The 'great outdoors' presents numerous opportunities to participate in physical activity and sport, and this has influenced the image of the bronzed Aussie and the stereotypical 'sports-mad Australian'. Many events in Australia's short history have influenced the national identity.



Has physical education changed in schools in the last 100 years? This picture shows calisthenics being performed in an Australian school in 1912.

WRITTEN ANALYSIS

'Sport to many Australians is life and the rest a shadow. Sport has been the one national institution that has had no "knockers". To many it is considered a sign of degeneracy not to be interested in it. To play sport, or watch others and to read and talk about it is to uphold the nation and build its character. Australia's success at competitive international sport is considered an important part of its foreign policy.'

The Lucky Country, Donald Horne, 1964

1 What does the author mean by 'knockers'?
2 How does the author interpret the importance of an interest in sport as a national value?
3 How has Australia's success in international competition influenced the perception of Australia as a 'sporting nation'?
4 To what extent do you think this statement accurately reflects Australia in the past, present and future?

WRITTEN ANALYSIS

Weblink

Go to the Australian Government Sport and Recreation website via http://vcepe12.nelsonnet.com.au. The website hosts a number of articles that identify historical and cultural influences on sport and recreation in Australia. Select three different topics and summarise the influence that the person, sport, event or environment has had on shaping Australia's sporting identity. Also consider the influence on participation in physical activity and sport in the past, present and future.

Alamy Stock Photo/Daily Mail/Rex

How did Don Bradman help shape Australia's sporting identity?

Historically, Australia has experienced success in many different sports and competitions, both locally and on the world stage. This includes team sports, individual pursuits and Olympic competition. Despite this, the Australian Sports Commission (2003) found that success in elite sport had little impact on choice of sport and physical activity. The sports that shaped Australia's early success, such as cricket, tennis, football and netball, are not necessarily those chosen by young (and not so young) Australians today. (See chapter 13 for more on participation rates.)

Participation in physical activity has changed dramatically in Australia over the last 50 years. Society has gone from being generally physically active to one that is predominantly sedentary. This chapter will focus on the individual, social, cultural, environmental and geographic factors that influence participation in physical activity.

Social influences on participation in physical activity

Social or interpersonal factors that influence involvement in physical activity include supportive behaviours, social climate and culture. Social environment refers to the people around you: your parents, siblings, peers, work colleagues, health professionals – and even your pets!

Social support can come from a number of different sources. It may come from your family, peers, classmates, work colleagues or teammates. Supportive behaviours can include being active with someone, encouraging others to be active, and providing support to be active, such as by offering transport or financial support.

Shutterstock.com/Kryvenok Anastasiia

Research has shown that people who own a dog walk more and are more likely to achieve sufficient physical activity than those who do not own a dog. Dogs are said to be man's best friend – they're a vital form of social support!

The culture of an organisation is shaped by the nature of the social relationships within it. You may have heard phrases such as 'This school has a strong sporting culture' or 'There is a culture of inactivity within this workplace'.

Changing the culture of an organisation is often very difficult, but a supportive culture is vital to encouraging participation in physical activity. Social relationships provide emotional support, develop expectations, and provide opportunities to take on various roles (coach, umpire, manager). The capacity of people to connect with others in the community enhances their social environment, which may have a positive impact on their participation in physical activity within that community.

Parental support across the lifespan

Your parents play an active role in supporting your involvement in physical activity. This support may include driving you to games and training, paying for fees, uniforms, equipment and membership, providing you with opportunities to be active, and playing with you or supporting and encouraging you when you are active. This role changes as you grow older.

Shutterstock.com/Photographee.eu

Play!

Shutterstock.com/Monkey Business Images

Opportunity!

Getty Images/Yellow Dog Productions

Support!

QUICKVID

Weblink

FLIP YOUR CLASSROOM

The Australian Sports Commission studied parents' attitudes and behaviours towards organised sport and sports clubs. A video clip on the findings can be accessed via http://vcepe12.nelsonnet.com.au.

Before coming to class, watch the video twice. The first time, you should just watch and listen. The second time, make and record three observations from the information presented. Write these three observations down and come to class ready to discuss the findings of the research.

FYI

Tai chi is part of the traditional Chinese culture and promotes health and overall wellbeing.

Cultural influences on participation

Culturally and linguistically diverse population groups are less likely to participate in sufficient physical activity to provide health benefits. People from non-English speaking backgrounds are at a higher risk of being inactive. Certain cultural expectations, obligations and religious beliefs can also restrict opportunities to be physically active.

Australia's migrant population has introduced a wide range of activities; for example, the high levels of participation in soccer in Australia have been partially attributed to the European migrant population.

Image courtesy of Tai Chi Australia, http://www.taichiaustralia.com.au

Tai chi at Federation Square in Melbourne

Environmental influences on participation in physical activity

The physical environment can also influence participation in physical activity. Studies have shown that accessibility of facilities, opportunities for activity, **aesthetics** and, to a lesser extent, safety and weather, all influence physical activity behaviour (Humpel, Owen & Leslie, 2002).

The natural environment includes features such as water (beaches, rivers, lakes), trees, grasslands and bushlands. These places provide aesthetically pleasing environments in which to be active.

Other factors of the natural environment can also influence participation in physical activity, including where you live – the location, the terrain and the infrastructure – and the weather.

Shutterstock.com/Gordon Bell

Crystal clear waters such as these make beaches popular places to swim!

Getty Images/Thinkstock Images

iStock.com/mcouper

The weather can sometimes enhance the experience of being physically active – and can sometimes make it impossible!

Built or constructed environments include buildings, the grounds around buildings, the layout of communities, transportation, infrastructure, parks and trails. The availability of facilities can influence physical activity levels. Having an aquatic centre with well-maintained grounds and grass areas, ample parking, and access by public transport and on walking/cycling paths, may encourage people within the community to be more active.

Community design and land use can also influence physical activity levels within the community. The proportion of land distributed across residential, commercial or institutional uses, or in parks and open spaces, as well as the connectedness and aesthetics of the environment, all influence physical activity. For example, the presence of cycling trails that connect communities can encourage active transport for members of the community.

CHAPTER CHECK-UP

1. Identify three social environmental factors that influence physical activities.
2. Describe how a lack of social support can be a barrier to physical activity for an older person.
3. Suggest three changes to the physical environment in your school that may encourage physical activity.
4. Does close proximity to physical activity facilities guarantee a person's access to these facilities? Discuss.

INVESTIGATION

COMMUNITY AUDIT

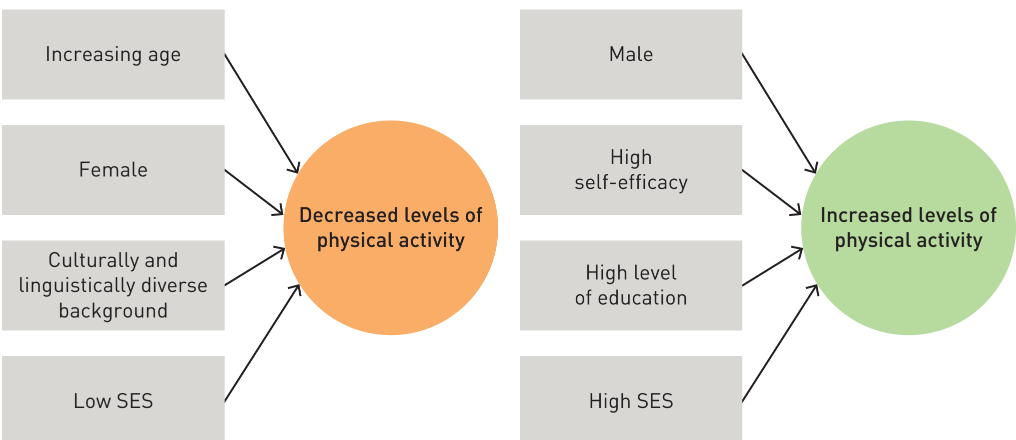
> Identify and locate one recreational facility in your community and answer the following questions:
>
> 1 Is it a natural or built environment?
> 2 How accessible is the facility by foot (e.g. footpaths) or bike (cycling paths)?
> 3 Is there a cost associated with using the facility? If yes, what is the cost?
> 4 What opportunities for physical activity are available in the facility?
> 5 How would you rate the safety of the facility? Consider lighting, crime rates in the neighbourhood, traffic, etc.
> 6 Is the facility aesthetically pleasing? Why/why not?
> 7 Is use of the facility weather dependent?
> 8 Which of these factors (accessibility, aesthetics, safety, weather) are modifiable and which are not? How could you modify one of these factors to increase the likelihood of people using the facility?

Geographic influences on participation in physical activity

Both geography and geographic location can also influence participation in physical activity. The geography of the physical environment refers to the nature and arrangement of places in a given area. Geographic location refers to the position of the area. If the area you live in is particularly hilly (geography), this may influence your decision to ride to school or to a friend's house. If you live in a rural area (geographic location) that is some distance from the town, schools or shops, this may influence your access to sporting facilities.

Individual influences on participation in physical activity

There are a number of individual factors that influence participation in physical activity. Some of these factors are non-modifiable – that is, they cannot be changed. Non-modifiable factors include age, sex, ethnicity or cultural background and genetic or inherited factors. Modifiable factors at the individual level include socioeconomic status (SES), level of education, **self-efficacy** and other cognitive variables.



The influences of individual factors on physical activity levels

Gender

According to the Australian Bureau of Statistics (ABS, 2015), in 2013–14 male and female participation rates in sport and physical recreation were similar, except in the 25–34 age group, where more males (67 per cent) participated in physical activity than females (61 per cent).

However, when looking specifically at vigorous-intensity activity, males tend to be more active than females. Older women, mothers, and women from non-English-speaking backgrounds are less likely to engage in sufficient levels of physical activity for health benefits. Involvement in physical activity is often influenced by cultural beliefs about the gender appropriateness of various forms of physical activity.

WRITTEN ANALYSIS

FLIPPING THE STEREOTYPE ON GENDER

Australian Rules football has long been considered a sport for men, but a number of women are changing that. Women's football in Victoria is the fastest-growing segment of the game, with more girls and women than ever involved in playing, coaching, umpiring and administration.

Weblink

Peta Searle was the first woman to join the senior coaching staff at an AFL club. You can read Peta's story at the AFL Saints' website, or link direct via http://vcepe12.nelsonnet.com.au.

After reading the article, discuss the issues that Peta may have faced in playing and then coaching Australian Rules football throughout her career.

Newspix/Ian Currie

Do you think that gender stereotypes exist in other sports? Provide examples of other sports that have a gender stereotype associated with participation.

FYI

A recent study found that children from lower-income households had more media (TV, DVD player, video games) in their bedroom but less access to play equipment (bikes and jump ropes) than those from higher-income households, meaning that lower SES homes provided more opportunities to be sedentary and fewer opportunities to be active (Tandon et al., 2012).

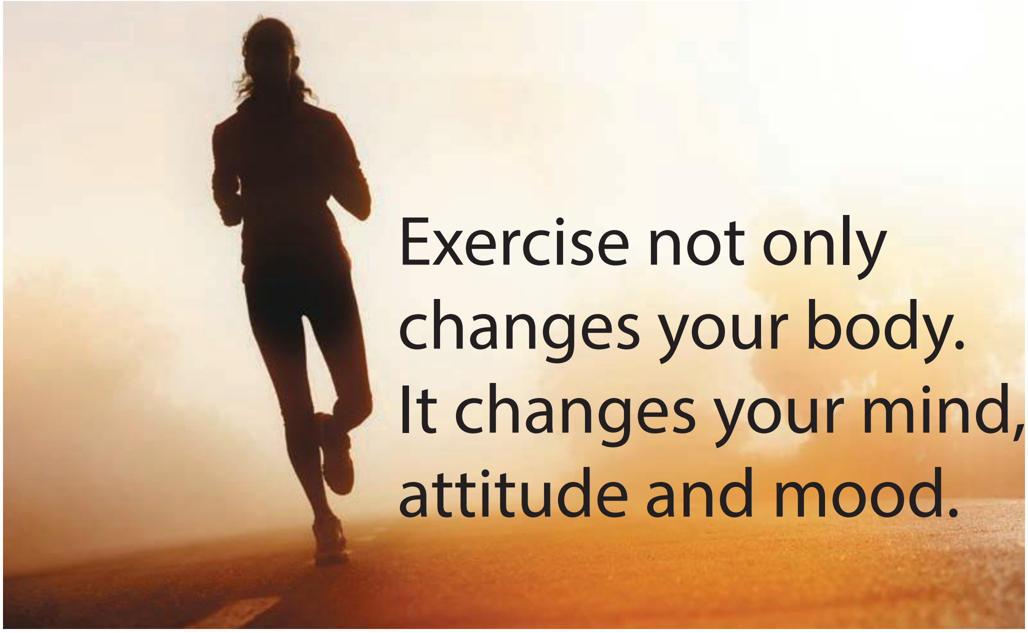
Socioeconomic status

Socioeconomic status affects a number of factors, including, but not limited to, level of education, household income, workforce participation and area of residence. These factors all influence participation rates. Men and women from low socioeconomic groups have lower rates of participation in physical activity. The impact of lower levels of education, lower household income and area of residence is that people in this group, particularly women, participate in insufficient physical activity to benefit their health.

Self-efficacy and other cognitive variables

Some cognitive variables (positive attitude, self-efficacy, enjoyment, expected benefits, intention to exercise) have a positive influence on physical activity. Others (perceived barriers to exercise, depression, negative attitude) have a negative influence. Importantly, these factors are modifiable – they can be changed!

Shutterstock.com/Daxiao Productions



FYI

Research suggests that regular exercise can be effective in preventing depression, and a moderately helpful treatment for mild to moderate depression in adults. It may be as helpful as psychological therapy or antidepressants in preventing or treating mild to moderate depression. Regular exercise alters the brain's chemistry, which leads to a better mood and feelings of wellbeing.

CHAPTER CHECK-UP

1 List four non-modifiable individual influences on physical activity behaviour.
2 Provide an example of how socioeconomic status can influence physical activity behaviour.
3 What is the association between people from non-English-speaking backgrounds and physical activity?
4 Explain how self-efficacy affects physical activity behaviour.

PHYSICAL ACTIVITY: ENABLERS AND BARRIERS

Enablers of physical activity are people or things that make it possible to participate in physical activity. Barriers are obstacles that block or impede access to physical activity. Enablers and barriers can be physical or psychological, perceived or real. They may fall into a number of categories, such as demographic (age, gender, level of education, income, marital status), social, cultural or environmental. Enablers and barriers differ between population groups, as they are specific to the circumstances of a given population. The following examples demonstrate how enablers of physical activity vary across four diverse groups within the population.

Enablers of physical activity

Children

» motor skill competence (locomotor and gross motor skills)
» perceived motor competence
» design of outdoors
» time of the week

Older adults

» social support
» time

People with chronic pulmonary disease

» access to health professionals
» equipment
» social support
» routine and extracurricular activities
» goals and motivation
» 'feeling better' after being active

People from rural locations

» functionality (infrastructure, accessibility/connectivity, distance, safety and continuity of activity)
» diversity
» spaces and places for all
» realistic expectations

Barriers to participation in physical activity

Barriers are those factors that make it difficult to do something. Barriers to participation in physical activity vary depending on the person and the situation. Table 12.1 provides some examples of types of barriers.

TABLE 12.1 Outline of categories and examples of barriers

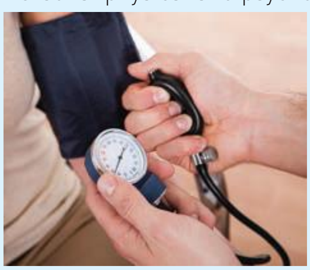
Perceived barrier	Examples
1 Time constraints and competing roles  Shutterstock.com/ Monkey Business Images	Being a parent, spouse or partner Caring for family members Occupational roles Roles within relationships (e.g. picking up groceries, collecting children from school, completing chores around the home/garden)
2 Personal physical and psychological health  Shutterstock.com/Andrey_Popov	Chronic diseases including diabetes, hypertension, arthritis, chronic pain, depression, back pain or injury
3 Individual (internal) factors  iStock.com/AntonioGuillem	Lack of self-efficacy, motivation, determination or interest Lack of energy, due to fatigue or lethargy Health problems Lack of social support from family, spouse, partner or friends Body weight or perception of appearance

TABLE 12.1 Outline of categories and examples of barriers *(continued)*

Perceived barrier	Examples
4 External factors 	Lack of local activity facilities, or transport to key destinations (e.g. fitness centre, shops, parks, beach) Cost of programs and access to facilities Poor weather, hilly terrain or lack of safety

Shutterstock.com/ TinnaPong

The main reported barriers to physical activity are:

- lack of time
- dislike of exercise
- feeling too tired
- lack of company
- lack of money.

Other factors that impact on participation in physical activity include injury or disability, lack of enjoyment, health issues and feeling self-conscious.

Barriers across the lifespan

Just as some factors can be a positive influence for one person and a barrier for another, barriers can also vary for an individual across their lifespan. Some examples are shown in table 12.2. Personal circumstances change throughout life, as do priorities. Certain periods within your life are known as transition periods. Key transitions include the transition from primary school to secondary school, from secondary school to TAFE/university or the workplace, from further study/training to full-time work, from being single to living with a partner, having a baby or even retirement. These transitions can be stressful and may trigger behaviours that are not good for your health, such as unhealthy eating, lack of sleep or lower levels of physical activity.

TABLE 12.2 Barriers to being fit, across the lifespan

Age group	Barriers
Young children	Competitive sports Highly structured activities
Teenagers and young women	Negative experiences at school Peer pressure Identity conflict Sports uniforms Boys' dominance in class Competitive classes Lack of teacher support
Adults	Negative school experiences Anxiety in unfamiliar surroundings Lack of social network Identity conflict Lack of role models
Older adults	Unclear guidelines Limited resources Access (transport) Pain/illness Lack of social support Lack of role models

FYI

Increased car ownership and use, and safety concerns, have led to less walking and cycling. Follow the link to an article about why Australian children are less likely to ride or walk via http://vcepe12.nelsonnet.com.au

Weblink

Barriers according to type of physical activity

The barriers to participation in physical activity may be different depending on the activity. For example, the barriers to walking may be different from the barriers to more vigorous activities such as jogging. Walking is considered accessible to all because it is a lifestyle physical activity that does not require expensive equipment or a high level of fitness. Walking can be planned or spontaneous and does not cost anything.

Commonly cited barriers to vigorous physical activity include:

» feeling self-conscious
» lack of energy
» the discomfort associated with strenuous exercise
» lack of financial resources.

DATA ANALYSIS

The quiz below lists reasons that people give for not being as physically active as they think they should be. Read each statement in the quiz and indicate how likely you are to agree, using the digital version of this table at http://nelsonnet.com.au. You will need your login code.

Scaffold

BARRIERS TO BEING ACTIVE QUIZ

	How likely are you to say ...	Very likely	Somewhat likely	Somewhat unlikely	Very unlikely
1	My day is so busy now. I just don't think I can make the time to include physical activity in my regular schedule.	3	2	1	0
2	None of my family members or friends likes to do anything active, so I don't have a chance to exercise.	3	2	1	0
3	I'm just too tired after work to get any exercise.	3	2	1	0
4	I've been thinking about getting more exercise, but I just can't seem to get started.	3	2	1	0
5	I'm getting older so exercise can be risky.	3	2	1	0
6	I don't get enough exercise because I have never learnt the skills for any sport.	3	2	1	0
7	I don't have access to jogging trails, swimming pools, bike paths etc.	3	2	1	0
8	Physical activity takes too much time away from other commitments – like work, family, etc.	3	2	1	0
9	I'm embarrassed about how I will look when I exercise with others.	3	2	1	0
10	I don't get enough sleep as it is. I just couldn't get up early or stay up late to get some exercise.	3	2	1	0
11	It's easier for me to find excuses not to exercise than to go out and do something.	3	2	1	0
12	I know of too many people who have hurt themselves by overdoing it with exercise.	3	2	1	0
13	I really can't see myself learning a new sport at my age.	3	2	1	0
14	It's just too expensive. You have to take a class or join a club or buy the right equipment.	3	2	1	0

	How likely are you to say ...	Very likely	Somewhat likely	Somewhat unlikely	Very unlikely
15	My free times during the day are too short to include exercise.	3	2	1	0
16	My usual social activities with family or friends do not include physical activity.	3	2	1	0
17	I'm too tired during the week and I need the weekend to catch up on my rest.	3	2	1	0
18	I want to get more exercise, but I just can't seem to make myself stick to anything.	3	2	1	0
19	I'm afraid I might injure myself or have a heart attack.	3	2	1	0
20	I'm not good enough at any physical activity to make it fun.	3	2	1	0
21	If we had exercise facilities and showers at work, then I would be more likely to exercise.	3	2	1	0

Source: www.cdc.gov/diabetes/ndep/pdfs/8-road-to-health-barriers-quiz-508.pdf

SCORING

Follow these instructions to score yourself:

1 Enter the circled number in the spaces provided, putting the number for statement 1 on line 1, statement 2 on line 2, and so on.
2 Add the three scores on each line. Your barriers to physical activity fall into one or more of seven categories: lack of time, social influences, lack of energy, lack of willpower, fear of injury, lack of skill, and lack of resources. A score of 5 or above in any category shows that this is an important barrier for you to overcome.

______ 1	+	______ 8	+	______ 15	=	______ Lack of time
______ 2	+	______ 9	+	______ 16	=	______ Social influence
______ 3	+	______ 10	+	______ 17	=	______ Lack of energy
______ 4	+	______ 11	+	______ 18	=	______ Lack of willpower
______ 5	+	______ 12	+	______ 19	=	______ Fear of injury
______ 6	+	______ 13	+	______ 20	=	______ Lack of skill
______ 7	+	______ 14	+	______ 21	=	______ Lack of resources

Demographic barriers – males and females

Many men and women feel self-conscious about exercising or being physically active in front of others. Entering an unfamiliar setting, such as a gym, can cause some anxiety. Some women feel more comfortable exercising in front of other women – this has led to the popularity of women-only gyms such as Fernwood and Curves.

Many women (and some men) hold multiple roles, and research has shown that these competing demands are a huge barrier to engaging in regular physical activity. These demands include being in paid employment, caring for children, and completing household chores, all in the same week, every week.

Social barriers – lack of social support

Social support has a positive influence on physical activity in general. Having someone to go for a walk, play sport or go for a ride with has an important influence on participation. People who feel isolated due to age, geographic location, or cultural or linguistic differences may not feel safe or confident participating in physical activity alone. Lack of social support can be a barrier to participation at all ages, from young children to the elderly.

Cultural barriers – Indigenous Australians

Indigenous Australians are at a higher risk of being inactive than non-Indigenous Australians. This may be due to the fact that for some Aboriginal and Torres Strait Islander people, physical activity is not thought of in the same way as for non-Indigenous Australians. Traditional activities, such as hunting, gathering and participation in customs, are important and have been linked to health aspects of life, social structure, education, building and maintaining relationships, building and maintaining wealth, and managing and preserving the environment.

AAP Image/Paul Miller

The National Aboriginal Sporting Chance Academy works with young Aboriginal people to empower them through health, education, sport and cultural programs. The program uses elite athletes as role models, and engages with business partners and sporting organisations to deliver positive programs and measurable outcomes. Find out more at the NASCA website, or link direct via http://vcepe12.nelsonnet.com.au.

Weblink

A cultural barrier to physical activity for Indigenous Australians is the importance of family and friends. Many Indigenous people prefer to spend time with loved ones, rather than exercising alone for personal benefit or for health reasons.

Other common barriers to physical activity for Indigenous Australians include:

- » the relative scarcity of sports facilities and healthcare providers in remote areas
- » the experience of racism. Indigenous Australians are twice as likely to be victims of racism as non-Indigenous Australians
- » low incomes, which mean less money to spend on physical activity opportunities
- » limited access to public transport, making it hard for those living in remote areas to get to physical activity venues and programs.

Sporting and recreational environments need to ensure that they are culturally inclusive and that the environment is safe and supportive for everyone.

PRACTICAL ACTIVITY

KEENTAN

'Keentan' is a traditional Indigenous running, passing and catching team keep-away game.

BACKGROUND

A keep-away game of catch-ball was played by both genders in the north-west central districts of Queensland. Because the action of the players jumping up to catch the ball resembled the movements of a kangaroo, the Kalkadoon people sometimes described this game as the 'kangaroo-play'. The ball itself was made from possum, wallaby or kangaroo hide tied up with twine.

PLAYERS

- » Teams of four to eight players

PLAYING AREA

- » A designated area suitable for the activity

EQUIPMENT

- » A ball such as a size 3 football (soccer ball) or gator skin ball.

Australian Sports Commission, artist Glenn Robey

>

> **GAME PLAY AND BASIC RULES**
>
> The ball is thrown from one player to another player on the same team. The players on the opposing team attempt to intercept the ball while they are off the ground (only a small jump is needed). The ball is only gained it if is caught while the defender is in the air.
>
> If the ball is dropped or knocked to the ground by a player attempting to catch it, the other team gains possession. A change in possession also occurs when a thrown ball falls to the ground untouched. No physical contact is allowed.
>
> Players cannot stop opposing players from moving around the area – no interference is allowed. Passes must be a minimum of 3 metres.
>
> The player in possession of the ball may run around the playing area for up to 5 metres. This player cannot be guarded (marked) or obstructed while he or she is attempting to pass the ball – the defender must be at least 1 metre away.
>
> Source: http://www.ausport.gov.au

Environmental barriers

A major barrier to being physically active is the physical environment, in particular the built (man-made) environment. New housing areas are commonly laid out in a cul de sac formation, in contrast to the traditional grid network. A cul-de-sac design (see below) generally has poor connectivity, which makes walking directly to specific destinations very difficult. Studies have shown that adults are more likely to walk if they can access a variety of places within 400 metres.

Shutterstock.com/trekandshoot

Alamy Stock Photo/redbrickstock.com

Traditional grid networks (right) have greater connectivity for walking than cul-de-sac designs (left).

Physical activity is also affected by the provision of footpaths, safety measures such as pedestrian crossings, traffic volume, calming devices and speed limits and mixed land use, including green spaces.

REAL WORLD APPLICATION

Physical activity in Western Australia

In Western Australia, a physical activity task force was set up to 'review emerging trends and issues, analyse current policies and delivery frameworks and set a vision and strategic framework for physical activity in this state' (Diagnosis of Physical Activity in Western Australia, 2011).

The task force found a number of enablers and barriers specific to Western Australia. Read the report, 'Diagnosis of physical activity in Western Australia', commissioned by the Western Australian government's physical activity taskforce, via http://vcepe12.nelsonnet.com.au (enablers and barriers can be found on pages 40–9).

Weblink

Question

From the report, list the enablers and barriers that are specific to Western Australia and then compare these to your perceptions of enablers and barriers to physical activity in Victoria, identifying similarities and differences.

CHAPTER CHECK-UP

1 Discuss how motor skill competence may enable children to participate in physical activity.

2 Identify two physical environmental factors that have a convincing association with adult physical activity.

3 The main reported barriers to physical activity are:
- lack of time
- dislike of exercise
- feeling too tired
- lack of company
- lack of money.

Suggest a strategy that could be implemented at the individual level for a 16-year-old student to overcome each of these barriers.

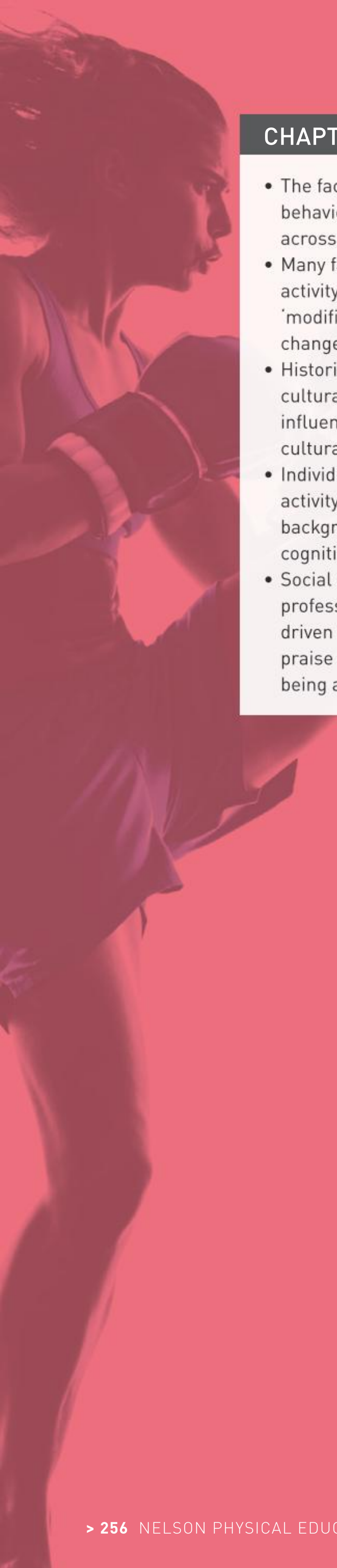
4 Lack of role models has been identified as a barrier to physical activity for adults and older adults. Suggest reasons why this may not be a barrier for children and young people.

Influences on physical activity across the lifespan, and the enablers of, and barriers to, physical activity, will change based on specific circumstances and contexts. Parental support may not be as important at 25 years of age as it was at 15. Social support from peers may be of greater influence for teenage boys than for middle-aged men, but just as important for older adults. It is important to remember that these factors are often interrelated; for example, access to some physical activity opportunities will be influenced by cost. An understanding of the influences, enablers and barriers to physical activity allows strategies and intervention programs to be tailored to specific groups and settings, such as individuals, workplaces, schools and communities. Chapter 14 will look at these strategies and interventions in more detail.

REAL WORLD APPLICATION

Video

Watch a quick video interview with Professor Jo Salmon about factors influencing physical activity. Log in to http://nelsonnet.com.au using your code. Go to chapter 12, page 255.



CHAPTER SUMMARY

- The factors influencing physical activity behaviours are very complex and vary across the lifespan.
- Many factors that influence physical activity participation are considered 'modifiable' and can be targeted for change within intervention programs.
- Historical influences can shape the cultural identify of a population and influence stereotypes and perceptions of cultural 'norms'.
- Individual factors that influence physical activity include age, sex, cultural background, SES, self-efficacy and other cognitive variables.
- Social support (family, peers, health professionals) can range from being driven to sporting venues to receiving praise and encouragement for being active.
- Physical environmental factors can facilitate or hinder physical activity. Physical environmental factors in both the natural and constructed environments include access to facilities, opportunities to be active, aesthetics of the environment, safety and weather.
- Barriers can differ depending on the type of physical activity. The barriers to walking are different from the barriers to more vigorous activity, such as jogging.
- Demographic, social, cultural and environmental enablers of physical activity may be different for different people. What might be an enabler for one person may be a barrier for another.
- Aboriginal and Torres Strait Islander people and people living in rural and remote communities are at higher risk of being inactive.

CHAPTER REVIEW

Multiple-choice questions

1 Generally, factors influencing physical activity behaviour are:
   - A generic across all age groups
   - B varied according to age group and context
   - C consistent across all contexts
   - D not related to age, gender or socioeconomic status.

2 Which of the following influences would not be considered an environmental factor?
   - A social factors
   - B age
   - C dog ownership
   - D constructed environment

3 Which of the following factors would encourage walking as a form of physical activity?
   - A walking groups (school or community based)
   - B lighting on walking paths
   - C connected communities
   - D all of the above

Short-answer questions

4 Can the same factor be an enabler for one person and a barrier for another? Explain in your own words, and provide an example.

5 Identify three individual influences on participation in physical activity.

6 Describe what self-efficacy is and how it relates to physical activity.

7 Environmental influences may be within the physical or the social environment. Outline three examples of each.

8 a Social support can be provided to a child in many forms. Give three examples.
   b Describe the link between dog ownership and physical activity behaviour.

9 a Explain what is meant by a barrier.
   b Describe how the competing roles of a student juggling part-time work, study and family commitments can be a barrier to physical activity. Suggest three ways to overcome these barriers so that more physical activity can be included in the day/week.
   c Outline three factors that are external barriers to physical activity.

10 State three commonly reported barriers to vigorous physical activity.

11 a Identify why Indigenous Australians are more likely to be inactive than non-Indigenous Australians.
   b Think about some of the people you know who are aged over 65 years, and describe four potential barriers that they may need to overcome in order to be active on a regular basis.
   c Provide three examples of barriers to children being active. Explain one of these examples.

12 a Patrick is eight years old. He has a trampoline and a pool in his backyard, has a bike and a scooter, and plays cricket, football and tennis. Both of Patrick's parents are physically active themselves, and support his activity by paying his fees, buying uniforms and equipment and driving him to venues. Identify the physical activity enablers for Patrick and explain how they have influenced his participation. Use correct terminology in your answer.
   b Children who are active are more likely to be active adults. Discuss this statement.

13 Kimiko recently moved to Australia from Japan. When she lived in Japan, Kimiko was a keen distance runner, but she has found it difficult to start running again since settling in Australia. She speaks limited English, has two young children and is caring for her elderly mother-in-law. Identify the barriers that Kimiko faces to being active, and suggest ways she may be able to increase her physical activity levels.

CHAPTER 13

PREVALENCE AND TRENDS IN PHYSICAL ACTIVITY, SPORT AND SEDENTARY BEHAVIOUR IN THE POPULATION

Key knowledge

- » prevalence and trends of physical activity, sport and sedentary behaviour in the population

Key skills

- » collect, analyse and interpret primary and secondary data relating to trends in participation in physical activity

iStock.com/OSTILL

HOW ACTIVE ARE AUSTRALIANS?

As discussed in chapter 10, an important role of governments is to set national physical activity guidelines and monitor what proportion of the population meets these guidelines. The dangers of high levels of sedentary behaviour to overall **health** have also been recognised in relation to chronic disease and obesity (see chapter 10).

National monitoring and surveillance of physical activity levels allows public health bodies and organisations such as the Australian Bureau of Statistics, Australian Sports Commission and Commonwealth Department of Health to systematically observe patterns and trends in physical activity levels and participation rates in organised sports. It also provides an opportunity to compare activity levels among subgroups of the population with the incidence of specific diseases, including type 2 diabetes, cancer and obesity. This increases our understanding of the causes of disease, enabling us to develop policies and programs aimed at preventing disease. Monitoring at a national level can also identify influences on physical activity and evaluate the effectiveness of community-wide education programs that promote physical activity. The following section describes the physical activity patterns among various groups based on research at the population level.

Our lifestyles require us to do a lot of sitting. Many activities that in the past required standing and moving have been replaced by sedentary activities. Many people spend their days moving from bed to a chair, to another chair, to the car, back to a chair and then back to bed, with minimal incidental activity in between. Despite growing awareness of the poor health outcomes associated with inactivity and long periods of sitting, ABS data for 2013 indicates that around a third of the adult population engage in more than five hours of sedentary leisure per day. The Australian Health Survey revealed adults spend 39 hours per week sedentary, with at least 10 of those hours sitting at work. Workers based in an office or sedentary occupations average 22 hours per week sitting for work.

PREVALENCE AND TRENDS IN PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

National level surveys are not done every year, as they are a costly exercise. At the time of writing, the largest and most comprehensive survey assessing physical activity and sedentary behaviour was the 2011–13 Australian Health Survey (AHS), which collected information on a range of health data. This chapter will focus on the findings regarding physical activity and sedentary behaviour (including screen-based activity), screen-based equipment and household rules and pedometer steps.

At the time the AHS data was collected and analysed, the national physical activity and sedentary behaviour guidelines in Australia were slightly different to the current guidelines. Table 13.1 summarises the data on physical activity and sedentary behaviour from the 2011–13 AHS. The AHS collected data on the following aspects, based on what subjects had undertaken in the week prior to the interview:

» Walking for transport
» Walking for fitness
» Moderate and vigorous physical activity for fitness
» Recreation or sport

» Sitting at work
» Sitting for transport
» Sitting or lying down for other social or leisure activities.

At the time the AHS was collected, the adult physical activity guidelines specified 150 minutes of physical activity over five or more sessions per week. There were no sedentary behaviour guidelines at that time.

REAL WORLD APPLICATION

We're still a nation of Norms

Australian Bureau of Statistics media release, 23 November 2013

It's been 35 years since Norm, the beer-swilling couch potato, climbed off his couch and declared 'Life. Be in it', but the majority of adult Australians still do not meet the recommended levels of physical activity, according to the Australian Bureau of Statistics (ABS).

National activity guidelines recommend adult Australians undertake at least 150 minutes of physical activity per week over five or more separate sessions.

The 2011–12 National Nutrition and Physical Activity Survey found that only 43 per cent of adult Australians met these guidelines. A higher proportion of males (45 per cent) met the guidelines compared with females (41 per cent).

The Australian Capital Territory had the highest proportion of its population (almost 50 per cent) meeting the national guidelines. The Northern Territory recorded the lowest proportion (37 per cent).

ABS Director Andrew Middleton said that, along with poor nutrition, sedentary behaviour and lack of physical activity are key factors associated with obesity and being overweight.

Couch potato 'Norm' was the main character of a series of television advertisements for the 'Life. Be in it.' campaign that began in the 1970s.

'One in five Australian adults exercise at very low levels, or not at all.'

'The level of physical activity among adult Australians varied according to age, income, education level and socioeconomic status. Australians living in higher income households were more likely to meet the national guidelines (52 per cent) compared with those living in lower income households (34 per cent),' said Mr Middleton.

Young Australians aged 18–24 years were more likely to meet the national guidelines (53 per cent) than any other age group. By comparison, only one in four Australians aged 75 years and older met the national guidelines.

Proportion of adult Australians who meet national physical guidelines, 2011–12

State/Territory	%
Australian Capital Territory	49.5
New South Wales	44.9
Western Australia	44.6
Victoria	43.4
Tasmania	40.5
Queensland	40.1
South Australia	38.8
Northern Territory	37.2

Questions

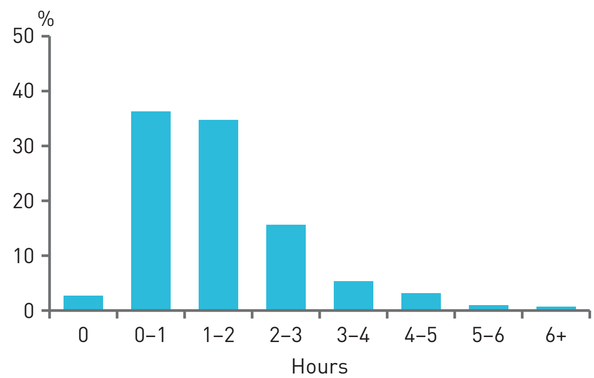
1 Which state or territory has the highest proportion of adults meeting the physical activity guidelines in Australia?
2 Which state or territory has the lowest proportion of adults meeting the physical activity guidelines in Australia?
3 What age group is the most active population sub-group?

TABLE 13.1 A summary of the physical activity and sedentary behaviour data for 2011–13

	Physical activity (PA)	Sedentary behaviour
2–4 year olds	» Averaged 6.2 hours (372 minutes) per day in PA » 47% of PA from outside activities » Qld and NT spent more time outdoors (3 hours 27 minutes and 4 hours, respectively, compared to the national average of 3 hours) » 72% were physically active for 3 hours per day on all 7 days prior to interview, therefore meeting the PA guidelines	» Averaged 1.5 hours (83 minutes) per day in sedentary activities, watching TV/DVD or playing computer games » 43% averaged no more than 60 minutes per day over the week » Only 1 In 4 (26%) met the screen-based activity for recreation target on all 7 days prior to the interview » 16% had at least one item of screen-based equipment in bedroom, such as a TV, computer or game console. These children averaged an extra 22 minutes per day engaged in screen-based activities and were twice as likely to exceed the 1 hour maximum screen time recommended per day for this age group.
5–17 year olds	» Averaged 1.5 hours (91 minutes) per day in PA » Just over 60% averaged at least 60 minutes per day » 1 in 5 (19%) doing recommended 60 minutes per day across all 7 days prior to interview » Almost half (48%) met the recommended 60 minutes per day on at least 5 out of the 7 days	» Averaged 2.5 hours (136 minutes) per day in sedentary behaviour » Averaged 6 minutes screen time use for homework per day » Less than 1 in 3 (29%) met the 'no more than 120 min utes of screen-based entertainment' target per day on all of the previous 7 days » 59% met the recommendation on at least 5 out of the 7 days
18+ year olds	» Averaged 33 minutes per day of PA » 60% reported doing less than 30 minutes » Fewer than 20% did 60+ minutes per day on average » 43% met the 'sufficiently active' target (59% males and 48% females) » 18–24 year olds were the most active (males averaged 46 minutes and females 32 minutes per day) » Levels generally declined with increasing age » Only 33% of males and 20% of women over 75 years were sufficiently active	» Sedentary leisure made up just over 4 hours per day on average » Almost 30% reported 5+ hours per day of sedentary leisure

Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity*, 2011–12, cat. no. 4364.0.55.004, viewed March 2016

According to the AHS (2011–12), children aged 5–17 years averaged 91 minutes of physical activity per day, and 60 per cent managed at least one hour per day. However, less than 30 per cent of young people met the recommended 60 minutes per day across all seven days prior to the interview, and only 48 per cent met the recommendation on at least five days a week.



Children 5–17 years: Average daily duration of physical activity, 2011–12

Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity*, cat. no. 4364.0.55.004, viewed 6 June 2016

Alamy Stock Photo / Angela Hampton Picture Library

The AHS found that children aged 2–4 years who had at least one item of screen-based equipment in their bedroom, such as a TV, computer or game console, averaged an extra 22 minutes per day engaged in screen-based activities and were twice as likely to exceed the 1 hour maximum screen time recommended per day for this age group.

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The AHS found that the average duration of physical activity for adults was just 33 minutes per day

REAL WORLD APPLICATION

Global report card on physical activity for children and youth

'The Active Healthy Kids Canada (AHKC) Report Card on Physical Activity for Children and Youth' evaluated prevalence of physical activity, priorities, policies and practice. This process was replicated in 14 other countries across five continents using nine common indicators:

- overall physical activity
- organised sport participation
- active play
- active transportation
- sedentary behaviour
- family and peers
- school
- community and built environment
- government strategies and investments.

In May 2014 the 15 report cards from around the world were presented at the Global Summit on the Physical Activity of Children held in Canada. Table 13.2 displays a matrix of the findings by assigning a grade to each country based on each of the nine common indicators. Overall physical activity and sedentary behaviour was based on the proportion of children meeting the guidelines. The global report card revealed a global crisis – overall, the proportion of children meeting the physical activity guidelines was low and was rated poor. For several indicators there was insufficient information available to assign a grade. As you might anticipate, low-income countries tended to have better grades in general for sedentary behaviour than higher income nations. In contrast, higher income countries had higher grades for the community and built environment indicator. Interestingly, countries with better infrastructure had lower PA and higher SB compared to countries with poorer infrastructure, which had higher PA and lower SB. The table below displays the grading framework used within the report card process. The report card for Australia can be found via http://vcepe12.nelsonnet.com.au.

Weblink

TABLE 13.2 Grading framework for the report card (Canada)

Grade	Interpretation
A	We are succeeding with a large majority of children and youth (>80%)
B	We are succeeding with well over half of children and youth (60–79%)
C	We are succeeding with about half of children and youth (40–59%)
D	We are succeeding with less than half, but some, children and youth (20–39%)
F	We are succeeding with very few children and youth (<20%)

TABLE 13.3 GLOBAL MATRIX PRESENTED IN RANK ORDER BY GRADE

Note: The grade for each indicator is based on the percentage of children and young people meeting a defined benchmark. No grade was assigned when the data was considered to be incomplete.

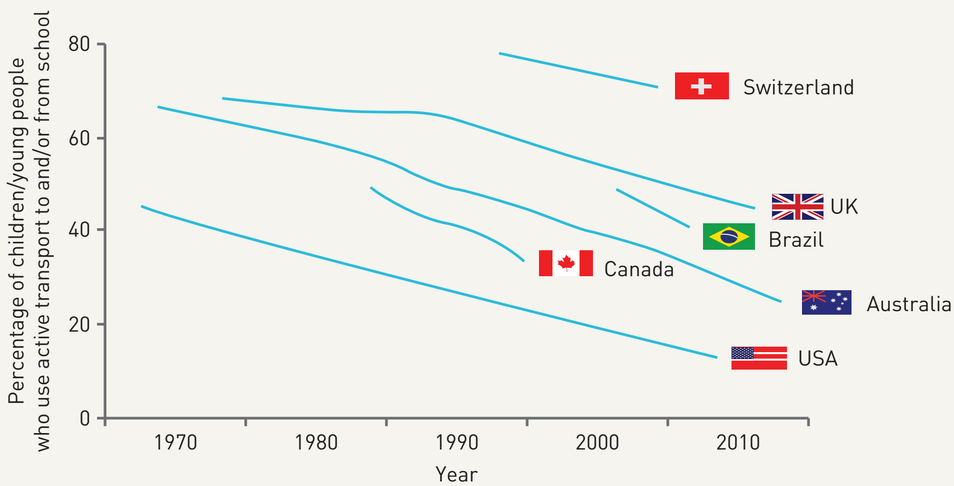
Grade	Overall physical activity	Organised sport participation	Active play	Active transport	Sedentary behaviours	Family and peers	School	Community and built environment	Government strategies and investments
A 81–100%							England (A-)	Australia (A-)	
B 61–80%	Mozambique New Zealand	New Zealand Australia (B-)	New Zealand	Finland Kenya Mozambique Nigeria Mexico (B-)	Ghana Kenya		Finland Australia (B-) New Zealand (B-)	Canada (B+) England Finland Ireland Scotland USA (B-)	Colombia Finland Scotland South Africa
C 41–60%	Mexico (C+) Kenya Nigeria	Canada (C+) Finland Ghana Kenya South Africa England (C-) Ireland (C-) USA (C-)	Kenya Mozambique Nigeria (C-)	England Scotland South Africa New Zealand (C-)	New Zealand Ireland (C-)	Australia Canada Finland Kenya New Zealand	Canada (C+) Kenya Mozambique Ireland (C-) USA (C-)	New Zealand (C-)	Australia (C+) Canada Kenya Mexico Mozambique

TABLE 13.3 GLOBAL MATRIX PRESENTED IN RANK ORDER BY GRADE *(CONTINUED)*

Grade	Overall physical activity	Organised sport participation	Active play	Active transport	Sedentary behaviours	Family and peers	School	Community and built environment	Government strategies and investments
D **21–40%**	England (D+) Colombia Ghana Finland South Africa Australia (D-) Canada (D-) Ireland (D-) USA (D-)	Colombia Mexico	Finland	Australia Canada Ghana Ireland	Colombia Finland Mexico USA Australia (D-)	Scotland (D-)	Ghana Mexico South Africa	Ghana South Africa	Ghana
F **0–20%**	Scotland	Mozambique		USA	Canada Nigeria Scotland South Africa		Colombia	Mexico Mozambique	

Source: Mark S. Tremblay et al., 2014, 'Physical Activity of Children: A Global Matrix of Grades Comparing 15 Countries', JPAH, Volume 11, Supplement: 2014 Global Summit on the Physical Activity of Children

Time trends in the percentage of children and young people who use active transport to and/or from school



Source: Active Healthy Kids Australia, 2015, *The Road Less Travelled: The 2015 Active Healthy Kids Australia Progress Report Card on Active Transport for Children and Young People,* Adelaide, South Australia: Active Healthy Kids Australia.

The report card for Australian children was generally very poor across all areas. Participation in organised sport was the most acceptable area, with two thirds of young people aged 5–17 years participating in organised sport.

OVERALL PHYSICAL ACTIVITY LEVELS: D-

- 19% of Australians aged 5–17 years and 15% of Australians aged 12–17 years meet the recommended Australian physical activity guidelines of accumulating at least 60 minutes of MVPA every day of the week.
- 17% of Australians aged 5–17 years are accumulating at least 12 000 steps per day. It has been reported that 60 minutes of MVPA per day can be approximated to 12 000 steps per day for children and young people.
- 72% of Australian parents report that their children aged 2–4 years meet the recommended Australian physical activity guidelines by accumulating at least 180 minutes of physical activity each day.

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ACTIVE PLAY

- According to parents, 78% of Australians aged 5–17 years participated in non-organised physical activity over the past week.
- According to parents, Australians aged 2–4 years play outdoors an average of 174 minutes every day.

ACTIVE TRANSPORT: D

- 20% of secondary school students (aged 12–17 years) travel to and/or from school using active transport at least once per week.
- According to parents, 35% and 39% of primary school students aged 6–7 and 11–12 years, respectively, travel to and/or from school using active transport at least once per week.

ORGANISED SPORT AND PHYSICAL ACTIVITY PARTICIPATION: B-

- 64% of Australians aged 5–17 years participated in organised sport or physical activity over the past 7 days.
- 66% of Australians aged 5–14 years participated in organised sport over the past 12 months.

SEDENTARY BEHAVIOURS: D-

- 26% of Australians aged 2–4 years meet the recommended Australian screen time guidelines of accumulating no more than 1 hour per day.
- 29% of Australians aged 5–17 years meet the recommended Australian screen time guidelines of accumulating no more than 2 hours per day.
- 20% of Australians aged 12–17 years meet the recommended Australian screen time guidelines of accumulating no more than 2 hours per day.

PHYSICAL EDUCATION AND PHYSICAL ACTIVITY PARTICIPATION IN SCHOOLS

- 71% of Australian secondary school students (aged 12–17 years) participated in at least 120 minutes of physical education at school per week during both summer and winter school terms.
- 78% of Australian secondary school students (aged 12–17 years) participated in physical education on two or more days per week during both summer and winter school terms.

Source: Active Healthy Kids Australia, 2014, *Is Sport Enough? 2014 Report Card on Physical Activity for Children and Young People*, Adelaide, South Australia: Active Healthy Kids Australia

Questions

1 Draw a graph and plot the data from Table 13.3 for overall physical activity by country, from A+ to F.
2 Highlight where Australia sits on the continuum.
3 Outline the physical activity and sedentary behaviour guidelines for Australia.
4 Identify in which indicators Australia rated (a) poorly and (b) well compared to other countries.
5 a Refer to the graph on page 264 showing the changes in the percentage of children and young people who use active transport to and/or from school. Decribe the trend in children's active transport use globally over the past 40 years.
  b Discuss how Australia compares to other nations in relation to active transport.
6 Refer to this page and the previous page. What proportion of Australian children aged 5–17 years:
  a met the Australian physical activity guidelines?
  b met the Australian sedentary behaviour guidelines?
  c participate in organised sport?
  d use active transport?

QUICKVID

Watch a video of Professor Jo Salmon talking about physical activity patterns across the lifespan via http://nelsonnet.com.au, using your login code. Go to chapter 13, page 265.

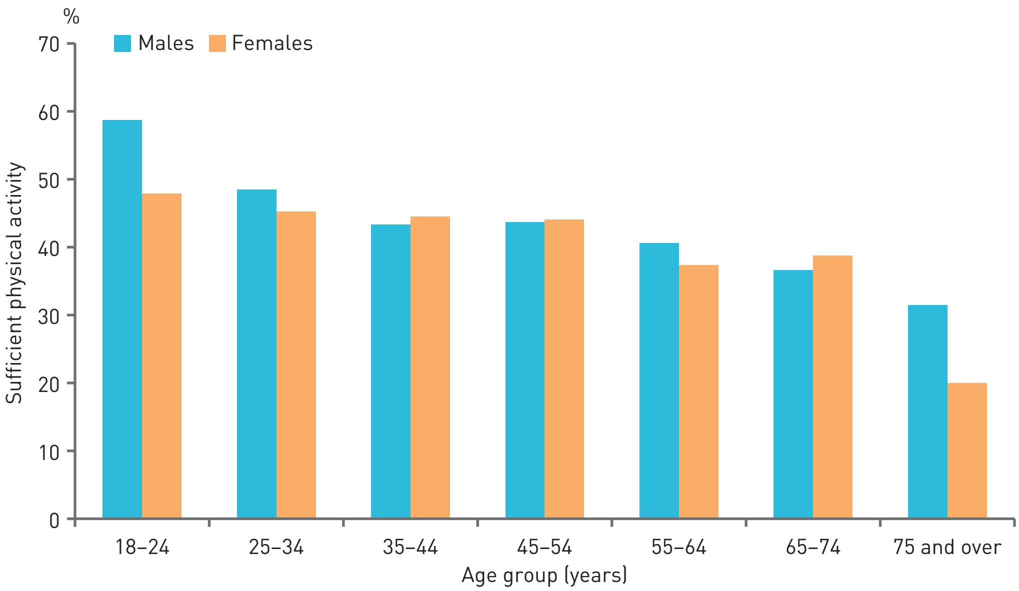
Video

Calculating sufficient physical activity

When calculating sufficient physical activity (see Table 13.4), the time reported in vigorous-intensity activity is multiplied by two to adjust for greater energy expenditure. In 2000, 57 per cent of Australians engaged in sufficient physical activity for health benefits. In other words, 43 per cent of Australians were not sufficiently active for health. Physical activity for both sexes declined between 1997 and 2000 but a decline among males was especially evident.

In the 2011–12 Australian Health Survey, 43 per cent of adults met the 'sufficiently active' criteria. The graph below displays the proportion of adults classified as 'sufficiently active' based on meeting the guidelines. Note the change in activity levels across the lifespan.

The highest levels of physical activity were among 18–24 year olds, with 59 per cent of males and 48 per cent of females in that age group classed as sufficiently active. Levels of physical activity tended to decline as people aged, with just one in three men and one in five women 75 years or over getting sufficient physical activity.



Note: at least 150 min of PA/week from last 5 sessions
Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity*, cat. no. 4364.0.55.004, viewed 6 June 2016

Scaffold

DATA ANALYSIS

1. Complete Table 13.4 to calculate whether you are sufficiently active for health. There is a blank copy online at http://nelsonnet.com.au. You will need your login code. Are you meeting the Australian physical activity guidelines for your age group?
2. Discuss what contributes to most of your activity. In your answer, include the intensities of the various activities.
3. Explain why it is preferable to participate in physical activity five or more days per week rather than accumulate your 150 minutes on the weekend only.
4. How did the Active Australia Survey define 'sufficient physical activity'?

TABLE 13.4 Calculating sufficient physical activity

Are you sufficiently active for health benefits?	
Walking: total times/week =	Total hours/week =
Moderate physical activity (MPA): total times/week =	Total hours/week =
Vigorous physical activity (VPA): total times/week =	Total hours/week =
Calculate:	
Sessions: walking + MPA sessions + VPA sessions = sessions/week	
Hours: walking + MPA hours + (VPA hours x 2) = hours/week	
Sufficiently active? (Tick if you meet either or both criteria.)	
⩾150 minutes/week	
⩾50 minutes/week and ⩾5 sessions/week	

People were more likely to be classified as 'sufficiently active' if they:

» self-reported their health as 'excellent', compared to those who reported 'fair' or 'poor'
» lived in an area of least disadvantage
» had a higher household income
» had high educational attainment.

See chapter 12 for sociocultural factors and other factors affecting physical activity.

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Who do you think are more likely to be active: children or adults?

TABLE 13.5 Average hours per week adults spent on physical activity, on sedentary behaviour during leisure time, and on sedentary behaviour including leisure and work in 2011–12

	Average hours spent in last week (a)		
	Physical activity (b)	Sedentary behaviour (leisure only) (c)	Sedentary behaviour (leisure and work) (c)
Males			
Age group (years)			
18–24	5.4	31.6	37.8
25–34	4.3	29.9	45.0
35–44	3.8	28.4	45.1
45–54	4.1	28.1	44.1
55–64	4.2	30.5	42.7
65–74	3.8	31.5	33.9
75 and over	3.2	30.3	31.0
Total males	*4.2*	*29.8*	*41.5*
Females			
Age group (years)			
18–24	3.8	31.1	39.3
25–34	3.6	28.2	39.6
35–44	3.5	24.7	35.3
45–54	3.8	25.6	36.4
55–64	3.4	28.6	35.5
65–74	3.3	31.0	32.8
75 and over	1.7	31.0	31.2
Total females	*3.4*	*28.0*	*36.2*
Total adults			
Age group (years)			
18–24	4.6	31.3	38.5
25–34	3.9	29.1	42.3
35–44	3.6	26.5	40.2
45–54	4.0	26.9	40.2
55–64	3.8	29.5	39.0
65–74	3.6	31.2	33.3
75 and over	2.4	30.7	31.1
Total	*3.8*	*28.9*	*38.8*

Notes:

(a) Excludes time not known.

(b) Includes walking for transport/fitness, moderate and vigorous physical activity.

(c) Sedentary is defined as sitting or lying down for activities.

Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity,* cat. no. 4364.0.55.004, viewed 6 June 2016

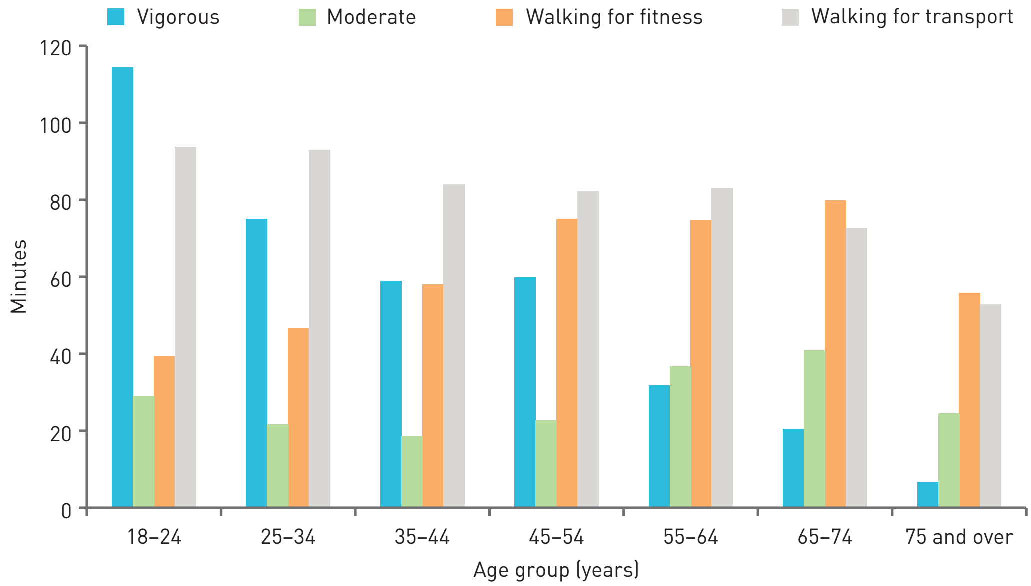
Looking at Table 13.5, you will notice that the most active group is the youngest adults and the least active is adults aged 75+. Those with the most hours of sedentary time across both leisure and work are aged 25–34 years. Adults 35–54 years tend to participate in less leisure time but have more than 40 hours a week in sedentary behaviour, largely due to work. By their late thirties, adults are starting to reach higher levels of responsibility and have greater demands on their time. Additionally, people in their 30s often have family responsibilities, reducing their opportunities for leisure.

CLASS DISCUSSION

Refer to Table 13.5. Females generally spend less time than males in physical activity and less time in sedentary behaviour during their leisure time. Explain why you think there is a gender difference.

The intensity and type of physical activity varies by age – this trend is consistently shown in national surveys of physical activity. Vigorous physical activity (VPA) is highest between 18 and 24 years, with averages of just under two hours (114 min) per week. As age increased, vigorous physical activity declined, with the 35–44 and 45–54 year olds averaging about an hour per week of VPA. The 75+ year olds averaged 7 minutes of vigorous physical activity a week. Only 5 per cent of people aged 75+ reported engaging in any VPA during the previous week.

The graph below shows that the proportion of people walking for fitness, recreation or sport was highest among people aged 45–74 years, who averaged 75–80 minutes a week, twice as much as their 18–24 year old counterparts. The increased proportion of time spent walking was directly related to a larger number of males walking (43 per cent by 55–64, compared with only 27 per cent for the 18–24 year olds).



Average minutes per week spent on physical activity by adults, 2011–12

Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity*, cat. no. 4364.0.55.004, viewed 6 June 2016

DATA ANALYSIS

Refer to the graph on page 269 displaying average minutes per week spent on physical activity in 2011–12 by adults.

1 a Summarise the association between walking for fitness and age.
  b Suggest why this may be the case.

2 a Describe the association between walking for transportation and age.
  b Explain why you think this pattern changes across the age spectrum.

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How does the walking for transport and walking for fitness data vary across the lifespan?

Measuring trends in physical activity levels

Most of the data presented so far in this chapter has been collected via cross-sectional surveys at the population level, which allow governments to monitor what proportion of various population subgroups meet the guidelines for physical activity and sedentary behaviour. An important part of monitoring and **surveillance** at the population level is to analyse trends in physical activity and sedentary behaviour over time. The only way a trend can be detected is to monitor activity levels over multiple time points (more than two).

According to the ABS, **sedentary levels** of physical activity have increased over the past decade, from 34 per cent in 2004 to 41 per cent in 2012 (see the graph below). This increase was observed in both male (from 33 to 39 per cent in males and 35 to 42 per cent in females). These gender differences were not considered statistically significant by the ABS.

Sedentary levels of physical activity over time by sex, 2004–05 to 2011–12

Source: Australian Bureau of Statistics, 2013, *Perspectives on Sport*, cat. no. 4156.0.55.001, viewed 6 June 2016

Pedometer steps

The range of physical activity data from the AHS examined so far was collected using self-report and proxy-report methods. These subjective measures were used to collect data on the duration and intensity of physical activity. Chapter 11 looked at the limitations of subjective measures. In addition to the subjective measures used in the AHS, pedometer data was also collected as an objective measure to quantify total volume of physical activity. Although pedometry cannot be used to assess physical activity dimensions such as type, frequency, intensity and duration, it provides an overview of total daily steps, which includes both incidental and intended physical activity.

Almost half (49 per cent) of respondents agreed to participate in the pedometer data collection component, which assessed four days of physical activity data (including at least one weekend and one weekday).

REAL WORLD APPLICATION

What's typical for average daily steps?

By Wendy Bumgardner, 5 November 2015

How many steps per day does the average adult take? Studies found that the average American adult only makes it about halfway to a goal of 10 000 steps per day, although those who wear an activity monitor pedometer seem to log more steps per day.

A study published in 2010 of over 1000 Americans found an average of 5117 steps overall, with men only slightly ahead of women at 5340 steps compared with 4912 steps.

The United States data was collected from people who wore a pedometer for two days during normal activity in 2003. The researchers compared with studies in other countries:

- United States: 5117 steps
- Switzerland: 9650 steps
- Japan: 7168 steps
- Western Australia: 9695 steps. A wider survey in Australia found an average of 7400 steps (Australian Health Survey 2011–12)

At 5000 steps, the average American walks about four kilometres each day

Pedometer researcher Dr. Catrine Tudor-Locke published a study in 2004, showing a wide variation in the 200 men and women who participated.

- Men: 7192 steps per day.
- Women: 5210 steps per day.
- Study participants with larger body mass indexes (a measure of overweight and obesity) took fewer steps per day on average.

People walked more on workdays, weekdays, and days they participated in sports or exercise.

Activity monitor steps per day data

With the debut of activity monitors and accelerometer chips in mobile phones, pedometer companies and app companies receive continuous data from their users on total daily steps.

This data may be skewed, because people who wear pedometers or activity bands are motivated to take more steps per day and reach targets. They may not wear the pedometer or carry the phone continuously throughout the day.

Withings released data from a panel of its pedometer users in 2015 that showed these averages:

- United States: 5815 steps per day
- France: 6330 steps per day
- Germany: 6337 steps per day
- United Kingdom: 6322 steps per day

Fitbit released data on the average steps per day for each US state, based on over one million users, comparing summer to winter 2012–2014. Overall, Fitbit wearers walked 7000 steps per day in winter and 8000 steps per day in summer.

How many steps a day are enough?

In general, a person should add 2000–3000 more steps to their day than they get from their general activities.

Read the full article via: http://vcepe12.nelsonnet.com.au.

Weblink

Questions

1. How many steps are recommended as a minimum daily target for adults?
2. Compare the average number of steps of Australian adults to other countries.
3. Explain why you think people who wear an activity monitor on their wrist are more likely to have a higher step count.
4. Discuss why you think people walk more on work days and weekdays.
5. Approximately what distance is covered in 5000 steps?

DATA ANALYSIS

The adults who participated in the Australian Health Survey pedometer study sample recorded an average of 7400 steps each day. Only 19 per cent recorded an average of 10 000 steps per day. The table below outlines the average number of steps per day by sex, age and selected characteristics.

Average steps per day for children aged 5–17 years from AHS pedometer data

	AVERAGE NUMBER OF STEPS [a]		
	Per weekday	Per weekend day	Average per day
Male	9975	8815	9654
Female	8782	8209	8625
Age group (years)			
5–8	10 171	10 085	10 147
9–11	10 384	9273	10 075
12–14	9362	7849	8943
15–17	7532	6938	7371
Has screen-based bedroom equipment [b]	8912	7906	8638
Does not have screen-based bedroom equipment [b]	9900	9179	9699
Underweight/Normal [c]	9595	8706	9347
Overweight/Obese [c]	8792	7910	8552
Met PA recommendation all days [d]	10 312	9799	10 175
Did not meet physical activity recommendation on any day [d]	7218	6662	7062
Met screen-based activity recommendation on all days [d]	10 298	9480	10 071
Did not meet screen-based activity recommendation on any day [e]	8260	6783	7839
Total children 5–17 years	**9377**	**8514**	**9139**

Notes: [a] Average calculated using the total number of steps by all persons who reported at least 4 days (incl. 1 weekday/1 weekend day) divided by the total number of days.

[b] Screen-based equipment includes TV, DVD/Blu-ray player, digital video recorder, computer, video game console.

[c] Measured BMI. Includes only those persons for whom height and weight were measured (excludes 17.6% of persons aged 5 to 17 years).

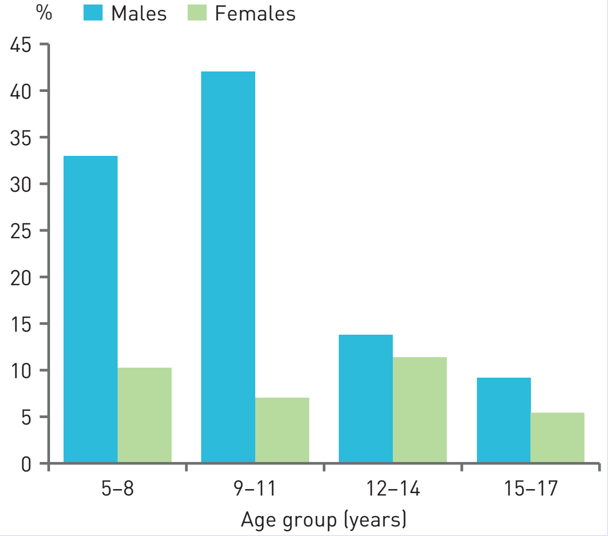
[d] The PA recommendation for children 5–17 years is 60 minutes or more each day.

[e] The screen-based activity recommendation for children 5–17 years is no more than 2 hours each day for entertainment.

Source: adapted from Australian Bureau of Statistics, 2013, Table 26.1, 'Average pedometer steps per day type by selected characteristics, Children aged 5–17 years (steps)', *Australian Health Survey: Physical Activity*, cat. no. 4364.0.55.004

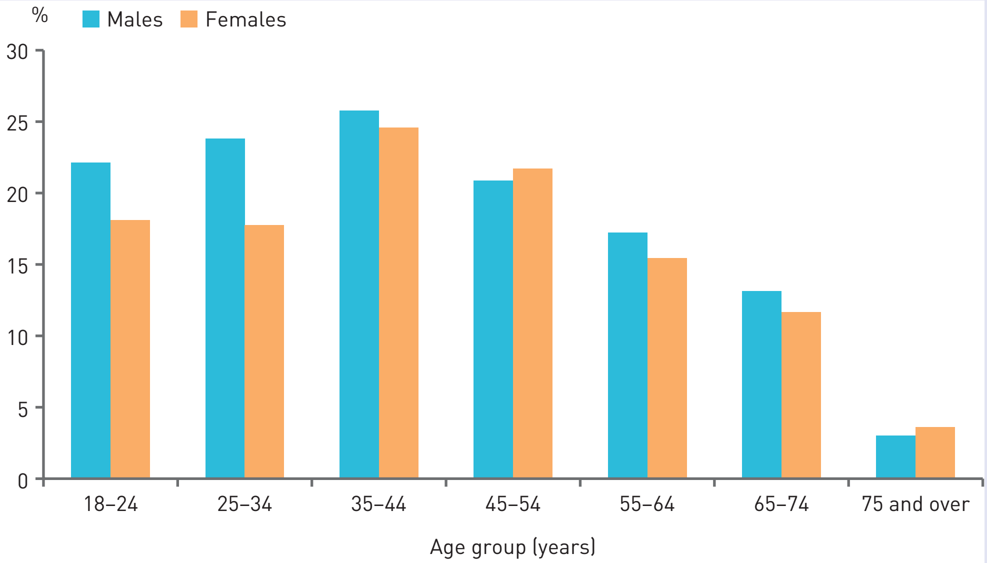
Referring to the table on the previous page and the graph at right, answer the following questions.

1 Outline which age groups and which sex accumulated the most steps.
2 Discuss why you think there is a difference in the number of steps accumulated during a normal weekday compared to a weekend day.
3 Describe the association between health risk factors and step average.
4 Describe the relationship between number of steps per day and the likelihood that the person complies with (a) the physical activity guidelines and (b) the sedentary behaviour guidelines.
5 Based on the table on the previous page, summarise the proportion of young people meeting the recommended 12 000 average steps per day.



Proportion of children aged 5–17 years who met the 12 000 average steps per day

Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity*, cat. no. 4364.0.55.004, viewed 6 June 2016



Proportion of adults who met the 10 000 average steps per day.

Source: Australian Bureau of Statistics, 2013, *Australian Health Survey: Physical Activity*, cat. no. 4364.0.55.004, viewed 6 June 2016

6 Identify which (adult) age group displayed the highest number of steps per day. Suggest one possible reason for this.
7 Describe the association between age and average daily steps.
8 Outline whether there was a difference in daily steps by sex for different age groups.

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A combination of subjective (survey) and objective (fitness tracker) measures were used during the AHS physical activity data collection.

International physical activity patterns

The World Health Organization (WHO) has online interactive maps and datasets estimating the number of adults and schoolgoing adolescents engaging in insufficient physical activity. Data was only used if it:

» was captured activity across all domains of life, including work/household, transport and leisure time

» came from a random sample of the general population, with clearly indicated survey methods.

Many of the surveys used the International Physical Activity Questionnaire (IPAQ). The map on page 274 displays global estimates of insufficient physical activity in 2010 among schoolgoing adolescents aged 11–17 years for both sexes. Explore the WHO website to determine which countries have the highest proportion of insufficient physical activity.

In chapter 11 we looked at a range of population measures of physical activity. Most of the physical activity data presented by WHO used either the International Physical Activity Questionnaire (IPAQ) or the Global Physical Activity Questionnaire (GPAQ). Both instruments assess the frequency, duration and intensity of physical activity. The main objective of these survey instruments is to estimate whether people accumulated sufficient physical activity to achieve a health benefit (**moderate-intensity physical activity**).

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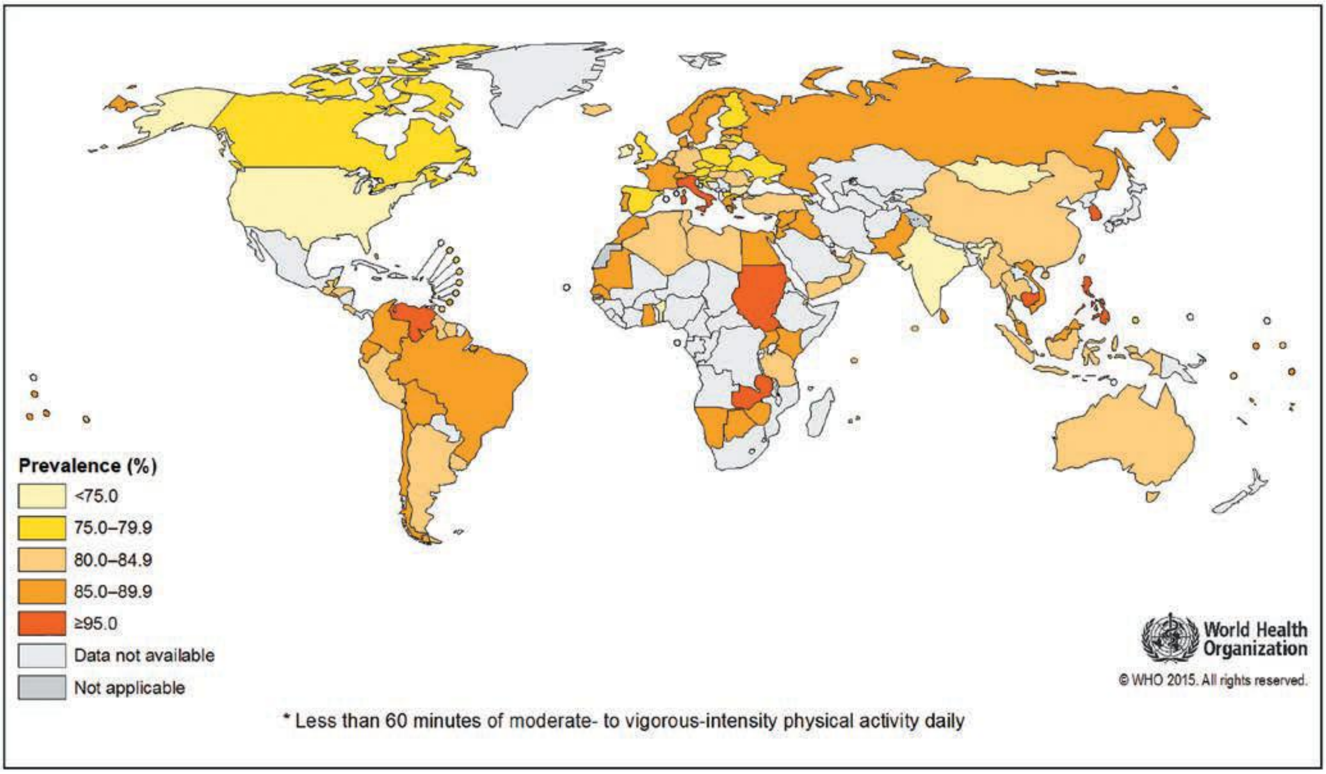
INVESTIGATION

Visit the BiomedCentral website via http://vcepe12/nelsonnet.com.au to read results from 20 countries of the 2008 IPAQ prevalence study on physical activity.



Global estimates for insufficient physical activity in 2010 among school going adolescents aged 11–17 years for both sexes
Source: World Health Organization, Health Statistics and Information Systems, 2015

PARTICIPATION IN SPORT AND PHYSICAL RECREATION

Australia is known across the world as a sports-loving nation. Sport is part of Australian culture and brings people from a diverse population together. Thousands of Australians play sport each year, but it is even more popular among spectators. Whether it's watching the under-12s soccer or an international one-day cricket match, more than 7.6 million Australians per year flock to stadiums to watch sport. Most (92 per cent) Australians report having an interest in at least one sport, and an average of six.

Sports volunteers are the largest volunteer group in Australia: more than 2.3 million people volunteer their time each year. People participate in sport for many reasons – friendship, fitness, the thrill of completion or the thrill of the game. Whatever the reason, participation in sport is very good for you. According to the Australian Sports Commission, the benefits of sport include:

» physical and mental health outcomes
» enhanced social connectedness
» reduced crime rates
» bridging of cultural boundaries
» improved international relations

Getty Images/Scott Barbour/Stringer

Passionate fans at the Australian Open tennis in Melbourne, 2015

» improved academic performance
» improved social outcomes
» more than $12.8 billion generated in annual income for the economy.

Table 13.6 presents the proportion of Australians across different age groups participating in a range of roles in sport. You will notice that participation declines as age increases. The participation rates of those playing sport vary across the different states and territories: just under 30 per cent of people in the ACT participate, compared with less than 20 per cent of Victorians aged 15+ years.

Fairfax Syndication / Mal Fairclough

Participation in organised sport declines with increasing age across the lifespan.

TABLE 13.6 Involvement in organised sport and physical activity, Australia, 2013–14

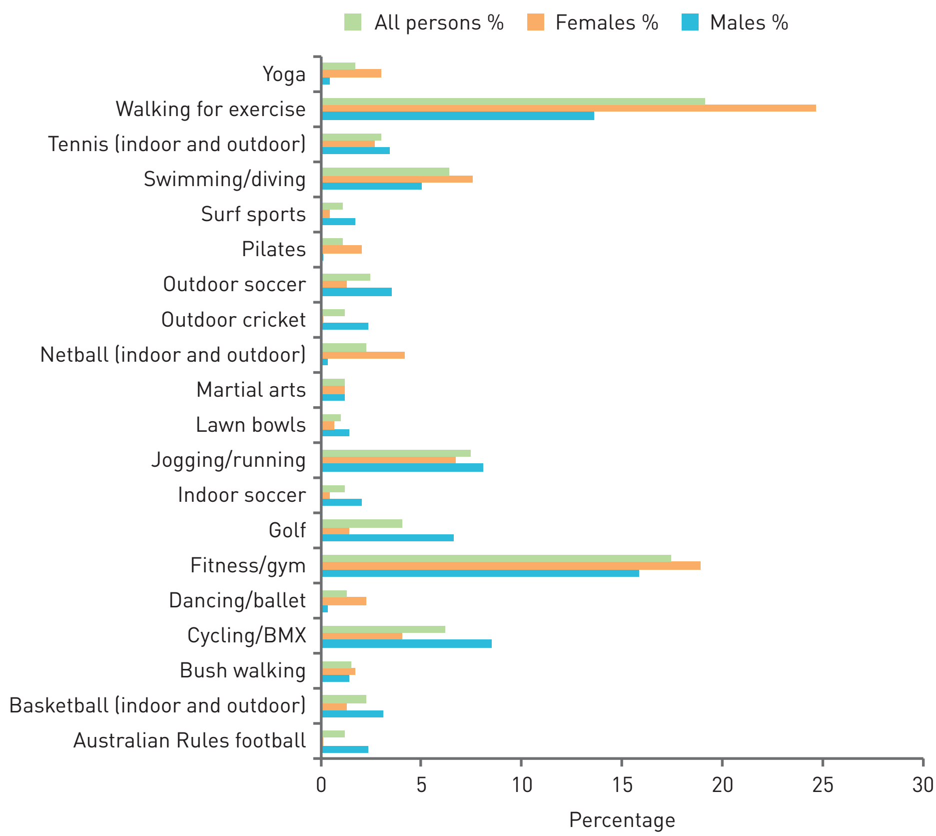
	Playing role only	Playing and non-playing roles	Non-playing roles only	All in playing role	All in non-playing roles	TOTAL	No involvement
	(A)	(B)	(C)	(A + B)	(B + C)	(A + B + C)	(D)
Age group (years)	Proportion of males (%)						
15–24 years	33.4	8.9	0.6	41.9	9.9	42.9	56.7
25–34 years	25.4	5.5	1.7	30.9	6.9	32.4	67.4
35–44 years	16.6	7.7	5.3	24.2	13.4	29.9	70.1
45–54 years	16.6	5.8	4.5	22.3	9.9	26.6	73.7
55–64 years	13.2	4.0	2.7	17.0	6.5	19.5	79.9
65 years and over	13.7	4.3	1.3	17.5	5.4	19.1	81.0
Total	**20.2**	**6.0**	**2.7**	**26.1**	**8.7**	**28.8**	**71.2**
Age group (years)	Proportion of females (%)						
15–24	32.8	9.4	0.8	42.7	10.4	44.4	55.7
25–34	24.8	3.1	1.5	27.8	4.5	29.0	70.9
35–44	20.9	5.1	5.0	25.9	10.4	31.0	68.9
45–54	14.8	4.8	3.4	19.9	8.0	23.2	76.7
55–64	15.0	2.8	1.3	17.6	4.1	19.3	81.0
65 and over	14.8	1.9	0.6	16.4	2.4	17.0	83.1
Total	**20.6**	**4.5**	**2.2**	**25.0**	**6.7**	**27.3**	**72.7**
Age group (years)	All persons (%)						
15–24	33.5	9.5	1.0	42.7	10.4	43.8	56.4
25–34	24.9	4.2	1.5	29.1	5.8	30.8	69.2
35–44	18.7	6.3	5.2	25.1	13.8	30.4	69.6
45–54	15.9	5.3	3.9	21.1	9.0	25.0	75.0
55–64	14.1	3.3	2.2	17.6	5.4	19.4	80.4
65 and over	14.3	3.0	0.9	17.1	3.7	17.9	82.0
State or territory of usual residence							
New South Wales	21.9	4.6	1.9	26.6	6.5	28.5	71.6
Victoria	19.9	6.8	3.0	26.7	9.8	29.9	70.4
Queensland	18.5	2.7	2.2	21.3	4.9	23.4	76.6
South Australia	17.2	6.9	3.2	24.1	10.3	27.6	72.4
Western Australia	20.6	5.4	2.6	25.9	8.4	28.5	71.3
Tasmania	22.5	7.9	3.4	30.3	11.3	33.5	66.4
Northern Territory	22.1	8.5	2.4	30.6	10.9	32.9	67.5
Australian Capital Territory	28.4	6.3	2.5	34.4	8.4	36.6	63.5
Total	**20.3**	**5.3**	**2.4**	**25.6**	**7.7**	**28.0**	**72.0**

Source: Australian Bureau of Statistics, 2015, Table 1, 'Persons participating in sport and physical recreation, States and territories, By sex and age', *Participation in Sport and Physical Recreation, Australia, 2013–14*, cat. no. 4177.0

Participation rates in various physical activities and sports

Adult data

The most common activities in Australia are lifestyle physical activities, including walking, going to the gym, jogging, swimming and cycling. However, there are very few sports within the top 20 physical activities that have more than a 3 per cent participation rate nationally. This is an important fact for physical education teachers to consider when designing a curriculum. In order to remain relevant, interesting and engaging for the majority of students, physical education programs need to include lots of lifestyle physical activities in addition to sport.



Top 20 physical activities/sports in Australia

Source: Australian Bureau of Statistics, 2015, Table 2, 'Persons participating in sport and physical recreation, Top 55 activities, by sex', *Participation in Sport and Physical Recreation, Australia, 2013–14*, cat. no. 4177.0

Young people

The National Sports Participation report (Morgan, 2015) identified swimming as one of the most common physical activities in Australia, with one in two children (aged 6–13 years) and 1 in 10 adolescents to adults (14+ years) participating regularly.

The report revealed the top 20 sports played by Australians. The research revealed that just over 10 per cent of children and adolescents go cycling, and 8.2 per cent play soccer. Just under half (48 per cent) participated in swimming and soccer, followed by cycling (37 per cent). Just under a third of children participated in athletics/track and field, basketball and dancing, a little over a quarter regularly play cricket and around 20 per cent play netball or tennis. Although the proportion of people who follow AFL is quite high in Victoria, the sport barely scraped into the top 10 sports in terms of participation, with only 18 per cent of young people playing Australian Rules football.

Walking is the most common physical activity for adults (45 per cent). Going to the gym/weight training is popular (13 per cent), followed by swimming and jogging (10 per cent) and yoga (9.4 per cent).

Michele Levine, CEO, Roy Morgan Research, says: 'Ten of the top 20 most popular sports and activities among Aussie kids aged six to 13 are team sports. Soccer is the clear favourite, with 1.2 million young players across the country, followed by around 750 000 basketballers, 630 000 cricketers and 500 000 netballers. But nearly all team sports move down the popularity list among those aged over 14, while many individual, non-competitive or exercise-based pursuits such as hiking, aerobics and surfing move up. The one constant is swimming, the number one sporting activity for kids and adults with over three million regular participants overall.'

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Swimming is the most common organised physical activity for young people in Australia. Discuss why you think this is the case.

TABLE 13.7 Top 20 sports and activities by regular participation rate

	Age 6–13	(000s)	%	Age 14+	(000s)	%	TOTAL Age 6+	(000s)	%
1	Swimming	1198	48.8	Swimming	1949	10.1	Swimming	3147	14.4
2	Soccer	1194	48.7	Cycling	1419	7.3	Cycling	2343	10.8
3	Cycling	924	37.7	Hiking/ Bushwalking	847	4.4	Soccer	1790	8.2
4	Athletics/Track and field	778	31.7	Aerobics	623	3.2	Dancing	1303	6.0
5	Basketball	748	30.5	Soccer	596	3.1	Basketball	1088	5.0
6	Dancing	743	30.3	Dancing	560	2.9	Hiking/ Bushwalking	1079	5.0
7	Cricket	631	25.7	Tennis	471	2.4	Tennis	961	4.4
8	Netball	503	20.5	Netball	343	1.8	Cricket	959	4.4

TABLE 13.7 Top 20 sports and activities by regular participation rate *(continued)*

	Age 6–13	(000s)	%	Age 14+	(000s)	%	TOTAL Age 6+	(000s)	%
9	Tennis	490	20.0	Basketball	340	1.8	Athletics/Track and field	874	4.0
10	Gymnastics	444	18.1	Cricket	328	1.7	Netball	846	3.9
11	Australian Rules	438	17.9	Martial arts	242	1.3	Aerobics	698	3.2
12	Hiking/ Bushwalking	232	9.5	Body surfing	231	1.2	Australian Rules	622	2.9
13	Rugby league	229	9.3	Surfing	211	1.1	Gymnastics	569	2.6
14	Softball	218	8.9	Australian Rules	184	1.0	Martial arts	457	2.1
15	Martial arts	215	8.8	Volleyball	133	0.7	Rugby League	339	1.6
16	Volleyball	189	7.7	Gymnastics	125	0.6	Body surfing	335	1.5
17	Baseball	165	6.7	Horse riding	122	0.6	Surfing	330	1.5
18	Field hockey	144	5.9	Rugby Union	113	0.6	Volleyball	322	1.5
19	Roller blading/ skating	127	5.2	Rugby League	110	0.6	Softball	271	1.2
20	Horse riding	119	4.9	Field hockey	103	0.5	Field hockey	247	1.1

Source: Roy Morgan Single Source (Australia), January 2014–December 2014, sample n=15,944 Australians aged 14+; Roy Morgan Young Australians Survey, January 2014–December 2014, sample n=2404 Australians aged 6–13

REAL WORLD APPLICATION

Participation in sport and physical recreation declines in Australia

18 February 2015

There has been a decrease in the number of Australians participating in sport and physical recreation, according to figures released today by the Australian Bureau of Statistics (ABS).

'Overall, 60 per cent of Australians aged 15 years and over participated in sport and physical recreation in 2013–14, compared with 65 per cent in 2011–12,' said Gary Niedorfer from the ABS.

The highest participation rate for sport and physical recreation in 2013–14 was in the Australian Capital Territory (73 per cent). Queensland recorded the lowest participation rate with 54 per cent.

'3.5 million people reported walking for exercise, still the most popular physical recreational activity undertaken by Australians in 2013–14 ... despite a significant drop in the participation rate from 2011–12,' said Mr Niedorfer.

'However this remains the exercise of choice for females in 2013–14, while the most popular activity for males was fitness/gym.

'There has also been a drop in the proportion of people undertaking other activities such as swimming and cycling.'

The proportion of Australians playing tennis fell from 4.2 per cent in 2011–12 to 3.0 per cent in 2013–14. There were also falls in participation in other sports such as golf and cricket.

Source: Australian Bureau of Statistics media release, 18 February 2015

Questions

1 a State what proportion of Australians participated in sport and physical recreation in 2013–14.
  b Compare this data to the data collected for the 2011–12 period.
2 Identify the most popular physical activities for females and males.
3 Outline which activities and sports have displayed a downward trend since 2011.

CHAPTER SUMMARY

- National monitoring and surveillance of physical activity levels allows public health bodies and organisations such as the Australian Bureau of Statistics, Australian Sports Commission and Commonwealth Department of Health to systematically observe patterns and trends in physical activity levels and participation rates in organised sports.
- One in five Australian adults exercises at very low levels, or not at all. Fewer than 20 per cent did 60+ minutes per day on average.
- Just 43 per cent of adults met the 'sufficiently active' recommendation (59 per cent of males and 48 per cent of females).
- 18–24 year olds were the most active (males averaged 46 minutes and females 32 minutes perday).
- Levels generally decline with increasing age.
- When calculating sufficient physical activity, the time reported in vigorous-intensity activity is multiplied by two to adjust for greater energy expenditure.
- Within the Australian Health Study, the most active group are the youngest adults and, inversely, the least active adults are those aged 75+ years.
- According to the ABS, sedentary levels of physical activity have increased over the past decade from 34 per cent in 2004 to 41 per cent in 2012.
- The adults who participated in the pedometer study sample as part of the Australian Health Study recorded an average of 7400 steps per day. Less than one in five adults (19%) recorded 10 000 steps per day on average.
- The Global Physical Activity Questionnaire (GPAQ) is a recall instrument designed to assess physical activity patterns. It was developed by the World Health Organization (WHO) for physical activity surveillance in all countries, especially in the context of developing countries. The GPAQ collects physical activity participation in three domains (settings): activity at work; travel to and from places; and recreational activity.

CHAPTER REVIEW

Multiple-choice questions

1 Which of the following physical activities would be the most commonly participated in by Australian adults?
   A Australian Rules football
   B soccer
   C walking for exercise
   D cycling

2 What proportion of Australians are very inactive or complete no physical activity at all?
   A 10%
   B 20%
   C 30%
   D 40%

Short-answer questions

3 Describe what happens to participation rates in sport across the lifespan.

4 What happens to physical activity across the lifespan?

5 a What is meant by the term 'surveillance'?
   b Can you use cross-sectional surveys to assess what proportion of the population is complying with the physical activity guidelines?
   c Describe the sorts of physical activities, other than traditional team sports, that should be included in all physical education programs in schools.

6 a Explain what is meant by an epidemiological study. You may have to do some research to answer this question.
   b Identify which gender generally engaged in more walking.

7 Explain how you could determine whether there is a trend in sedentary behaviour levels.

8 a Explain a major limitation of asking people whether they were active at least once in the past 12 months as a measure of population activity levels.
   b Describe the major limitation of asking people how much physical activity they have done in the past two weeks as a measure of their usual activity levels.

CHANGING PHYSICAL ACTIVITY BEHAVIOUR: THE SOCIAL–ECOLOGICAL MODEL AND THE YOUTH PHYSICAL ACTIVITY PROMOTION MODEL

14

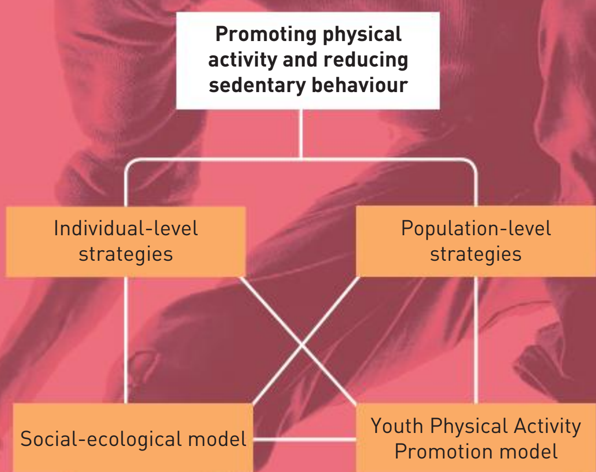
CHAPTER

Key knowledge

» components of the social-ecological model (individual, social environment, physical environment and policy) and/or the Youth Physical Activity Promotion model

Key skills

» apply a social-ecological model and/or the Youth Physical Activity Promotion model to critique physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour for a range of populations in a variety of settings



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PHYSICAL ACTIVITY BEHAVIOUR CHANGE

This chapter will describe a range of strategies designed to increase, or (if a person is sufficiently active already) maintain, physical activity behaviour.

The following diagram relates to the planning, implementation and evaluation of both interventions on a large group scale as well as that used for individual activity plans. We will look more closely at individual activity plans later in the chapter.

Baseline measures (pre-intervention)

- Asses total physical activity.
- Assess cycling:
  - frequency (trips per week)
  - duration (minutes per week)
  - distance covered (kilometres per week).
- Assess self-efficacy for cycling.
- Assess perceived social support for cycling.

Intervention program

- Participate in a school-based bicycle education program.
- Ride with an after-school cycling club.
- Ride to school with a friend at least twice per week.
- Program facilitated by active role models.

Change in mediators

- Increased competence on bicycle
- Increased social support for cycling
- Enhanced self-efficacy to ride to school

Post-intervention measures of behavioural change

- Increased total physical participation
- Increased cycling frequency, duration, distance
- Increased number of trips to school
- Increased number of bike paths used
- Increased self-efficacy to ride to school
- Increased perceived social support for cycling
- Association between social support and cycling

Assessing behavioural change within a school-based cycling intervention program

As discussed in chapter 12, determinants of physical activity and sedentary behaviour help us understand the factors that influence how active a person is. For example, in the diagram on the previous page, the second box describes an intervention designed to encourage a teenager to ride his or her bicycle more often. The third box depicts the mechanisms that led to a change in cycling behaviour (**mediators**). The last box shows changes to the young person's cycling behaviour.

It is important to understand that physical activity mediators can also influence other mediators. For example, **self-efficacy** and reminding yourself to be active may also be mediators. If a person is taught strategies to remind themselves to be more active, this might also lead to improved self-efficacy. The combined improvement in these mediators may increase the chance of behavioural change occurring – that is, increased physical activity or a reduction in sedentary behaviour.

It can be difficult to determine which elements or strategies of an intervention program, if any, result in changes to physical activity behaviour. In the diagram on the previous page, notice that physical activity behaviours (total physical activity and cycling) and potential influences (self-efficacy, social support) are measured both pre- and post-intervention. If cycling behaviour was only assessed post-intervention, it would not be possible to determine whether there had actually been a change in behaviour.

THEORETICAL MODELS OF PHYSICAL ACTIVITY BEHAVIOUR

At best, correlational research testing theories, and models focusing on individual-level factors, only explain 20–40 per cent of the variance in physical activity. This has led to a shift to broader, multilevel, ecological approaches to physical activity promotion. In chapter 12, we referred to determinants as factors that influence how active a person is; they can be enablers or barriers. These factors do not usually influence behaviour in isolation; instead, a combination of factors may be at play.

Theoretical models of behavioural change can incorporate several of these factors in an attempt to better understand physical activity behaviour.

While theories of behaviour change in relation to physical activity are not discussed in the VCE Physical Education course, there are two models that provide a framework for physical activity promotion. These models are made up of multiple theories. Several conceptual theories and models are used to explain health behaviour and can be applied to predict what factors will lead to a change in certain health behaviours (such as physical activity, alcohol consumption or smoking). Theories and models of physical activity are used to:

» explain influences or determinants of physical activity
» explain the relationship between these factors (for example, beliefs, barriers) and physical activity
» explain the conditions under which relationships with physical activity do and do not occur (for example, the time, place and circumstances that lead to physical activity).

Theories and **theoretical models** are classified as either individual (intrapersonal) or interpersonal models of adult physical activity (see Table 14.1).

TABLE 14.1 Classification, description and example theories of adult physical activity

Classification and description	Example theories
Individual (intrapersonal) theories explain health behaviour and behavioural change by focusing on individual factors. To design effective interventions requires an understanding of the role of the individual in physical activity behaviour.	» Health belief model » Trans-theoretical model (includes stages of change and self-efficacy) » Theory of reasoned action » Theory of planned behaviour
Interpersonal (social environment) theories explain behaviour by focusing on the interaction between the individual and the environment.	» Social cognitive theory (includes self-efficacy) » Ecological models (includes social-ecological model, Youth Physical Activity Promotion model)

THE SOCIAL-ECOLOGICAL MODEL

An individual's social and physical environment (family, workplace, community or school) can directly and indirectly affect their beliefs and physical activity behaviour.

For decades, individual theories were used to inform physical activity interventions. However, **psychosocial models** alone cannot inform intervention strategies that focus beyond the individual level. Over the past decade there has been a shift to develop environmental-level physical activity programs in schools, community and workplace settings. This shift originated in the late 1970s, when Urie Bronfenbrenner proposed the first ecological model in an attempt to 'describe the multiple levels of influence in the environment including interpersonal relationships, organisations and institutions that affect individual's behaviour' (Bauer et al., 2004).

An ecological perspective suggests **reciprocal causation** between the individual and the environment. In other words, individual behaviour can influence the environment, and the environment can influence individual behaviour. Social-ecological models are not only used to predict physical activity behaviour; they have also been used in areas such as eating behaviour, smoking, sexual behaviour, cultural influences on child abuse, and workplace occupational health and safety.

It is important to understand that no single factor on its own can lead to behavioural change. Behavioural change is a complex process that involves a number of variables. For example, increasing John's physical activity may require all of the following factors: more social support from his partner, enhanced self-efficacy, introduction of a weekly ride-to-work-day at his workplace, and a warning from his GP about his high blood pressure. Even in this simple example, a combination of factors interact, eventually leading to behavioural change. An ecological model can explain the multiple levels of influence that interact, resulting in an increase in John's physical activity behaviour.

Two important points to remember are:

1. **ecological models** of physical activity reinforce the interplay of demographic, psychological, social and environmental variables influencing physical activity behaviour. Therefore, if you make a change at one level it could affect all other influencing factors.
2. **social-ecological models** of physical activity are characterised by multiple levels of influence on behaviour and an emphasis on environmental and policy influences.

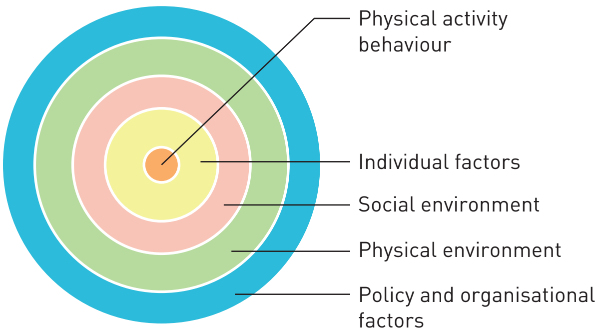
Table 14.2 outlines the levels of influence on an individual or group, and lists sample components making up these levels of influence. Each level will be described in more detail later in this chapter.

TABLE 14.2 The social-ecological model of influences on physical activity

Individual (intrapersonal) factors	Interpersonal (social) environment factors	Physical environmental factors		Policy and organisational factors
		Natural environment	Constructed environment	
» Demographics » Biological » Cognitive or affective » Behavioural	» Supportive behaviours » Social climate » Culture	» Weather » Geography	» Information environment » Urban/suburban environment » Architectural environment » Transportation environment » Entertainment infrastructure » Recreation infrastructure	» Policies governing incentives for activity or inactivity » Policies governing resources and infrastructure related to activity or inactivity

Note: Social and physical environments need to be considered within key behaviour settings, such as home, neighbourhood, school, workplace, parks, public buildings and facilities for recreation and sports.

There are many ways a social-ecological model could be depicted. Within some ecological models individual factors, social environment, physical environment and policy are all separate. In others, policy is integrated within the social and environmental level. The most fundamental depiction of the social-ecological model is shown in the diagram below.

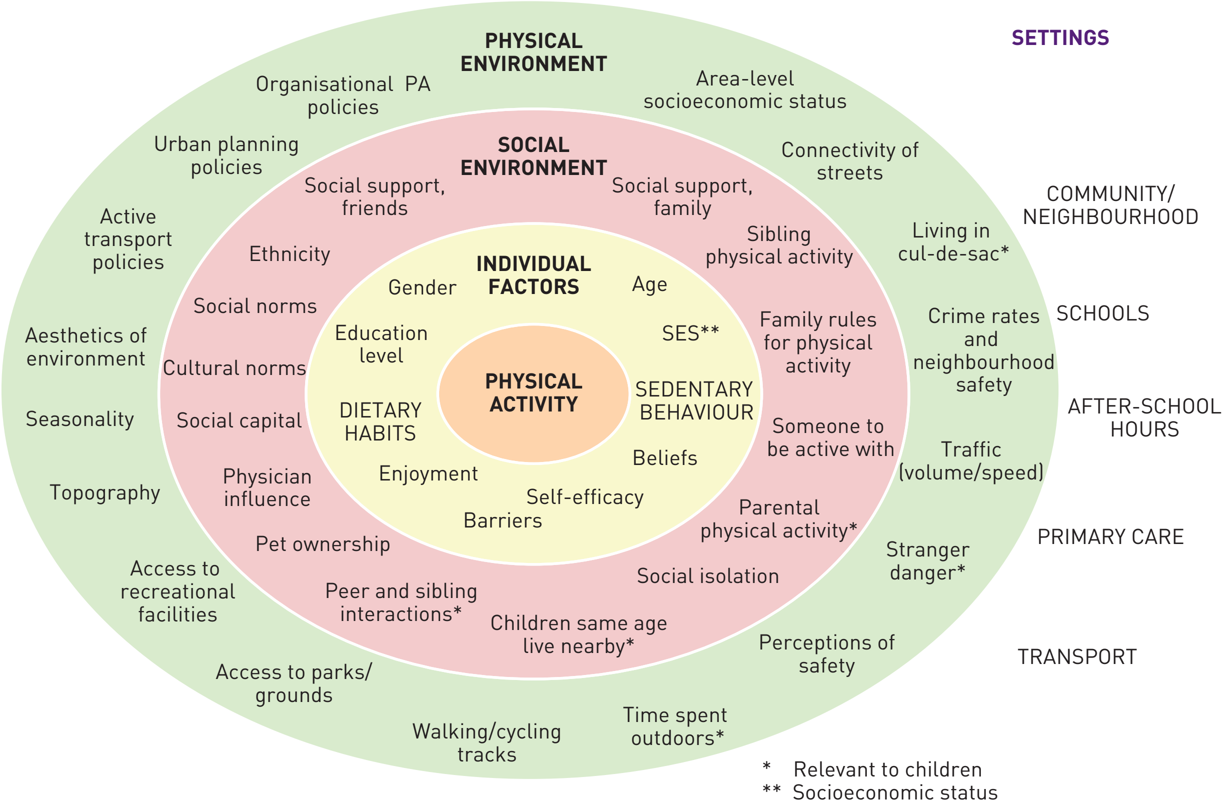


Components of a social-ecological model for promoting physical activity

The illustration on page 288 shows another example of a social-ecological model of physical activity. Note that it is aimed at a wide range of settings (community, schools, etc.), and there are multiple levels of influence (environmental/policy, sociocultural and individual factors) on physical activity. Each factor within each level of influence has been identified as a determinant of physical activity, and it is these factors that need to be targeted when developing intervention strategies. Some factors are more relevant to children, while others relate more to adolescents and adults.

As an example, consider parental physical activity from the socio-cultural level of the diagram above as an influence on children's physical activity. Knowing that this factor is a key influence on children's physical activity, an intervention strategy used within a community-based program may be to encourage more parents to be active role models for their children.

Now let's examine the levels of influence in more detail.



Social-ecological model of physical activity
Salmon & King, 2005

Multiple levels of influence

Within the social-ecological model, physical activity behaviour is determined by factors at four levels: individual, social environment, physical environment and policy. These are the factors that physical activity intervention programs need to target. This section looks in more detail at the four levels of influence on physical activity behaviour and a range of strategies that can be tailored to each of these levels of influence (see Table 14.3).

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Participating in a team sport provides social and emotional support. What are some of the other benefits associated with team sports?

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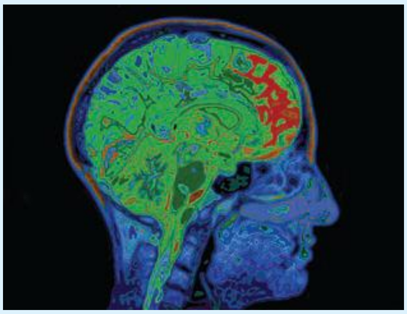
Where you live and the climate in the area influence your access to physical activity facilities, environments and programs.

The area you live in and the season both influence the physical activity you participate in. For example, a teenager living in Anglesea on the west coast of Victoria may be more likely to include surfing as part of their schooling and extracurricular activities than a teenager living in Bright, within the Alpine region of Victoria, who may be more likely to take up snowboarding.

TABLE 14.3 Social-ecological model factors and strategies for promotion at each level of influence

Level of influence	Influencing factors	Example intervention strategies at that level
 Shutterstock.com / SpeedKingz Individual (intrapersonal) factors	These are individual characteristics, such as attitudes, behaviour, self-concept, behavioural skills e.g. goal setting, or fundamental motor skill confidence and knowledge (e.g. comprehending the benefits of being active).	» Educational programs (e.g. enrolling in a spin or Zumba class, or Pilates) » Support groups (e.g. walking groups) » Organisational incentives directed at individuals (e.g. subsidised gym memberships for staff who go to the gym at least once per week) » Counselling by professionals » Mass media, by targeting individuals to consider being more active
 Shutterstock.com / Ery Azmeer Social environment (interpersonal factors)	This refers to the formal and informal social climate and support network and systems surrounding an individual (e.g. single or dual parents, siblings, extended family, peers). Supportive behaviours can be provided by primary groups, which include the family, work group and friendship circle. Supportive behaviours include providing or sharing transport to sport or a park, encouraging someone to be active, offering to be active with someone, and helping to pay fees.	» Strategies should focus on changing the culture (the nature of the existing social relationships) to encourage and provide support for physical activity. While the ultimate target of the strategies may be to increase physical activity in individuals, the interim targets are the social norms and social influences. » For example, to increase the physical activity of individuals in a community aged-care facility, the interim target is to create a lifestyle activity culture within the facility. » Organised social competitions (e.g. tennis, indoor sports)

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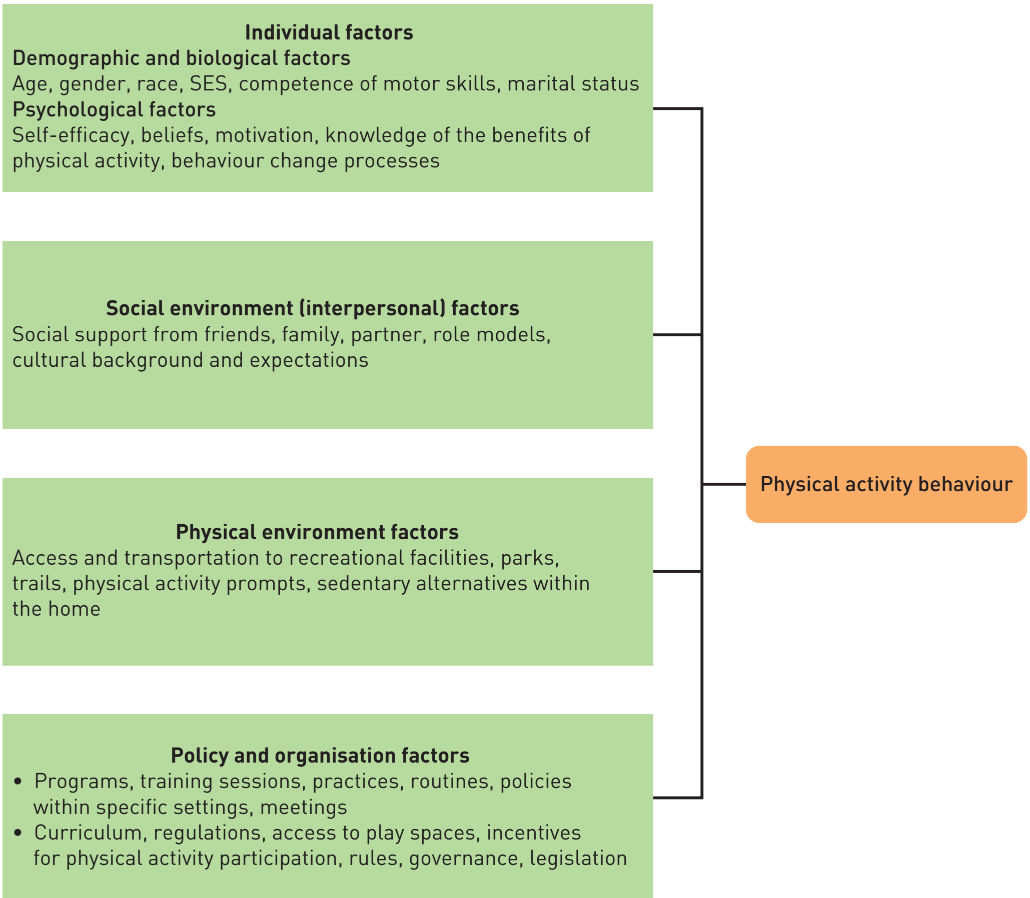
Level of influence	Influencing factors	Example intervention strategies at that level
 Physical environment	The physical environment plays a huge role in influencing physical activity behaviour. Natural environment relates to topography (mountains, coasts, bush), weather and climate, and features such as trees, water (beaches, rivers, lakes and creeks), grasslands and wildlife, which can create an attractive environment in which to be active. The built environment includes buildings, roads, public open spaces, public transport, parks, home and yard size, ovals, gymnasiums, court areas, fields, grandstands, changing facilities, pools, car parking. It also includes walking trails, boardwalks and cycling paths. Many new housing estates build walking trails, cycling paths, parklands and even water features to incorporate opportunities to be active.	» Measures to increase population density and mixed land use (e.g. retail, residential, light industrial showrooms) » Improved availability and accessibility, e.g. introducing ramps or smooth surfaces so that people using wheelchairs can access the area safely. » New recreational or sporting facilities built close to a school, community shopping centre or aged-care facility to ensure they are accessible to specific target groups. » Traffic calming measures around school areas in order to increase safety, thereby encouraging more children to walk or cycle to school. » Improved lighting of walking trails and safer footpaths with better signage » Improved aesthetics of urban green spaces
 Policy and organisational change	Policies: laws, regulations, formal rules, informal rules or understandings that are adopted on a collected basis to guide individual and collective behaviour. Organisational factors: organisational characteristics of social institutions, including rules (formal & informal), regulations, guidelines and governance of operation.	» Incentives, resources and infrastructures for activity or inactivity » Paying employees an extra $500 per year if they use a gym; or a secondary school having at least one physical education teacher allocated to every 80 students » Making changes to the school day to extend lunch breaks » Policies to restrict computer and mobile phone use during lunch breaks

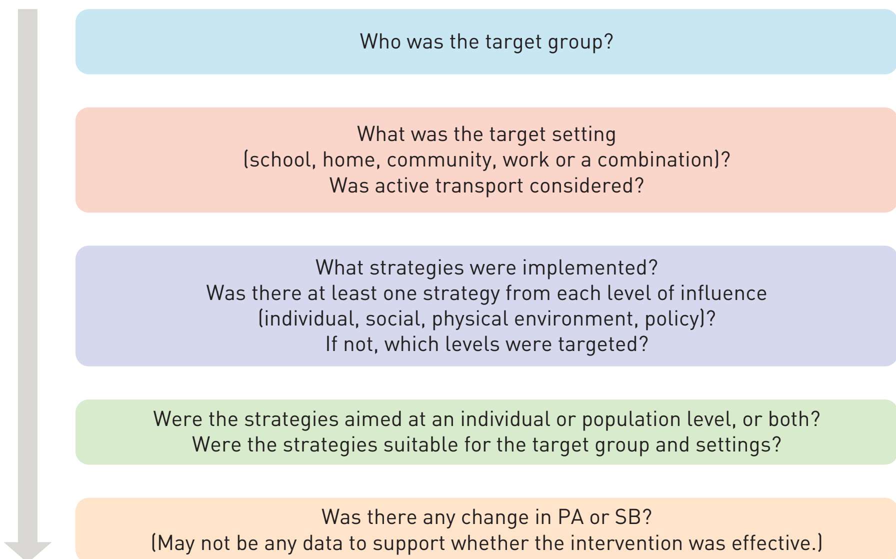
Of course, this example is a generalisation – obviously, physical activity participation is influenced by a more complex combination of factors than just proximity and seasonality. Individual factors might include skill level, perceived competence to surf/snowboard, and socioeconomic status.

'Access' and 'availability' should not be used interchangeably. As an example, you may have a wonderful facility around the corner from where you live, but if you cannot access it due to cost or opening hours, then it will not be an enabler.

The table above brings together all the information about the social-ecological model.



A social-ecological model of physical activity



A framework for critiquing physical activity intervention programs based on the social-ecological model

LABORATORY REPORT

APPLYING SOCIAL-ECOLOGICAL MODELS

The most effective interventions will incorporate at least one strategy from each major area of the social-ecological model.

AIM

Using a social-ecological model, critique strategies aimed at promoting physical activity or reducing sedentary behaviour among certain target groups.

METHOD

1. Identify an intervention program being implemented to promote physical activity or reduce sedentary behaviour within a school, workplace or community setting. What is the name of this program?
2. Describe the target group the intervention is aimed at and identify the setting.
3. Use the social-ecological framework template below to identify strategies used by your chosen intervention program. An online copy is on the student website at http://nelsonnet.com.au. You will need your login code. Tick the appropriate boxes for the strategies used and factors being targeted within each level of influence.

DISCUSSION

1. Describe whether the program you critiqued has employed a social-ecological framework.
2. Discuss two strategies used within each of the levels of influence.

Scaffold

Social-ecological framework template			
Name of intervention program:			
Are the following factors used in the program's strategies? Write Y (yes), N (no) or n/a (not applicable) in each box.			
Individual (intrapersonal) factors	**Environment**		**Policy and organisational factors**
	Social (interpersonal) environment factors	**Physical environment factors**	
☐ Increases knowledge attitude towards physical activity. ☐ Increases self-efficacy. ☐ Enhances behavioural skills (e.g. goal-setting, reward systems, reminder systems). ☐ Builds fundamental motor skill confidence. ☐ Implements education programs. ☐ Uses mass media. ☐ Uses counselling. ☐ Involves support groups. ☐ Uses incentives.	☐ Considers family. ☐ Considers peer group, friends. Considers social support via: ☐ someone to be active with ☐ someone to encourage physical activity ☐ someone to drive to venues for physical activity. ☐ Considers relationship with work colleagues. ☐ Considers neighbours. ☐ Provides access to role models. ☐ Provides new social networks and/or opportunities. ☐ Provides new social roles (e.g. player, coach). ☐ Includes social events, meetings, training.	☐ Changes the built environment (e.g. new walking trails, traffic calming). ☐ Removes barriers in the environment. ☐ Considers the natural environment (e.g. coastal area, climate). ☐ Includes new facilities (e.g. gymnasium, tennis courts, oval). ☐ Provides access to showers and changing facilities. ☐ Increases accessibility. ☐ Introduces signs. ☐ Provides new equipment (e.g. playground equipment, balls). ☐ Provides shelter near activity areas (e.g. shade cloth).	☐ Creates organisational change (e.g. timing, programming, changes to Physical Education). ☐ Changes rules, guidelines, governance, policy. ☐ Uses new resources and funding. ☐ Forms new partnerships or networks. ☐ Changes the power structure. ☐ Targets changes in social norms or beliefs.
☐ **At least one factor above has been addressed.**	☐ **At least one factor above has been addressed.**	☐ **At least one factor above has been addressed.**	☐ **At least one factor above has been addressed.**

Template for critiquing strategies within a social-ecological framework

Source: Active Healthy Kids Australia, 2015

REAL WORLD APPLICATION

Interview with Professor Jo Salmon

Jo Salmon is Alfred Deakin Professor, NHMRC Principal Research Fellow and President of the International Society of Behavioral Nutrition and Physical Activity, Deputy Director, Centre for Physical Activity and Nutrition Research, School of Exercise and Nutrition Sciences, Faculty of Health.

Jo, how did you get into this career path? What is your background?

I have an academic background in psychology and behavioural science and a practical background in dance and the fitness industry. I worked in gyms for about 13 years. So I was able to 'marry' my two loves, being physically active with understanding the psychology of why people are or are not active.

Can you explain in plain language what is meant by an ecological model?

An ecological model provides a useful framework for explaining the many levels of influence on participation in physical activity, including: the individual level (for example, biological and cognitive factors such as age or weight status and physical activity preference or motivation); the social level, such as social networks and influences (for example, family and peers); the cultural level (for example, ethnicity); the physical level (for example, the presence of a nearby park or access to public transport); the policy environment (for example, restricting dog walkers on a beach to certain hours of the day); and the economic environment (for example, funding provision for development of new sports complexes). All of these levels of influence interact and combine to help us understand facilitators and barriers to being active.

What is the key benefit of ecological frameworks over individual models of physical activity?

Individual models of physical activity really only focus on what a person thinks or believes about activity. They are not a reflection of real life which, as noted above, is influenced by factors external to a person in addition to cognitive factors (that is, what is going on in a person's head). For example, a person might be highly motivated to participate in physical activity; they might have high self-efficacy and positive beliefs about the benefits of being active. However, the environment in which they live may be very unsupportive and make being active very difficult. There are also hybrid models and theories available, such as the Youth Physical Activity Promotion model that incorporates social influences (reinforcing the behaviour), individual influences (Am I able? Is it worth it?), enabling influences (fitness, skills, access), and personal demographics (age, sex).

Could you describe an example of how you have employed a social-ecological framework in your research within schools, workplaces or the community?

We developed a comprehensive primary school-based initiative, Transform-Us!, that successfully reduced children's sitting, promoted their physical activity and benefitted children's health over a 2.5-year period. The program was based on an ecological framework and incorporated changes to the physical environment inside and outside the classroom, changes to pedagogical practice, and engaged teachers and parents in supporting children's active play during school and active homework after school hours.

Please explain how you employed a social-ecological approach to design and implement and evaluate an intervention program.

As described in the Transform-Us! Program, this incorporated an ecological model and also drew on social cognitive theory and behavioural choice theory. One of the significant outcomes of this study was the results got stronger over time, this is rare for an intervention study to show strengthening of results in this way and suggests that changes to the environment and teaching practices in this instance led to sustained changes, rather than diminishing, over time.

Questions

1 Identify examples of factors Professor Salmon listed within each level of the social-ecological model.
2 Explain how the Transform Us! study employed a social-ecological approach.

Video

QUICKVID

Watch a short interview with Professor Jo Salmon on the Youth Physical Activity Promotion model and other social-ecological approaches. Log in via http://nelsonnet.com.au with your code, then go to chapter 14, page 294.

TAILORING THE SOCIAL-ECOLOGICAL MODELS

Social-ecological models need to be tailored to each behaviour or health condition. They must also be tailored to the needs, attitudes, interests and behaviours of a specific population. Different populations require different implementation strategies, even if they have common components across the social-ecological model. For example, children and adults will perform different physical activities in different settings using different equipment. Chapter 15 will explore initiatives and strategies for specific target groups using a social-ecological model.

THE YOUTH PHYSICAL ACTIVITY PROMOTION MODEL

While many theoretical models have been developed to understand the factors influencing adult physical activity, there are only a few for children. Although examining differences in correlates explains some of the differences in physical activity behaviour, physical activity is complex and influenced by multiple factors across social and environmental levels. The Youth Physical Activity Promotion model (YPAP model) was developed by Greg Welk (1999) to bridge the gap between theory and practice.

Originally based on the PRECEDE-PROCEED planning model (Green & Kreuter, 1991), YPAP integrates a range of individual and environmental variables with a systematic socio-ecological framework. It is a conceptual model of physical activity promotion that is based on unique developmental, psychological and behavioural characteristics of children. The YPAP model considers individual, social and environmental influences on children's physical activity. The YPAP model also incorporates ideas from other theoretical frameworks. Ecological models can incorporate factors in multiple domains that influence physical activity in youth.

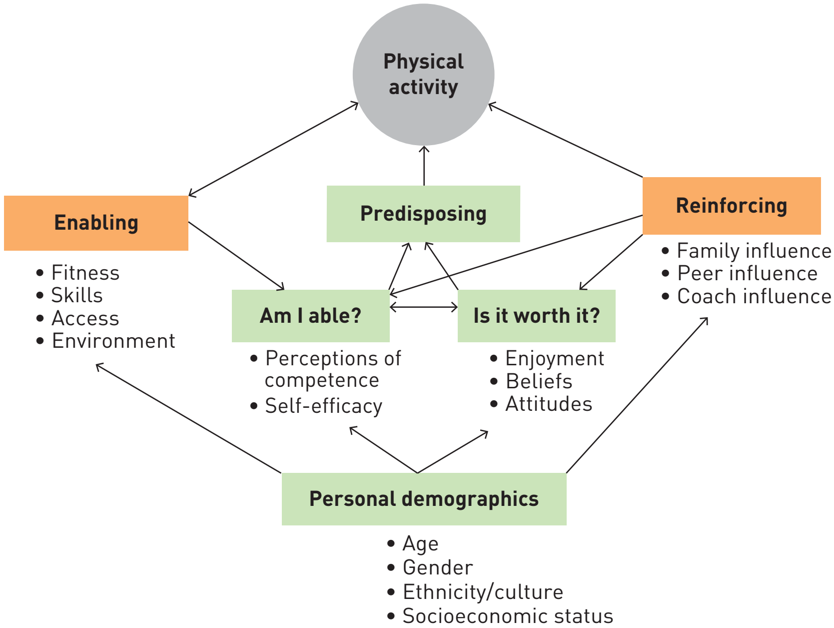
The YPAP model (following) is a social-ecological model that categorises factors affecting physical activity among youth into three major components:

1 Predisposing factors
2 Enabling factors
3 Reinforcing factors.

Predisposing factors

Predisposing factors increase the likelihood of a child regularly being physically active. Physical activity behaviour is broken down into two questions for the child to consider:

1 'Am I able?'
2 'Is it worth it?'



A conceptual diagram of the Youth Physical Activity Promotion model
Source: Gregory J Welk, 1999, 'The Youth Physical Activity Promotion Model: A Conceptual Bridge Between Theory and Practice', *Quest* Vol. 51, Iss. 1

The first question (Am I able?) relates to a child's self-efficacy; their perceived competence. Perceived self-efficacy is a belief in your ability to organise and execute the courses of activity required to achieve a given goal. Barriers to self-efficacy are defined as 'confidence in overcoming barriers'.

The second question (Is it worth it?) reflects a child's enjoyment of, and beliefs and attitudes towards, being physically active. The child must feel that participating has valued benefits. A child who is intrinsically more motivated to be active and enjoys physical activity is more predisposed to being active.

The more these two questions interact, the more predisposed the child is. Even if the child values physical activity, they are less likely to engage in it unless they feel competent.

Enabling factors

Chapter 12 introduced a range of factors that enable a child to be physically active. The YPAP model highlights two major categories of determinants, including environmental and biological determinants. Based on **determinant correlate** research, Welk identified environmental attributes as things like having access to equipment, parks and programs. Availability of play spaces has been identified as a significant predictor of children's physical activity. But the presence of certain factors within the community doesn't necessarily correspond with use. For example, a local community might have an indoor swimming pool, but if the opening hours are restrictive, many children may not be able to access the facility.

Biological factors such as physical fitness and skills are also classified as enabling factors. Being physically fit makes it easier to be physically active. Those who have higher skills and are more physically fit are more likely to employ strategies to be regularly active.

Children with low fitness and poor skills are less likely to seek out opportunities to be active. Notice the arrows in the diagram on the previous page, showing a relationship between the different components. There is a link between having success in these areas and perceived competence to be active. Similarly, children who perceive they are competent are more likely to be active, and so will enhance their fitness skills.

Reinforcing factors

Reinforcing factors refer to support from significant others that encourages a child to be physically active. This could be from family, teachers, peers or even a coach. Examples of reinforcing factors include:

» parental encouragement
» friend and family social support
» social influences
» parental barriers
» parental social support (e.g. take child to the park, drive child to training/park, pay fees for programs)
» parental belief systems
» PE teacher providing active opportunities.

These factors can influence a child's physical activity directly or indirectly. The messages parents, teachers and coaches send to a child about physical activity can influence the child's interest, perceived confidence and, ultimately, their behaviour.

Demographics

The YPAP model incorporates different demographic variables, recognising that these variables can influence each major component. 'Personal demographics' refers to:

» age
» gender
» ethnicity/culture
» socioeconomic status.

For example, there are generally significant gender differences in each primary domain (predisposing, enabling and reinforcing). Research suggests boys are more intrinsically driven towards physical activity, where girls may depend on extrinsic incentives and require reinforcement to develop or maintain interest. Age and maturity can also play a key role. Young people also vary in terms of cultural differences and differences between individuals.

Promoting physical activity using the YPAP model

Greg Welk, who developed the YPAP model, suggested that the most effective way to promote youth physical activity is to develop approaches that:

» emphasise perceptions of competence (I am able)
» generally attract young people to physical activity (It's worth it)
» are comprehensive
» are community-based initiatives that address each link in the model
» are consistent with the social-ecological framework
» promote physical activity through a coordinated school health program, with links established between school, family and community.

TABLE 14.4 Promotional issues for consideration when implementing the YPAP model in school PE, in families and in the community

Setting	Consideration
Physical education (school)	The major role of school physical education is to influence a child's enabling and predisposing factors. This can be achieved by creating written goals and objectives for activity, fitness skills and knowledge. In the PE curriculum skills and competencies are progressively built. Children need to master a variety of skills. During middle and secondary school, adolescents need to build on the broad base set in childhood to learn behavioural skills (self-monitoring, self-reinforcement and program planning) that will promote lifelong patterns of physical activity.
Family influences	The YPAP model encourages reinforcement, beyond parents being active role models or being active with the child, to also include parental encouragement and influencing children's behaviour indirectly through predisposing factors.
Community programs	Community-based programs offer a cost-effective option to reach a larger number of people. Children need accessible facilities and programs that include sport and non-sport activities, walking and bike paths and parks. Community-based activity programs need to focus on individual level mastery and fun, rather than competition. As many young people have working parents, physical activity opportunities in after-care programs are important.

Most children start out active; as they get older, however, sociological, cultural and personal factors begin to influence their choices.

The YPAP model provides a conceptual framework for understanding the factors that may predispose, enable and reinforce a child to be physically active (Welk, 1999). The model is underpinned by the general principles of the social-ecological models to include dimensions of influence (intrapersonal, sociocultural and environmental) and recognise the interactions between the various factors. Finally, the model is behaviour-specific and was designed specifically for children and youth.

The YPAP model provides a simple way to conceptually integrate potential influences from school, family and community interventions into a single model of activity behaviour for children (Welk, 1999).

INVESTIGATION

YOUTH PHYSICAL ACTIVITY PROMOTION SURVEY

The following survey is based on the YPAP model and was developed by Associate Professor Amanda Telford. Think about a new physical activity model that has been introduced, or that your school is thinking about introducing (e.g. yoga, tchoukball, speedminton, taekwondo, water polo, speedball, ultimate, quidditch). It just has to be new for you.

Complete the survey below by linking to a digital survey on your student website (http://nelsonnet.net.au). You will need your login code.

Scaffold

	Predisposing (Am I able?)	Scale
1	I am confident I could try/play the new physical activity.	SA^{5} A^{4} N^{3} D^{2} SD^{1}
2	I am good at physical activity and sport.	SA^{5} A^{4} N^{3} D^{2} SD^{1}
3	I am competent in the skills I would need to play the new physical activity.	SA^{5} A^{4} N^{3} D^{2} SD^{1}
4	I am confident I could master the skills required to participate in the physical activity.	SA^{5} A^{4} N^{3} D^{2} SD^{1}

	Predisposing (Am I able?)	Scale
	Is it worth it?	
5	I would enjoy participating in the new physical activity.	SA^5 A^4 N^3 D^2 SD^1
6	I have a positive attitude towards being physically active.	SA^5 A^4 N^3 D^2 SD^1
7	I believe being active is good for me.	SA^5 A^4 N^3 D^2 SD^1
8	I can't be bothered trying a new physical activity. (Note: reverse score for negative statement)	SA^1 A^2 N^3 D^4 SD^5
9	I expect participation in the new physical activity would improve my fitness/health.	SA^5 A^4 N^3 D^2 SD^1
10	Being active is important to me.	SA^5 A^4 N^3 D^2 SD^1
	Reinforcing factors	
11	My parent A is regularly active.	SA^5 A^4 N^3 D^2 SD^1 NA
12	My parent B is regularly active.	SA^5 A^4 N^3 D^2 SD^1 NA
13	My siblings are regularly active.	SA^5 A^4 N^3 D^2 SD^1 NA
14	My parents/guardian remind me to be active.	SA^5 A^4 N^3 D^2 SD^1 NA
15	My parents/guardian encourage me to be active.	SA^5 A^4 N^3 D^2 SD^1 NA
16	My parents/guardian praise me for being physically active.	SA^5 A^4 N^3 D^2 SD^1 NA
17	My peers are regularly active.	SA^5 A^4 N^3 D^2 SD^1 NA
18	My peers encourage me to be regularly active.	SA^5 A^4 N^3 D^2 SD^1 NA
19	My coach encourages me to try new physical activities.	SA^5 A^4 N^3 D^2 SD^1 NA
	Enabling factors	
20	How would you rate your personal fitness level from 1–10 (1 = Not at all fit; 10 = very fit)	
21	My school has PE timetabled how many times per week?	5 4 3 2 1
22	I have walking trails near my house.	Yes^2 No^1
23	I can access programs in my community.	Yes^2 No^1
24	I can access physical activity facilities in my local community.	Yes^2 No^1
25	I can access interschool sport teams in my school.	Yes^2 No^1
26	I can access lunchtime activities at my school.	Yes^2 No^1
27	I have a park within walking distance from my home.	Yes^2 No^1
28	I have exercise equipment in my home.	Yes^2 No^1
29	How big is your yard/outdoor space to play in?	V Large^5 Large^4 Medium^3 Small^2 No yard^1
30	How long do you spend outdoors per day?	5+ hrs^5 3–5h^4 1–2h^3 less than 1h^2 None^1

Add up your total __________________ score

The higher the score the more likely you are to be regularly active.

Video

QUICKVID

Watch a short video by the author on changing behaviour using social-ecological models. Login via http://nelsonnet.com.au and your login code. Go to chapter 14, page 298.

CHAPTER SUMMARY

- Individual (intrapersonal) theories explain health behaviour and behavioural change by focusing on individual factors. To design effective interventions requires an understanding of the role of the individual in physical activity behaviour.
- Social-ecological models of physical activity are characterised by multiple levels of influence on behaviour. They reinforce the interplay of the following types of factors influencing physical activity behaviour:
  - individual (or intrapersonal), including demographic and psychological factors
  - social (interpersonal) environment
  - physical environment
  - policy and organisational.
- Interpersonal (social environment) theories explain behaviour by focusing on the interaction between the individual and the environment.
- Determinants are factors that influence how active a person is. In general, these factors do not influence behaviour in isolation, and a combination of factors may be at play.
- Interpersonal refers to the formal and informal social climate and support network and systems surrounding an individual.
- The physical environment plays a huge role in influencing physical activity behaviour, in terms of both the natural environment and the constructed environment.
- Policies can relate to the governance of incentives for activity or inactivity or the governance of resources and infrastructure related to activity or inactivity.

CHAPTER REVIEW

Multiple-choice questions

1 The Youth Physical Activity Promotion model:
   A is a theory
   B is a model based on the social-ecological model
   C is designed for adult physical activity
   D focuses primarily on individual-level factors.

2 Which of the following is an example of an enabler within the social environment?
   A Timetabled PE classes
   B A buddy system of Year 10 students encouraging Year 7s to be active
   C New walking trail
   D Removal of schoolyard seating

Short-answer questions

3 a Introducing new resources and facilities can be a useful environmental strategy for the promotion of physical activity. Would building a set of bike racks on an unused car parking space be a change to the natural environment or the constructed environment? Explain your answer.
   b Describe four examples of environmental changes that could be made to facilities in a workplace to promote physical activity.
   c Describe an educational program that could support these environmental changes.
   d Provide an example of a policy that could also accompany the environmental changes you proposed in part b.

4 Explain what is meant by tailoring, in relation to programs that promote physical activity. Include an example in your response.

5 Explain the difference between the natural and man-made environment as it relates to physical activity.

6 Explain the meaning of reciprocal causation in relation to social-ecological models of physical activity.

7 a Identify the four key levels of the social-ecological model according to Table 14.3.
   b List three factors within each of the levels.
   c Explain one of these factors. Include an example in your response.

CHAPTER 15

PROMOTING PHYSICAL ACTIVITY AND REDUCING SEDENTARY BEHAVIOUR

Key knowledge

- a range of physical activity promotion and sedentary behaviour reduction initiatives and strategies that target different populations based on factors such as age, sex and gender, as well as people with disabilities, cultural and Indigenous groups
- settings-based approaches (schools, workplaces and community) to reducing sedentary behaviour and promoting physical activity

Key skills

- apply a social-ecological model and/or the Youth Physical Activity Promotion model to critique physical activity initiatives and strategies aimed at increasing physical activity and/or reducing sedentary behaviour for a range of populations in a variety of settings

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PHYSICAL ACTIVITY PROMOTION

Varying approaches to health promotion are commonly used when promoting physical activity. This chapter provides an overview of several strategies used. Physical activity is an extremely complex health behaviour influenced by different factors on several levels. The most effective interventions target changes in four of these levels:

» individual (intrapersonal)
» social (interpersonal)
» physical environment
» policy.

Physical activity promotional strategies can be classified into two major categories: individual approaches and population-based approaches (see Table 15.1). Different strategies are used depending on the level being targeted. One, or several, individual-level and/or population-level strategies may be applied within a **settings-based approach** to physical activity promotion. The setting or focus, for example, might include primary schools, a specific community, families or workplaces.

TABLE 15.1 Examples of strategies used to promote physical activity

Individual level	Population level
Print and web-based media	Environmental change
Counselling	Policy
Processes of change	Mass media

This chapter will discuss components of the social-ecological model and the Youth Physical Activity Promotion model, which both use a combination of approaches at both the individual level and the population level. It will look at examples of initiatives and strategies to promote physical activity and reduce sedentary behaviour in specific target populations. However, before exploring these examples, you will need a sound understanding of individual- and population-level strategies used to promote physical activity.

Individual strategies for promoting physical activity

Reducing physical inactivity involves changes to both individual behaviour and the environment, but most physical activity research tends to focus on changing individual behaviour. Many health professionals, health educators, medical practitioners and psychologists also use approaches that encourage the individual to change their behaviour. Individual approaches focus on biological, **cognitive** and behavioural factors.

Print and web-based media

Print materials promoting physical activity include booklets, brochures, handouts and websites. Print materials are available from:

» community-based recreational centres (sporting clubs, leisure centres, fitness clubs, weight-control centres)
» healthcare providers such as medical practices, rehabilitation centres (physiotherapy, osteopathy, chiropractic, massage therapy), hospitals and chemists
» schools and workplaces
» government, industry and commercial websites.

Some community-based programs mail out information regularly to their participants. The main advantage of print-based information is that it does not require access to the internet or a computer, which can sometimes be difficult for older people, people of low socioeconomic status (SES) and those from non-English-speaking backgrounds (NESB).

Web-based media such as Twitter, Facebook, email and text messages has enormous potential to communicate information widely. Interactive websites allow people to find advice that suits their level of physical activity and motivational readiness. Prompts that can be delivered via online technologies can be tailored to a person's level of physical activity, and apps can link to wearable activity monitors.

However, while web-based approaches can be effective in the short term, the novelty value of some websites and email reminder systems appears to wear off after initial use. More research is needed in this area to understand its potential for behavioural change.

FYI

Instead of a prescription for medication, a GP may prescribe a specific 'dose' of physical activity, such as walking for 35 minutes five times per week. These prescriptions can be tailored either to the patient's condition (for example, obesity, type 2 diabetes, hypertension, cardiac rehabilitation) or to the population subgroup to which the patient belongs.

Counselling

Counselling is a widely used individual approach to physical activity promotion. Advice about being physically active can be provided by a personal trainer, general practitioner (GP), osteopath, physiotherapist, physical activity adviser, physical education teacher, fitness instructor or psychologist. Counselling has proven to be a very effective method of promoting physical activity at an individual level. Advice about physical activity may be delivered via:

» health-professional counselling
» telephone or email/online counselling
» automated telephone- or online-delivered advice (via text messages, email, etc.).

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Why is a GP in an ideal position to counsel people about the benefits of physical activity?

Strategies used in counselling

Many strategies can be employed during counselling sessions at an individual level. The following section will briefly outline the following eight commonly used strategies (Blair et al., 2001):

1 assessing motivational readiness
2 matching **processes of change** with motivational readiness
3 identifying opportunities to be active
4 contracting
5 enlisting social support
6 reminder systems
7 gradual programming
8 tailoring.

1 Assessing motivational readiness

One of the first steps when counselling someone to become more active is to find out how ready they are to make changes. This is called motivational readiness. Once a person's stage of motivational readiness is known, strategies can be tailored to meet their needs.

2 Matching processes of change with motivational readiness

The processes of change are the ways in which people change their physical activity behaviour. Processes of change (Table 15.2) can be grouped into two categories: cognitive and behavioural.

TABLE 15.2 The processes of physical activity behavioural change

Cognitive strategies	Behavioural strategies
Increasing knowledge Encourage the individual to read and think about physical activity.	**Finding alternatives** Encourage the individual to participate in physical activity when they are tired, stressed or unlikely to want to be physically active.
Being aware of risks Ensure the individual understands that being inactive is very unhealthy.	**Enlisting social support** Encourage the individual to find a family member, friend or co-worker who is willing and able to provide support for being active.
Caring about consequences to others Encourage the person to recognise how their inactivity affects their family, friends and co-workers.	**Rewarding yourself** Encourage the individual to praise and reward themselves for being physically active.
Comprehending benefits Assist the individual to understand the personal benefits of being physically active.	**Committing yourself** Encourage the individual to make promises, plans and commitments to be active, and then write these down.
Increasing healthy opportunities Help the individual to increase their awareness of opportunities to be physically active.	**Reminding yourself** Teach the individual how to set up reminders to be active, such as keeping walking or running shoes in the car and at the office, ready to be used at any time.

Adapted with permission, from BH Marcus and LH Forsyth, 2009, *Motivating people to be physically active*, 2nd ed., Champaign, IL, Human Kinetics, 18

The most successful counselling intervention programs tailor or match their materials and information to the individual's level of physical activity. This is sometimes referred to as 'stage-matched' materials. Research has shown that basing the processes of change on the individual's activity level results in a greater success rate.

In general, people who are not meeting the physical activity guidelines require mostly cognitive processes, with some behavioural processes, while people who regularly meet the guidelines typically use mostly behavioural processes and some cognitive processes. In a stage-matched intervention, individuals who are not meeting the guidelines might benefit from cognitive strategies such as increasing awareness and knowledge of the benefits of physical activity. The focus for individuals who are meeting the guidelines might include behavioural strategies such as developing a reminder system and using rewards for being physically active (see Table 15.2).

DATA ANALYSIS

PROCESSES OF CHANGE QUESTIONNAIRE

1 Complete the questionnaire developed by Marcus and Forsyth (2009), the first four questions of which are shown below. Circle the appropriate number for each of the 40 items. You can find a digital copy on the NelsonNet student website, http://www.nelsonnet.com.au. You will need your login code.
2 Table 15.3 (page 306) shows which items relate to each process of change. To find your average score for each process, add the four numbers you circled for those items and divide by four. (For example, for 'increasing knowledge', add the numbers you circled for items 5, 8, 17 and 28. Divide the total by 4.) Do not score an individual process if fewer than three items were answered.
3 Compare your scores with those in Table 15.4, which shows the average scores by activity level for the questionnaire.

Scaffold

QUESTIONS

1 In which three processes of change did you score highest?
2 In which three processes of change did you score lowest?
3 Describe the strategies you could use to improve three of your processes of change.

Processes of change questionnaire

Physical activity or exercise includes activities such as walking briskly, jogging, cycling, swimming or any other activity in which the exertion is at least as intense as these activities.
The following experiences can affect the exercise habits of some people. Think of any similar experiences you may currently have or have had during the past month. Then rate how frequently the event occurs. Please circle the number that best describes your answer for each experience.
How frequently does this occur?

1 = never 2 = seldom 3 = occasionally 4 = often 5 = repeatedly

1 Instead of remaining inactive I engage in some physical activity.	1	2	3	4	5
2 I tell myself I am able to be physically active if I want to.	1	2	3	4	5
3 I put things around my home to remind me to be physically active.	1	2	3	4	5
4 I tell myself if I try hard enough I can be physically active.	1	2	3	4	5

Source: Marcus & Forsyth, 2009

TABLE 15.3 Grouping related items on the processes of change questionnaire

Process	Items
Increasing knowledge	5, 8, 17, 28
Being aware of risks	11, 12, 13, 14
Caring about consequences to others	30, 33, 34, 37
Comprehending benefits	15, 31, 35, 38
Increasing healthy opportunities	10, 22, 32, 36
Substituting alternatives	1, 21, 39, 40
Enlisting social support	16, 19, 24, 25
Rewarding yourself	7, 18, 20, 23
Committing yourself	2, 4, 6, 27
Reminding yourself	3, 9, 26, 29

Source: Marcus & Forsyth, 2009, p. 59

TABLE 15.4 Average score by physical activity level for the processes of change questionnaire

Process	Inactive	Low active	High active
Increasing knowledge	1.88	2.76	2.99
Being aware of risks	1.92	2.26	2.46
Caring about consequences to others	1.82	2.46	2.47
Comprehending benefits	2.14	3.22	3.28
Increasing healthy opportunities	2.14	2.75	2.79
Substituting alternatives	1.71	2.72	3.55
Enlisting social support	1.78	2.42	2.64
Rewarding yourself	1.52	2.54	3.01
Committing yourself	2.08	3.17	3.68
Reminding yourself	1.42	2.02	2.20

Source: Marcus & Forsyth, 2009

3 Identifying opportunities to be active

Before you can identify times during the day when you could be more active, you need to be aware of how often you move. You may be surprised at the amount of time you spend sitting each day when travelling to school, in class and after school. (See the sample daily personal activity record or diary below.) Modern technology has minimised the need to move, meaning people today sit for hours longer than previous generations.

It is also important to identify alternatives for certain situations. For example, if it is raining, walking around a shopping centre or large indoor market would be a good alternative to outdoor exercise. If it is too windy to go bike riding, use an exercise bike instead.

FYI

If you walked up and down every aisle of a large Bunnings store, you would accumulate over 2 km on your pedometer!

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Physical education teachers and coaches can assist young people to identify opportunities to be physically active. Can you identify adults in your life who can assist you to identify opportunities in your school or community?

A blank copy of this sample daily personal activity record or diary is available on your student website: http://www.nelsonnet.net.au. You will need your login code.

Scaffold

Sample daily physical activity record (diary)			
Date: *4 July*	Weekday/weekend day (circle)		
Time (duration & frequency)	Activity (type)	Physically active	
		Yes	No
7 a.m.–9 a.m.	*Shower, got dressed*	*5 min.*	
	Walked to bus stop	*8 min.*	
	Travelled by bus to school		*13 min.*
	Walked to class	*2 min.*	
9 a.m.–12 p.m.	*Sat in English class*		*100 min.*
	Walked to canteen	*2 min.*	
	Sat and talked with friends at recess		*20 min.*
	Sat in Biology class		*50 min.*
12 p.m.–4 p.m.	*Sat with friends on oval*		*45 min.*
	Walked to class	*3 min.*	
	Sat in Maths class		*50 min.*
	Travelled home by bus		*12 min.*
	Walked down to local shops	*15 min.*	
4 p.m.–10 p.m.	*Watched television*		*120 min.*
	Chores	*15 min.*	
	Netball game	*40 min.*	
	Homework		*120 min.*
	Ate, and watched more television		*65 min.*
	Total time	*90 min.*	*645 min.*

4 Contracting

A useful strategy for encouraging someone to make a commitment to an activity plan is to write up a simple contract that states your activity goals and have a witness sign it. Having someone check on your progress regularly makes you more accountable for your behaviour. Ensure that goals can be measured and are specific, and set a date to assess your progress.

If you have met your goal, you should reward yourself. Rewards might include dinner at your favourite restaurant, going shopping or going to the movies. Punishments can also be used, but these should be determined by you, not the witness. An appropriate punishment might be no television or computer games for a week, or no chocolate for five days. Punishments should not be in the form of physical activity.

PRACTICAL ACTIVITY

KEEPING A DIARY OF PHYSICAL ACTIVITY

Refer to the sample diary on page 307.

1 Keep a similar diary during a typical weekday and repeat for a weekend day. You may choose to complete this exercise with a family member who is generally less active than you.
2 After you have completed the diary, try to identify potential times when you could reduce the amount of time spent being sedentary (e.g. watching TV, using the computer) and replace this with some physical activity. Suggest three ways you could easily incorporate physical activity into your day without making major changes to your lifestyle.
3 Identify three strategies you could use to turn light activity (for example, shopping, doing chores or walking to the cafe) into moderate-intensity activity.
4 Devise an activity plan that includes activity type, frequency, duration, intensity and context (for example, who you do it with, or in what setting).

5 Enlisting social support

Not having an exercise partner is often reported as a barrier to physical activity. Studies indicate that having someone to exercise with greatly increases your chances of being sufficiently active. Among older women, having social support is the most consistent predictor

Getty Images / Zia Soleil

Social support is one of the strongest predictors of meeting the physical activity guidelines. What kind of group do you think is shown here?

of a long-term commitment to being active. Individuals should be encouraged to actively seek other people to be active with, such as family members, partners, friends, work colleagues or other community members.

6 Reminder systems

Reminding yourself to be active is an essential strategy, especially when you have not been regularly active for at least six months. Reminder systems could include:

» leaving yourself a note on the refrigerator, computer or mirror
» writing a note in your diary
» putting a poster on your office wall or on a wardrobe door
» asking a friend to send you an email, text message or Facebook message reminding you to get up from your desk regularly, or to see if you want to meet at the park for a walk
» setting reminders using your computer or mobile phone.

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How do you remind yourself to be regularly active?

7 Gradual programming

Gradual programming is essentially the same principle as 'progressive overload', one of the training principles you will learn about later in VCE PE. Gradual programming requires a gradual increase in workload, frequency or intensity. For people who have not been regularly active for many years, or who have never been regularly active, a slow, step-by-step approach is desirable. It is unrealistic to expect these people to meet the physical activity guidelines after only a few months of being active or attempting to be active. These individuals must build their activity gradually. For a beginning exerciser, being exhausted at the end of a session greatly reduces the likelihood that they will continue to be active.

8 Tailoring

Wholesale exercise programs are constantly marketed as the perfect way for any individual to become more active or increase their fitness. But just as no two people are the same, no two physical activity programs should be the same. Tailoring allows a counsellor (for example, a personal trainer) to prescribe a physical activity plan that meets the individual needs of each person. Individual factors to consider include social support, access to walking trails and other facilities, work hours and settings, whether the person is a morning person, when they eat throughout the day, cultural factors, family structure, fitness levels and climate. It is impossible to write a one-size-fits-all physical activity program based only on the individual's goals.

CHAPTER CHECK-UP

1. List five professions or occupations that are likely to use counselling to encourage individuals to be more physically active.
2. State three methods of delivering physical activity advice, and describe one of them.
3. Outline six strategies used in physical activity counselling, and summarise two of these.
4. Describe two cognitive and two behavioural processes of change.
5. Provide specific examples of two cognitive and two behavioural strategies that people could employ to become more active.

Population-based approaches to physical activity promotion

The Ottawa Charter, released by the World Health Organization (WHO) in 1986, identified the need for a multilevel approach to health promotion that considers the important role the environment and public policy play in health (USDHHS, 1999). Research in physical activity during the late 1990s and early 2000s has moved away from understanding change in physical activity levels among individuals, and has become more focused on supportive environmental and policy interventions. These kinds of interventions have enormous potential, as they are designed to impact on large groups and populations.

Environmental strategies and tailoring

Physical activity intervention programs should be tailored to settings. For example, installing bicycle racks may promote cycling to school in a rural area, but may be impractical in a suburban area with limited bike paths and heavy traffic. Examples of strategies used in various settings are provided later in this chapter.

Removing impediments to activity

Sometimes the goal of environmental intervention is to remove barriers to people being active (as discussed in chapter 12), such as heavy traffic and 'stranger danger' or other street crime. Environmental changes, such as the installation of speed humps and reduced speed limits near school zones, can significantly reduce the volume and speed of the traffic, increasing safety for pedestrians and cyclists.

Introducing new resources and facilities

Other environmental interventions aim to provide resources that facilitate activity, such as:

» installing showers in the workplace
» providing footpaths and bike trails in the community
» installing a new or upgraded playground in a local park or school.

Educational programs

Whenever possible, environmental interventions should precede educational programs. For example, a media campaign encouraging people to walk in their neighbourhood will not have much impact in an area where footpaths are poorly maintained and drug deals take place in the park. Instead of a media campaign, the priority in this neighbourhood would be to reduce crime and provide a safe recreational environment for people to be active in. Only then can an educational program successfully encourage people to walk in their neighbourhood.

Environmental and policy targets for physical activity interventions

Table 15.5 lists examples of physical activity interventions in the following four categories:

» natural environment
» constructed (built) environment factors
» policies related to incentives
» policies related to resources and infrastructure.

TABLE 15.5 Suggested environmental and policy interventions for promoting physical activity

Natural environment factors	Constructed (built) environment factors	Policies related to incentives	Policies related to resources and infrastructure
Weather In wet or cold areas, provide additional resources for indoor activities and activities such as skating and cross-country skiing.	**Information environment** Provide prompts to be active, delivered via TV, radio, billboards, internet or posters in various settings.	**Information environment** Use a variety of media to publicise incentive programs or physical activity contests.	**Information environment** Require TV broadcasters to provide as much time for promoting physical activity as they give to promoting their own programs.
Geography In hilly areas, provide recreation centres in each valley. Construct walking/biking trails through valleys.	**Suburban environments** Establish walking/biking trails, separate from roads, that connect homes with shopping areas. Create more parks and recreation centres.	**Suburban environments** Target incentive programs for suburban dwellers to use cars less and active transport more.	**Suburban environments** Require building codes to mandate that shopping be within a 10-minute walk of all homes. Require bike paths for transport. Require numerous parks and recreation centres.
	Buildings Separate buildings from car parks by green space. Make stairways more open, accessible and attractive.	**Buildings** Sponsor competitions for stair use in multistorey buildings.	**Buildings** Change building codes to require car parks to be located away from buildings and to make stairways more accessible.
	Work environments Install showers and changing rooms in workplaces. Provide secure parking for bicycles.	**Work environments** Subsidise health club memberships for employees. Pay employees a per-kilometre rate for transport by bicycle. Reduce insurance rates for active and fit employees.	**Work environments** Require showers and changing rooms in workplaces. Require secure parking for bicycles.
	Entertainment infrastructure Develop more electronic games that require activity. After movies, show advertisements that encourage activity.	**Entertainment infrastructure** Health agencies could give rewards to entertainment companies that actively promote physical activity.	**Entertainment infrastructure** Require activity promotion advertisements on TV and after movies.
	Transport infrastructure Build more walking/biking trails. Provide more bike carriers on buses.	**Transport infrastructure** Give awards to the states with the best programs for promoting active transportation.	**Transport infrastructure** Provide more funding for walking/biking trails.
	Recreation infrastructure Provide more parks and supervised programs for children and adults.	**Recreation infrastructure** Give awards to parks and recreation departments that are most effective in promoting physical activity.	**Recreation infrastructure** Provide more funding for parks and recreation departments, targeting physical activity promotion programs.

Source: Sallis, Bauman & Pratt 1998

The natural environment, including terrain, climate and vegetation, is often a barrier to physical activity. For example, if you live in the alpine region of Victoria, your physical activities during winter are likely to include snow sports or indoor activities. This would be quite different for someone living in Mildura, which has higher winter temperatures and lower rainfall.

The constructed environment (sometimes referred to as the **built environment**) may also provide barriers to being physically active. For example, it is often difficult to locate the stairs in shopping centres, while the escalator or lift is easily identified.

Nearly all interventions in the natural or constructed environment require funding, and this is usually accompanied by changes in policy. Unfortunately, these decisions are often made by agencies outside the health sector, whose primary concern is usually economic efficiencies, rather than the promotion of physical activity and healthy lifestyles.

PRACTICAL ACTIVITY

IDENTIFYING ENVIRONMENTAL MODIFICATIONS

1 Go for a walk around the area surrounding your school and identify where environmental factors have been modified to encourage physical activity.
2 Classify these factors as changes to either the natural environment or the constructed (built) environment.
3 Identify several factors in the local area that would be barriers to being active.
4 Describe 10 potential environmental changes that could be made to the local community to encourage more physical activity.
5 Rank your 10 changes along a continuum, from what you think would be the least expensive to the most expensive.
6 Explore the local park in your community and discuss the characteristics and functionality of the park.

Getty Images / David Hannah

Urban green spaces such as parks provide aesthetic environments where people can be active in their local communities.

Characteristics	Functionality	Outcomes derived from park use
Features and facilities	Space for physical activity/exercise	Physical health benefits
Condition	Social interaction	Psychological health benefits
Hygiene	Cultural activities	Social benefits
Accessibility	Rest and restitution	
Attractiveness		
Perceived safety and security		
Distance from home		

Relationship between park characteristics, functionality and outcomes

Policy

Policies may be defined as laws, regulations, formal rules, informal rules or understandings that are adopted on a collective basis to guide individual and population-wide behaviour. There are many policies that affect people's opportunities to be physically active; these policies can act as either enablers or barriers. Think about your own school: there may be policies such as no ball games in certain areas, or no access to the gym or other recreational areas before and after school; these are barriers. These kinds of policies limit physical activity opportunities for thousands of students around Victoria, although the reasons might be quite legitimate (for example, safety concerns). On the other hand, the mandated time for physical education and sport in government schools is an enabling policy because schools are expected to provide these for all students from Prep to Year 10. Policy can be classified as legislation or organisational policy.

Legislation

Legislation refers to formal, documented policies that are often governed by law-enforcement agencies and organisations. Having to wear a seatbelt in a car is an example of legislation based on an issue affecting public health. Speed limits, such as 40 km/h zones around schools, are enablers for physical activity opportunity because they increase safety for active commuting to and from school.

Organisational policies

These are designed to establish an appropriate behaviour within a particular organisation. For example, many primary schools have a SunSmart policy that prevents children playing outside unless they are wearing a hat. Although this organisational policy is designed to reduce the incidence of skin cancer, it also has a direct influence on physical activity. Teachers should monitor their classes closely to ensure that individual students are not deliberately forgetting to bring a hat in order to avoid being active or playing outside.

When you critique strategies used at the population level to promote physical activity, think about:

» tailoring
» removal of impediments

» resources and facilities
» educational programs and policies to support environmental change.

Mass media

Another approach to physical activity promotion at the population level is the use of mass media. Mass-media interventions aim to reach groups of individuals using a medium other than personal contact or face-to-face meetings. Examples of mass media include:

» online advertising, pop-ups, social media, websites
» television and radio broadcasts and advertisements
» billboards, posters and commercials at cinemas
» print media such as newspapers, magazines and brochures
» web-based interactive information.

The main benefit of using a mass-media approach is the potential to reach large numbers of people at a lower cost per person than individualised approaches. The main purpose of a mass-media campaign is to raise awareness and increase motivation. Such campaigns are important, but on their own they are not enough to significantly impact on the behaviour of individuals. Mass-media campaigns need to be combined with programs offered at a local community level.

The roles of mass media

The key roles of mass media in the promotion of physical activity include:

» increasing awareness of physical activity as a public health issue
» providing information about the health benefits associated with regular physical activity
» providing information about other non-health benefits of being active
» providing information about the consequences of inactivity
» increasing interest in physical activity participation and raising awareness of community-based programs
» motivating individuals to take action towards physical activity participation.

INVESTIGATION

Search the web for examples of mass-media campaigns, past and present, that aim to promote physical activity and reduce sedentary time.

PRACTICAL ACTIVITY

MULTIMEDIA PRESENTATION: PROMOTION OF PHYSICAL ACTIVITY

Your task is to create a media campaign promoting physical activity for a chosen target group.

1. Identify your target group (for example, parents at home with toddlers, people aged 65+ years) and discuss why you selected this group to focus on.
2. Determine which medium you will use to present your promotion (for example, video, DVD, audio recording, print, digital recording of a role-play).
3. Design a 30-second radio or television commercial, or a brochure, radio jingle, web page or slogan for a media campaign promoting physical activity among your target population.
4. Share your presentation with the rest of your class or present it to younger students in your school.
5. Discuss the potential advantages and disadvantages of using mass media to encourage people to be more active.

CHAPTER CHECK-UP

1. List three examples of population-level approaches to physical activity promotion.
2. Explain the difference between the natural and constructed environments.
3. Define the term 'policy' and explain why policy development is an extremely important component in the promotion of physical activity at the population level.
4. List three key roles of mass media in the promotion of physical activity.

Key promotion groups

Promotion of physical activity and reducing sedentary behaviour are in the best interests of all Australians. Promoting active lifestyles is the responsibility of a range of key organisations and groups, including:

» the Australian Government's Department of Health
» state and local governments
» government agencies
» non-government agencies and organisations
» national sporting organisations (NSOs) and state sport associations (SSAs)
» the Australian Sports Commission
» local sporting clubs and coaches
» sporting and recreational providers
» schools
» parents
» commercial industries
» allied healthcare providers
» researchers.

The Australian Government's Department of Health:

» is responsible for the monitoring and surveillance of health behaviours including physical activity
» publishes a wide range of information about physical activity benefits, guidelines and initiatives (relating to healthy eating, regular physical activity and weight management) to support all Australians to lead healthy and active lives
» funds research and promotion initiatives.

INVESTIGATION

Check out the Australian Department of Health via http://vcepe12.nelsonnet.com.au for publications and information about physical activity initiatives and reducing sedentary behaviour.

Weblink

Blueprint for an active Australia

In 2014 the National Heart Foundation released the second edition of the *Blueprint for an Active Australia*, outlining the evidence and a range of areas to be addressed to achieve a more physically active Australia. The blueprint reinforces the need for a coordinated and strategic national effort. Developed by leading academics in physical activity research, it comprehensively focuses on 13 action areas:

- built environments
- workplaces
- healthcare
- active travel
- prolonged sitting
- sport and active recreation
- disadvantaged populations
- Aboriginal and Torres Strait Islander peoples
- children and adolescents
- older people
- financial measures
- mass-media strategy
- research and program evaluation.

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The National Heart Foundation's *Blueprint for an Active Australia* contains strategies for improving the health of Australians by increasing their physical activity.

Each action area highlights:

- the existing evidence and why the action area is important
- what must be done to increase physical activity
- changes to policy and to physical environments, such as facilities
- the need for programs and initiatives.

Blueprint for an Active Australia is a comprehensive resource and a great starting point when completing your research on a contemporary issue in physical activity later in the course.

A SETTINGS-BASED APPROACH

As a result of social, environmental and lifestyle changes over many years, today there are limited opportunities to move and expend large amounts of energy as part of our daily routine. The increasing use of technology within the westernised world has had a detrimental effect on health; increased mechanisation has led to reduced physical activity within daily life. Several other factors contribute to this problem – it is not only about individual behaviour. These factors include:

- urban planning, which restricts opportunities for physical activity
- an increased reliance on motorised transport

» increased working hours
» an increased demand on public open space
» increased demands on the education curriculum
» changing leisure patterns, which contribute to the emerging pattern of inactivity (Government of South Australia, 2004).

A review by Salmon et al. (2000) concluded that a settings-based approach has been the most popular strategy for promoting physical activity in Australia. Interventions have been conducted in community settings, workplace settings, and school and university settings. However, most of the strategies to promote physical activity within these settings have employed individual methods of behaviour change. In addition, although many of the interventions demonstrated short-term success, few evaluated long-term effects, and those that did found weak evidence of long-term maintenance of behaviour change.

A multilevel approach that uses individual methods of behaviour change within a settings-based approach, and includes environmental policy support, appears to be the most viable strategy for sustained behaviour change (Salmon et al., 2000). Further research by Salmon concluded that many studies used multiple settings to promote physical activity to children and adolescents, making it difficult to differentiate the independent effects of promoting physical activity in the community (Salmon et al., 2003).

A range of individual- and population-level strategies used to promote physical activity was described earlier in this chapter. This chapter will also describe many specific strategies and initiatives used by government and non-government organisations to promote physical activity. When these strategies are implemented, it is usually within a specific target setting such as a school, childcare centre, transport system, community centre, workplace, healthcare centre, family home or local park.

Intervention strategies aimed at promoting physical activity for all members of the community often use a settings-based approach. A setting is broadly defined as a geographical area or institution containing a large 'captive' audience, where health messages can be delivered efficiently (Sallis & Owen, 1999). This chapter will focus on intervention strategies and initiatives used within three key settings: schools, workplaces and the community. Before exploring some examples of specific initiatives, first consider the potential of each of these key settings as a place to promote physical activity.

REAL WORLD APPLICATION

A day in the life of a child

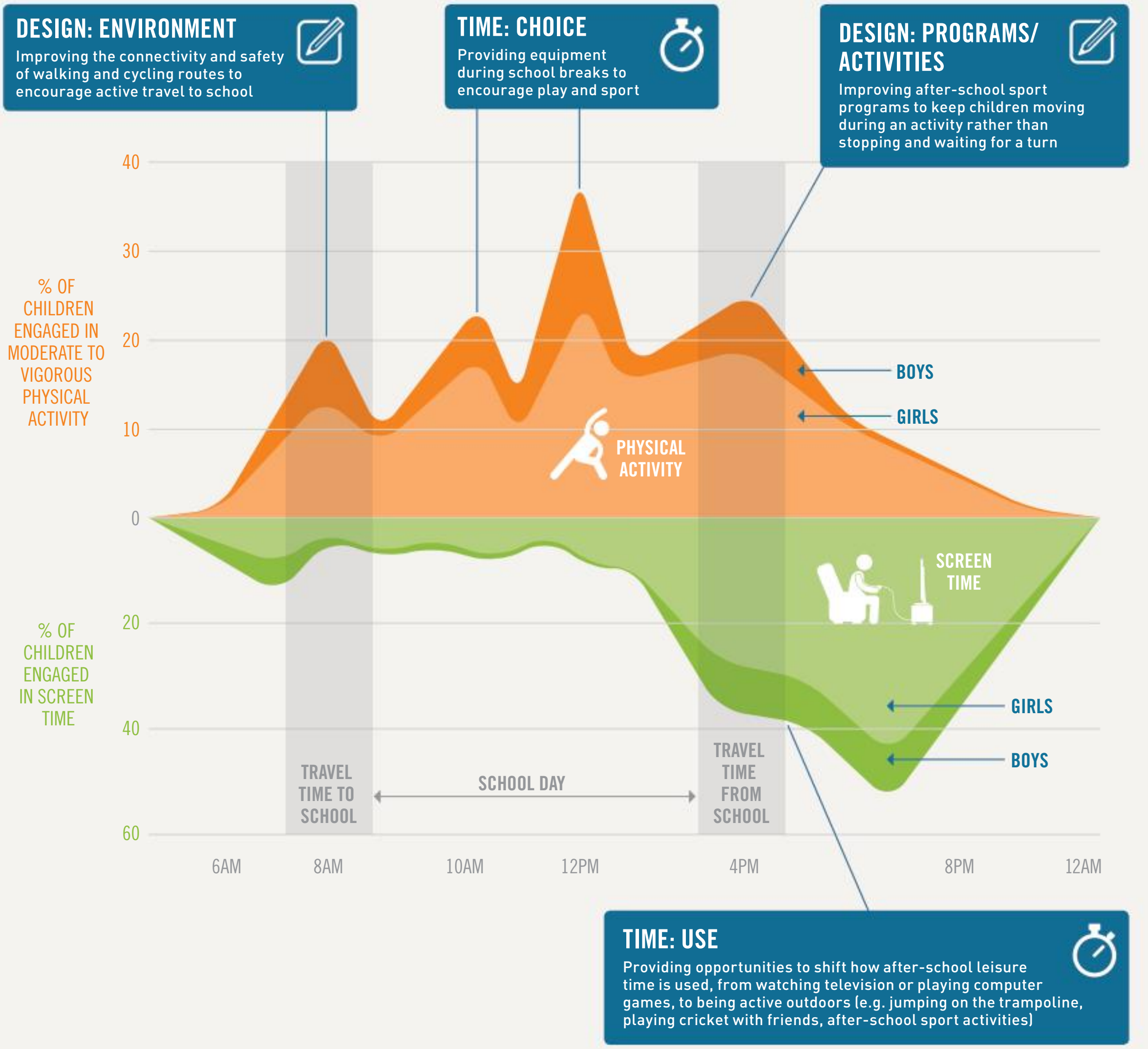
The following page from the 2014 *Active for Life* resource depicts a day in the life of a child. It highlights the opportunities for a child to be active within the home, school and community settings and through active commuting between these settings. Opportunities exist when travelling to and from school, during active breaks, recess and lunch breaks, physical education and sport in schools, active play and sport during leisure time and after-school care settings.

Using an example of a child's school day, we can begin to map a child's interactions with the places where they live, learn and play – across each of the school, sport, community and home settings. We can see that opportunities for physical activity are influenced by the structure of their day.

Working within that structure, we can begin to consider the concepts of design and time to get children moving more and sitting less, from the time they get up in the morning to when they go to bed.

A day in the life of a child

Looking closely at a child's daily routine helps us to understand current patterns of activity and sedentary behaviour and, consequently, where there are the greatest opportunities for making a difference.



Source: VicHealth, *Active for Life*, 2014

Questions

1 Identify the key settings for children to be (a) physically active and (b) sedentary.
2 For each setting, outline the active opportunities depicted in the graph.
3 Describe the time periods associated with the most screen time and physical activity.

Research suggests that working through a range of settings provides the opportunity to influence policies and programs and reach different target groups within the population (NPHP, 2004). The National Heart Foundation of Australia recommends that a comprehensive multi-strategy approach to increasing community levels of physical activity should be employed through the settings where Australians live and work. The World Health Organization (WHO) recommends that school, workplace and community settings offer practical opportunities and structures for the implementation of comprehensive strategies. Within a settings-based approach, the choice to be physically active needs to be made convenient, easier, safer and more enjoyable through initiatives designed to create an environment supportive of participation in physical activity.

SCHOOL SETTINGS

Schools play an essential role in providing a physical and social environment that supports children, their parents and the whole school community in enjoying an active life. A school setting has the potential to reach large numbers of children within one local area for a significant proportion of their lives. It provides access to at-risk groups such as inactive children.

Physical education and sport education classes provide opportunities for all students to participate in curriculum-based programs to develop fundamental motor skills. Outside the formal classroom setting, there are also opportunities for play at various times throughout the day, including before- and after-school programs and participation in sport and extracurricular or co-curricular activities.

The *Active for Life* resource published by VicHealth (2014) outlines a range of practical action for building physical activity in the school environment. Table 15.6 summarises the six recommended actions and examples of how schools can build physical activity into the school environment. VicHealth offers a range of freely available online publications for schools encouraging active play, walking, sport and active transport to and from school.

TABLE 15.6 Actions for schools to build physical activity in the school environment

Action	Practical strategies for schools to consider
Introduce variety into play spaces, temporary play equipment or structures to stimulate children's imagination and interest and encourage play-based activity	» Introducing pop-up play spaces to provide new play experiences » Using a variety of equipment or objects, such as car tyres, to stimulate creative play » Encouraging multiple uses of spaces for a variety of sports, games and activities, such as putting temporary tennis nets on a basketball court
Explore alternative options for delivering sport and physical education, to enhance students' fundamental movement skills, enjoyment and participation	» Student-led classes, to improve students' experiences, skills and ability, develop student leaders and enhance social connections across the school » Sharing trained teachers, sports equipment and temporary play facilities with nearby schools to reduce costs and enhance physical activity opportunities for students

TABLE 15.6 (continued)

Action	Practical strategies for schools to consider
Consider a whole-school approach to physical activity involving students, staff, families and community organisations to encourage positive attitudes towards physical activity in children and more active lifestyles for families	» Fostering links with sports and recreation clubs, local councils, or creating new non-traditional community partnerships, for example, with local workplaces » Creating greater awareness among parents and children of the opportunities to be active outside the school » Strengthening relevant school policies to support physical activity
Change teaching and learning methods across subject areas and modify the learning environment to integrate elements of physical activity within the existing school curriculum	» Holding outdoor or walking classes » Incorporating outdoor activities and projects in subjects such as maths, science and geography » Using sport, dance, active play or walking in delivering the school curriculum » Using standing lessons to break up extended sitting time
Engage students to lead the solutions to encourage walking and riding to school, such as through a school project or student committee. This will help to raise students' awareness of active travel options, engage parents in the discussion and strengthen links between the school and local stakeholders, such as councils and public transport operators	» Engaging students in the design and provision of safe and secure bike parking » Undertaking school projects focused on active travel, such as walkability audits

Source: VicHealth, *Active for Life*, 2014

One of the Heart Foundation's recommendations is to ensure that physical education is provided to all children in all schools, and that physical activity opportunities are available to children and adolescents in the broader community. Obviously, schools are a key setting for implementing this recommendation.

Lifelong physical activity behaviours are initially developed in schools. Schools are busy places and are often expected to address all of society's ills, including violence, poor nutrition, obesity and poor manners. Within the crowded curriculum, physical education sometimes has to fight to obtain or maintain high-value class time within the weekly timetable; in some schools the crowded curriculum is a barrier to providing opportunities for regular participation in physical activity. In secondary schools there is difficulty in accessing and intervening in the curriculum and extracurricular programs as even more pressure is placed on students and teachers. As a result, a substantial decline in participation can occur during the secondary years of schooling.

FYI

TAKE10 is a program that brings physical activity into the classroom by integrating movement, nutrition and health with core academic content using fun and creative 10-minute activities for primary school children. In 2016 the program was implemented in over 50 00 classrooms, reaching more than 1 million students in the USA. (Source: http://take10.net/)

Social environment approaches

» Introduce a common-interest group or school working party of staff, students, families and organisations to develop sustainable ideas to promote physical activity.
» Ensure adequate supervision during lunch breaks.
» Train teachers to prompt and encourage students to engage in active play.
» Set up a peer-support program in which older students gather and play games, activities and sports with younger students.

» Establish after-school activity groups or clubs for a variety of activities such as tennis, cycling, aerobics, weight training, circus skills and dance. The emphasis should be on fun and on social interaction.
» Run physical activity events or activities and invite parental involvement; for example, fun runs, Great Victorian Bike Ride, camps, hiking, canoeing, volleyball, tennis or badminton round robins.
» Foster links between local community clubs/programs and school physical education.
» Ensure that teachers encourage students to join activity-related organisations.

Physical environment approaches

» Develop well-equipped playgrounds with playground equipment, line markings on courts, walls, grassed areas, goal posts.
» Establish walking/cycling paths around the school perimeter for use by students, families and the community.
» Ensure adequate traffic calming measures (such as speed humps, signage, roundabouts) in streets around schools to increase safety for pedestrians and cyclists.
» Introduce a bike shed or bike-lockable area with racks.
» Ensure outdoor fields and courts have lights for evening use by community groups.
» Have an extensive range of movable equipment available for student use, such as basketballs, frisbees, tennis balls and skipping ropes.
» Ensure school grounds, facilities, fields and gymnasiums are accessible to the community during non-school periods; for example, at night-time and holiday periods.

Alamy Stock Photo / Geoff Marshall

Changes to the physical environment, such as traffic calming features, can significantly increase pedestrian safety and result in more walking in an area.

Policy approaches

Policies and guidelines can influence decision making among school leadership teams and changes to infrastructure within schools. Policies are the foundation upon which new programs and initiatives can be implemented.

Shutterstock.com / Ivonne Wierink

Line and other markings in the playground have been shown to increase children's play.

Policy options include:

» Ban all staff from using physical activity as a form of punishment.
» Ensure the recommended time (mandate) for physical education and sport is met by timetabling.
» Allocate funds for staff professional development in the areas of physical activity promotion and physical education.
» Incorporate lifetime physical activity throughout the school curriculum, not just for team sports.
» Establish an employee steering committee to promote physical activity.
» Establish rules around portable devices during break periods.
» Seek and obtain funding from government and non-government organisations for new or improved physical activity facilities.
» Incorporate SunSmart policies into physical activity planning.

REAL WORLD APPLICATION

The Physical and Sport Education Mandate

Another example of organisational policy affecting physical activity is the Physical and Sport Education Mandate. This policy was introduced in all government schools in 1993 by the Department of Education and Early Childhood Development. Since its inception, all state governments have supported it. The mandate states that all government schools must meet compulsory time requirements for sport and physical education for students from Prep to Year 10. This means that all government schools are expected to timetable:

- Prep to Year 3: 20–30 minutes of physical education per day

- Years 4–6: 3 hours a week of physical education and sport with a minimum of 50 per cent of that time for physical education
- Years 7–10: 100 minutes per week each for physical education and sport.

The physical education and sport mandate is an extremely important policy and it makes up a significant proportion of many children's and adolescents' weekly physical activity. Unfortunately, many schools do not meet this mandate.

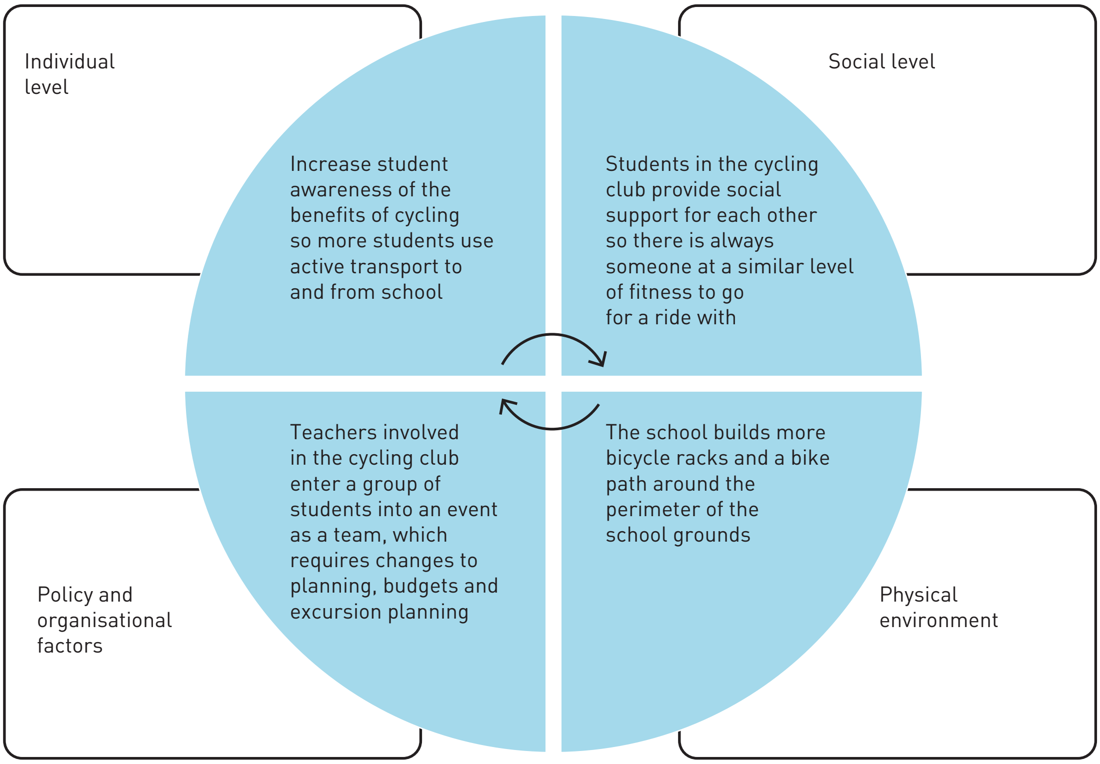
Questions

1 Discuss whether your school meets the mandate for physical education and sport at various year levels.
2 Describe how the Department of Education and Training could monitor and enforce this policy.
3 Explain three key strategies that primary schools with no designated physical education teacher could implement to support classroom teachers providing quality physical education and to ensure the mandate is met each week.

Newspix / News Ltd

What other social and environmental opportunities to promote physical activity are found in school settings?

Chapter 14 explored the social-ecological and YPAP models as a framework for intervening across multiple levels of influence to change behaviour. In the diagram that follows, you will see that if you make a change to one level of influence within the social-ecological model, this can interact with other levels. The more levels a program is supported at, the more likely it is to be effective in achieving the desired goals.



Levels within the social-ecological model interact with each other.

iStock.com/Christopher Futcher

Lunchtime or after-school bike riding club training for the 'Great Victorian Bike Ride' and 'Around the Bay in a Day' events.

SCHOOL-BASED INITIATIVES

Most school-based physical activity interventions employ a multifaceted approach rather than a one-dimensional intervention. Analysing samples of the types of interventions that have been adopted in the school setting reveals that most interventions:

» use combinations of social influences
» use strategies to change individual behaviour
» provide facilities
» use physical activity in cultural and leisure events
» incorporate activities within the formal school curriculum.

An example of interventions that adopt such approaches in a school setting is the Transform-Us! study.

REAL WORLD APPLICATION

Transform-Us!

Led by Professor Jo Salmon at Deakin University, Transform-Us! (Salmon et al., 2011) was a cluster-randomised controlled trial (RCT) to promote children's physical activity and break up prolonged sitting. A range of innovative behavioural and environmental strategies within the classroom, school and home settings were implemented that did not focus on sport or physical education, but instead were employed in addition to these. Over 1600 children (aged 8–9 years) and 226 teachers from 20 government primary schools in Victoria participated in the study. After 2.5 years of program delivery, compared to usual practice, children who received the program spent approximately an hour more being physically active in recess and lunch breaks, and 2.8 hours less time sitting, across the school week. The program was cost-effective – less than 10 cents per child – and most of the outcomes showed moderate to strong effect sizes, which would have substantial health impacts at a population level. The first table below outlines the mediators that were targeted within the Transform-Us! study and the program objectives. The constructs used in the study were underpinned by several theories of physical activity behaviour. The last table (page 327) presents the findings in relation to sedentary time and physical activity. This approach is set to roll out within many more Victorian primary schools from 2017 onwards.

Theoretical* basis of the Transform-Us! intervention and links to program objectives

Constructs	Mediators or determinants	Program objectives
Intrapersonal		
Confidence	Self-efficacy	Improve confidence in ability to be active or reduce sedentary time
Preference	Enjoyment	Increase enjoyment and preference for physical activity
Expectations	Benefits/barriers	Increase knowledge of benefits and strategies to overcome barriers
Expectancies	Evaluation of anticipated outcome	Alter perception of pros and cons of being more active
Skills	Self-management	Self-rewards, self-instructions, TV viewing styles
Behavioural rehearsal	Self-monitoring and contracting	Goal setting, contracting with others, rewards

Constructs	Mediators or determinants	Program objectives
Interpersonal		
Observational learning	Modelling by parents/ siblings	Encourage parents and siblings to reduce their own SB and increase PA
Social support	Modelling/social support	Encourage parents and siblings to support child to spend less time in SB and more time in PA; teachers encourage/support PA during recess/lunch
Social structure	Rules	Parents enforce rules regarding limiting screen time at home, during meals, during daylight hours
Environmental		
Imposed environment	Availability	Increase the amount of PA equipment available at school and home. Reduce the availability of TVs/computers/electronic games at home
Imposed environment	Access	Increase access/opportunities for PA at school and at home. Decrease access to TV/computers/electronic games at home
Imposed environment	Policy	Interrupted sitting during class-time; presence of supervising teachers during recess/lunch

* Based on social cognitive theory, behavioural choice theory and ecological systems theory

Source: Salmon et al., 2011, Licensed under CC BY 2.0

Transform-Us! intervention components

	SB-I	PA-I	SB+PA-I
School setting			
Curriculum component	» 18 key learning messages (9 per year)	» 18 key learning messages (9 per year)	» 18 key learning messages (9 per year)
Class strategies	» Standing lessons (1 × 30-min/day) » Active 2-min breaks after 30-min class time	» NA	» Standing lessons (1 × 30-min/day) » Active 2-min breaks after 30-min class time
Physical environment	» Standing easels » Novelty timer	» Provision of sporting equipment, line markings and signage » Provision of pedometers	» Standing easels » Provision of sporting equipment, line markings and signage » Provision of pedometers
Family setting			
Homework tasks	» Reduce sitting time while completing home work	» Homework tasks incorporate PA	» Homework tasks incorporate PA and reductions in sitting time
Newsletters	» Tips for reducing sitting time at home	» Tips for increasing PA at home	» Tips to reduce sitting time and promote PA at home

Note: PA: physical activity; SB: sedentary behaviour; PA-I: physical activity intervention; SB-I: sedentary behaviour intervention

Source: Salmon et al., 2011, Licensed under CC BY 2.0

Children's physical activity, sedentary time per intervention group *relative to usual practice* (controls) after 2.5 years of the Transform-Us! program*

	PA only group	SB only group	PA + SB group
Sedentary time (mins/school wk)	+34.5	-170	-100
Light-intensity (mins/wk recess-lunch)	+19.5	+15	+26.0
Moderate-vigorous (mins/wk recess-lunch)	+17.5	+9.5	+32.5

*accelerometer assessed; PA: physical activity; SB: sedentary behaviour

Source: Salmon et al., 2011, Licensed under CC BY 2.0

Questions

Read through the Transform-Us! study information and data, or alternatively, research a range of school-based physical activity initiatives and programs online. Useful websites include.

Weblink

- VicHealth
- Heart Foundation.

1 Describe the impact the program had on physical activity and sedentary behaviour.

2 Using either the social-ecological model or the Youth Physical Activity Promotion model described in chapter 14, summarise the key components the program focused on to change behaviour by influencing the key mediators.

3 Discuss the benefits and limitations of using standing desks in school classrooms.

PRACTICAL ACTIVITY

AUDIT OF SCHOOL PHYSICAL ACTIVITY BEHAVIOURS AND ENVIRONMENT

1 On a map of your school, identify the physical activity areas. Develop an appropriate legend to denote various facilities and features.

2 Also on your map, identify potential barriers to people being active (for example, out-of-bounds areas, unsafe surfaces, areas that are inaccessible for wheelchairs).

3 Present a list, table or graph representing the number of students participating in various physical activities during particular time periods, within specific areas of the school. (You could use SOPLAY; see chapter 11.)

4 Make a list of the policies within your school that may either encourage or be a barrier to physical activity opportunities.

5 From your observations, suggest six strategies that could be employed in your school to further promote physical activity. These strategies should be easily sustained and inexpensive to conduct. Identify whether each strategy is a short- or long-term strategy and how it would be implemented. Try to suggest at least one strategy within each of the following categories: social environment, physical environmental policy.

6 Discuss which strategies address the recommendations for school and community programs promoting physical activity among young people mentioned earlier in this chapter.

CHAPTER CHECK-UP

1 What are the responsibilities of the Australian Department of Health in relation to physical activity?

2 Identify three examples of major physical activity promotion and sedentary behaviour reduction initiatives that could be implemented in schools.

3 Why are schools excellent settings for promoting physical activity?

4 Describe three actions recommended by the VicHealth *Active for Life* resource.

COMMUNITY SETTINGS

Community settings can be broadly defined to include groups of people from the same suburb, town, city or country. Such broad groupings provide particular challenges in implementing intervention strategies but also provide great scope for far-reaching impact. The diversity within a community can sometimes make it difficult to provide whole-community interventions that successfully increase physical activity levels for all. Therefore, you will notice that many of the community-based examples of strategies and initiatives described later in this chapter were tailored to meet the needs and interests of specific target groups, and to overcome the unique barriers to those groups within a community setting.

The WHO proposes that the neighbourhood setting is a priority, and the Heart Foundation recommends that environments are designed to enable people to be active as part of their everyday tasks (for example, walking to the shop to buy milk or bread, or to the post box to post a letter). However, the Heart Foundation acknowledges that this will require effort from planners and developers as well as federal, state and local government authorities.

Parks, green space, streetscapes, beaches and recreation facilities are the most frequently used environments for physical activity. Within the community setting, it should be a priority to develop environments that facilitate choices that are both active and easy. Later, this chapter will look at supportive features in the built environment that increase opportunities to be active.

Effective community-based settings are those in which the infrastructure, funding and organisational structures maximise the impact of the coordinated programs (Bauman, cited in Moodie & Hulme, 2004). The WHO recommends that urban planning policy choices include plenty of safe footpaths and cycling paths, open spaces, parks and facilities for physical activity. It is important for planners to consider providing safe indoor and outdoor spaces. Actions by local government and municipalities should concentrate on developing local legislation and policy to support physical activity.

Community settings–based interventions offer opportunities to:

» support and partner local councils and other organisations
» **disseminate** information resources that encourage physical activity
» work collaboratively with local and regional government transport agencies to improve opportunities for people to be physically active in their local environment through recreation and transport (active commuting)
» increase access to affordable, safe exercise and recreation facilities and programs
» support media campaigns promoting physical activity.

Social environment approaches

» Encourage the development of, and participation in, walking clubs/groups at community centres or parks.
» 'Come and try' days provide opportunities for people to try new and different physical activities for a day or for an event, e.g. a community walking event.
» Organise a 'meet the expert' day so people can hear about new physical activity programs or skills; for example, golf professionals, a Pilates instructor, a celebrity athlete.
» Introduce some community clubs/groups that do not focus on fitness; for example, fishing or gardening groups.
» Encourage people to seek and find an activity buddy to be active with.
» Train important community leaders and social groups to promote physical activity; for example, peer group counsellors, church leaders, elders.
» Encourage personal challenges, contracts between friends and family; for example, a competition to reach 10 000 steps per day, measured on a pedometer, on the greatest number of days in a week.
» Set up a community hotline that people can call for more information about physical activity programs.

» Implement family- or peer-focused sessions, activities or programs to encourage people to bring someone.
» Work with local healthcare providers to encourage patients to be active and to become involved in community programs.
» Run programs for people with similar conditions or needs; for example, older people or those with diabetes, cancer or disabilities.

Many community-based interventions have had a focus on walking and transport.

Physical environment approaches

» Maximise walkability of community streets.
» Parks should include shade, seating and drinking water.
» Cycle and walking paths and trails should link important destinations, schools, housing, parks and shops.
» Trees and other vegetation and water features encourage activity.
» Town planners should include traffic calming strategies.
» There should be a mix of land use such as residential, office, commercial (cafes, retail) and industrial.

You can also read a fact sheet about healthy spaces via http://nelsonnet.com.au, using your login code.

FS
Fact sheet

Policy approaches

» Develop a community directory (resource list) that lists all the local physical activity facilities and programs, including sporting clubs; provide people with costs and contact details.
» Insert brochures of Australian physical activity and sedentary behaviour guidelines with pay slips, or in mailboxes or pigeonholes on a monthly basis.
» Encourage recreation and leisure centres to offer single- or multiple-session introductory activity classes for gym, swimming and aerobics.

PRACTICAL ACTIVITY

AUDITING PHYSICAL ACTIVITY ENVIRONMENTS

Weblink

EQUIPMENT

One pedometer per person

AIM

To familiarise yourself with the skill of auditing physical environments (built environments) within a community setting to identify factors encouraging physical activity and potential barriers to physical activity

BACKGROUND

In urban design, 'walkability' is the measure of the overall walking conditions in an area. Factors that commonly make up walkability indices include shade, aesthetics, lighting, crossings, access to footpaths, traffic calming, driver behaviour, safety and crime. In this activity, you will explore factors affecting the walkability of your local community setting.

WALKABILITY EXERCISE

1 Go for a walk around your community.
2 Using the neighbourhood walkability checklist produced by the Australian Heart Foundation, rate the walk. You can find the checklist online via http://vcepe12.nelsonnet.com.au.
3 Refer to the section that outlines what can be done to improve walkability of communities. Identify five barriers to walking and five strategies to address these issues based on your assessment of this area.
4 Total distance ______________ and total steps ______________.

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Walkability is influenced by safety and aesthetics.

COMMUNITY INITIATIVES

Changing the game: increasing female participation in sport

Chapter 13 examined the prevalence of physical activity and the evidence consistently showed that not enough females are sufficiently physically active. These participation levels decline further as females get older. One of VicHealth's objectives is to get tens of thousands of Victorian females who are inactive and somewhat active to become active more regularly through sport. VicHealth, via the 'Changing the Game' initiative in 2016, wants to raise the profile of female sport and reach more than 100 000 females in Victoria and beyond, as part of its long-term plan to get more Victorians living healthier and happier lives. As part of the 'Changing the Game' program, VicHealth provided funding to six sports to increase their participation rates among women and girls who don't normally participate in sports programs provided through clubs and competitions. The following summary outlines each of the physical activity programs and initiatives designed for women.

AFL Active (AFL Victoria, together with AFL)

'AFL Active' is a group fitness session aimed at improving women's health and wellbeing. It can be tailored to suit any fitness level and doesn't require any Australian Rules football-specific skills. The program is designed to use activities that combine the unique Australian Rules-specific fitness components of endurance, speed, strength, agility and dynamic movement. It's a constantly changing, total-body workout based on Australian Rules training techniques which can be delivered anywhere. It is the first product developed by the AFL to reduce key barriers of physical contact, organised sport structure and rigid time commitments and has been consciously developed for women.

Social Spin (Cycling Victoria)

Cycling Victoria's program will provide women-only pop-up spin classes to prepare women for independent bike riding. Based on a fun and social experience, spin classes can be delivered at community locations such as halls or parks using participants' own bikes or setting up 'resistant' indoor bicycles. Over time, the aim of the program is to transition women into short supported rides. A user-pays model will be introduced to continue the program.

Move My Way (Gymnastics Victoria)

Gymnastics Victoria's entry-level program will teach and engage women in simple, fundamental movement that establishes the strength, flexibility and mobility required to advance into other physical activity pursuits. The program allows women to choose how they learn the movement, either through following video instructions online in their own time, or by participating at a gymnastics club, leading to other providers such as a yoga studio or other sports programs. The development of an online and local community option will be encouraged to motivate women to participate.

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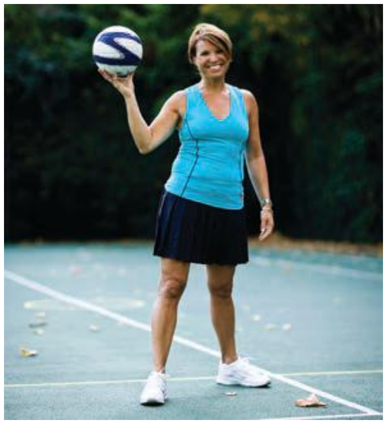
Rock Up Netball (Netball Victoria)

'Rock Up Netball' is an initiative developed by Netball Victoria, which offers flexible, participant-led and 'pay-as-you-go' activities for women and girls aged over 15 who want to become more active. It is designed to provide social, fun and unstructured opportunities for both beginners and those coming back to netball. Accredited Rock Up Netball venues will have skilled coordinators who understand varying fitness and skill levels and respond with a mix of skills, drills and game play – participants will make the rules!



Alamy Stock Photo / Buzz Pictures

Coasting (Surfing Victoria)

Surfing Victoria's introductory program will deliver stand-up paddleboarding (SUP) to Victorian women at both beach and inland locations in Melbourne, as well as major regional locations. Participants in an initial session will be directed to clubs, SUP schools, social groups and retailers to continue the sport under the supervised direction of the Surfing Victoria SUP program.

iStock.com / Jmichl

Get into Cardio Tennis (Tennis Victoria, together with Tennis Australia)

Tennis Australia is creating an introduction to its innovative Cardio Tennis program specifically for inactive/somewhat active women who want to get moving. It will be low impact and easy to participate in, regardless of tennis ability. It will feature fun fitness activities using a racquet and a ball and can be delivered to large groups in non-traditional settings, such as parks and the workplace.

Alamy Stock Photo / ZUMA Press, Inc.

Source: VicHealth, 2015

INVESTIGATION

CREATE AN INITIATIVE

Table 15.7 provides a basic template to summarise a range of strategies implemented by physical activity initiatives within different settings. You can make your own, or fill in the online template on your student website at http://www.nelsonnet.net.au, using your login code. Collect this information and then evaluate the initiative using the following questions:

1. Was there at least one strategy implemented at each level/construct of the social-ecological model/Youth Physical Activity Promotion model?
2. Can the outcomes be measured? E.g. steps per day, minutes of active transport, total moderate to vigorous physical activity, reduced minutes of sitting during work hours.

Scaffold

TABLE 15.7 Sample template for summarising an initiative using the social-ecological model

Name of program	Organisation and target (sub-population) group	Strategies used at different levels of influence based on the social-ecological model			
		Individual-level strategies	Social strategies	Physical environmental strategies	Policy and organisational strategies
Active April: Doing 30 minutes of exer-cise for 30 days	Victorian government target group = families	Families register on the internet to record their participation and be eligible for prizes.	Families were encouraged to be active together in numerous indoor and outdoor physical activities.	No specific changes to the physical environment – but families were encouraged to be active within all sorts of natural and aquatic environments in addition to visiting constructed recreational and sporting facilities.	Mass media campaign – radio, newspaper advertisements, website info, incentives and prizes. For example, participants received a 20-visit pass for YMCA, discounts for Rebel Sports, National sports museum and Aquarium. School rewards programs.

The 10 000 Steps challenge

One of the most successful research interventions that has been translated into widespread implementation at an individual and community level in Australia is the 10 000 Steps program. The original project, begun in 2001 and known as 10 000 Steps Rockhampton, was a whole-of-community project funded by Sports Medicine Australia and the Heart Foundation. It was conducted by the University of Queensland (UQ), Queensland University of Technology (QUT) and Central Queensland University.

The program has since been rolled out in several forms within schools and in community and workplace settings.

Many schools, workplaces and communities participated in the original 10 000 Steps challenge, a two-year trial funded in 2001. Some communities challenged each other to see how many individuals could meet the recommendation of 10 000 steps per day. (For example, 60 teams of five people in Rockhampton challenged 50 teams of five people in Townsville to participate in a six-week challenge.) The challenge was promoted using displays in shopping centres and mass media such as radio, newspapers and television commercials. Information about the challenge was also disseminated via email to large groups in workplaces. Organisers within each town ran a series of walks for all teams. Participants were required to enter their daily steps into a step log.

These are just a few examples of communities and workplaces that have implemented the 10 000 Steps challenge; hundreds of similar stories can be found on the 10 000 Steps website.

Strategies for 10 000 Steps

Examples of strategies used in many schools, workplaces and communities to implement the six-week 10 000 Steps challenge include:

» Have participants record the daily number of steps in a step log and/or on the 10 000 Steps website.
» Use incentives such as prizes and giveaways (for example, water bottles, T-shirts, stress balls, hats).
» Invite participants to a breakfast launch.
» Promote the challenge via the internet, emails, posters, newsletters, mass media.
» Use a map to track the teams' progress across Australia.
» Provide discounted pedometers or use a pedometer loan scheme (for example, the local library could lend out pedometers).
» Use a team format for social support.
» Get senior management involved to be role models for others.
» Conduct come-and-try events and support activities (group walks).
» Distribute weekly newsletters.
» Provide certificates for all participants and prizes for the highest number of steps.
» Spray running shoes gold or bronze to make trophies.
» Encourage the most inactive individuals to focus on achieving personal bests rather than 10 000 steps per day.

10 000 Steps community initiatives

In addition to running the six-week 10 000 Steps challenge, many communities have embraced a whole-of-community initiative that consists of a range of strategies. For example, the Mackay City Council in Queensland launched the 10 000 Steps Mackay Program in 2005, with the aim of increasing:

» access to pedometers
» awareness of the 10 000-steps-per-day message
» the number of supportive environments that promote walking
» the level of physical activity in Mackay
» workplace participation in the 10 000 Steps challenge.

The following strategies were implemented.

Library pedometer loan scheme

Residents were able to borrow a pedometer from any Mackay City Council library for a period of four weeks. Promotional information was displayed within the libraries.

Walkway signage

Series of signs were put up around several walking circuits. Each circuit was approximately 5000 steps (3.5 to 4.2 kilometres, depending on stride length) and took around 50 minutes to complete. A mixture of totem poles and stencils on the ground were used to maximise visibility of the signage.

Walkway maps

A brochure (print media) containing maps of the signed walkways was printed and distributed to community health centres, visitor centres, libraries, shopping centres and pharmacies.

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Signage and distances marked on the ground are powerful physical activity prompts to encourage walking. What other factors promote public use of the area pictured here?

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INVESTIGATION

Click on the link to view the 10 000 Steps website and other similar sites, where you can read about numerous challenge programs, initiatives and strategies that have been implemented in communities, schools and workplaces across Australia. Link via http://vcepe12.nelsonnet.com.au.

PRACTICAL ACTIVITY

MY ROUTES

Using a map of your community, identify a range of common routes you take on a weekly basis. For example:

- walking from your house to the local park
- walking from the bus stop to your school
- walking from the car park to the supermarket.

Using a pedometer, calculate the number of steps you would take on some of your most common routes. Comment on how much some of these incidental or active transport trips would contribute to your daily goal of at least 10 000 steps.

WORKPLACE SETTINGS

Workplaces are an ideal setting in which to promote physical activity because the majority of the population works part-time or full-time for a significant proportion of their adult lives. According to the ABS, in 2014 more than 11 million Australians spent an average of eight hours a day in the workplace. Workplaces bring together large groups of people, who can provide each other with social support or share environmental resources.

Promoting physical activity in the workplace offers numerous benefits to employers, including:

» improved employee morale
» increased productivity (quality and quantity)
» reduced absenteeism
» increased ability of employees to handle stress
» improved community relations
» reduced staff turnover.

Approaches that can be adopted in a workplace setting include:

» an environmental audit
» campaigns encouraging employees to use the stairs rather than the lift
» providing access to gyms at subsidised rates
» offering incentives to cycle or walk to work rather than drive
» provision of facilities such as showers and changing rooms to support the use of active transport.

Typically, worksite policies and actions that have had some effect include educational strategies; individualised exercise programs; access to bike tracks and shower areas; lifestyle, health and wellness newsletters; company recreational events; flexitime to allow employees to participate in physical activity; shared, subsidised programs; onsite group programs; installing equipment and facilities; and organising workplace buddy systems.

The Strategic Inter-Governmental Forum on Physical Activity and Health (SIGPAH) concluded there was good evidence that a comprehensive approach may be the most promising and appropriate in many workplaces. Such an approach would include:

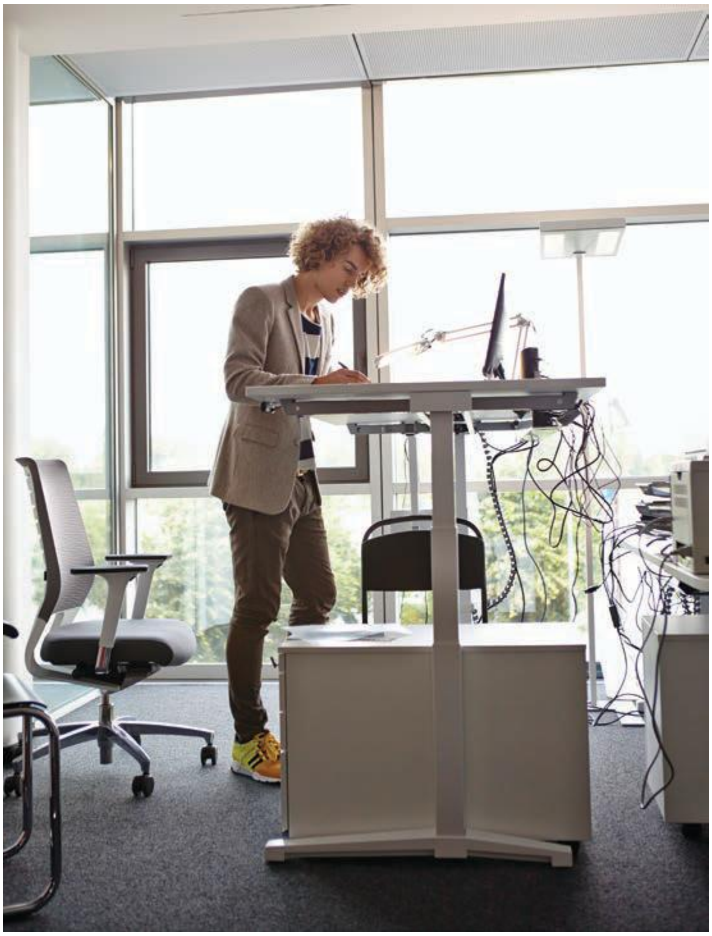
» changing organisational structure and culture
» highlighting physical activity opportunities
» providing supportive environments
» 'point of decision' prompts, such as signs encouraging employees to use the stairs.

Very large workplaces in the United States have shown increased levels of physical activity and significant savings and benefits resulting from health-related programs.

Research has suggested that workplace interventions achieve short-term rather than sustained improvements in physical activity. Reviews have found several problems with workplace programs, including low recruitment, high drop-out rate and poor maintenance of programs.

FYI

Some workplaces subsidise golf or tennis club memberships or gym memberships to encourage their employees to be more active. Greater physical activity can result in increased productivity, reduced absenteeism and a happier and healthier workplace.



Getty Images / Westend61

Standing workstations/desks are becoming the norm in workplaces where staff health and wellbeing are important.

Comprehensive strategies are required to improve physical activity in workplaces (Sallis & Owen, 1999). While further research on effective interventions is needed, there is little doubt that workplaces are an important setting for physical activity promotion, particularly the promotion of incidental physical activities.

The Heart Foundation provides tips for moving more during work hours and sitting less at work (see below). As a starting point, they encourage people to organise the following in their workplaces:

» regular heart health checks
» lunchtime walking or exercise groups
» standing desks and standing meetings, using height-adjustable desks so you can work standing or sitting
» shift meetings outdoors and take a walking meeting.

There are plenty of ways you can make sure you stay active and cut down your sitting time at work.

» Take regular breaks from your computer. Get up and take a break every 30 minutes, and have lunch away from your desk.
» Rotate sitting tasks with standing tasks across your shift.
» Get into the habit of standing to greet visitors or when you're on the phone (a headset or speaker phone can make it easier).
» Instead of phoning or emailing a colleague, get up and go talk to them.
» Use the stairs instead of the lift or the hoist.
» Use meetings as a chance to stand. Stand at the back of the room during toolbox talks or presentations. If you have to sit in long meetings, take standing breaks. Suggest standing or walking meetings.
» Drink more water. Going to the water cooler and toilet will break up sitting time.
» Move your bin away from your desk so you have to get up to use it.

Source: National Heart Foundation of Australia: http://heartfoundation.org.au/active-living/active-workplaces, accessed May 2016

Social environment approaches

» Run large activity events such as a workplace 'ride to work day' or enter a work team into corporate/community events such as fun runs, corporate lawn bowls, softball or social tennis.
» Implement lunchtime walking groups.
» Sponsor an aerobics instructor or group trainer to come to the workplace and conduct a class for staff.
» Invite guest speakers to staff meetings to talk about health and wellbeing with a focus on physical activity.
» Train supervisors, leaders, directors and coordinators in the importance of physical activity and strategies for encouraging other staff to be active.
» Encourage staff to seek social support from like-minded co-workers who are keen to be more active.
» Where possible, involve employees' partners and families in physical activity events, such as family days at the park, tenpin bowling, lawn bowls or a barbecue at the beach.
» Encourage staff to organise a walking or activity buddy with whom to go for lunchtime walks, a hit of squash or a bike ride.
» Encourage managers to foster an environment that promotes activity at lunchtime or during breaks.

Physical environment approaches

» Put up posters in staff areas listing the consequences of inactivity, the health benefits of regular physical activity, or how to perform specific exercises such as stretches.
» Put up posters in staff areas demonstrating how to exercise while sitting at a desk or standing at the photocopier.

» In a variety of places, display newsletters, booklets, pamphlets, brochures, flyers and bulletin boards promoting physical activity programs at work and in the local area.
» Provide employees with a safe and secure location to lock up their bicycles.
» Provide changing facilities, showers, lockers and exercise facilities. Install full-length mirrors, and scales for employees to weigh themselves in the changing rooms.
» Post signs publishing distances from place to place around the building, or to various destinations in the surrounding area.
» Construct walking and cycling paths/trails around worksite grounds.
» Display signage promoting the use of stairs. Stairwells should be accessible, well-lit and with music where possible.

Choosing the stairs over an escalator will expend significantly more energy over an extended period, which for some people in the workplace could make a difference of kilos of weight.

INVESTIGATION

ACTIVE LIVING PROGRAMS

Search online for examples of school, community and workplace physical activity intervention programs or initiatives. Find one that was designed to promote active living or reduce sedentary behaviour among one of the following population subgroups: older people, gender-diverse youth, people with disabilities, cultural and Indigenous groups.

Summarise your research. Describe the program, who the target audience was and any evidence collected in relation to the effectiveness of the program in increasing physical activity. Consider using a table to summarise your findings.

Policy approaches

» Close escalators or lifts for one week and replace with increased signage encouraging use of stairs.
» Subsidise staff memberships to gymnasiums.

» Develop a promotional strategy: name of program, logo, T-shirts, pens, magnets. Launch the program with a celebrity or CEO and invite the press.
» Send organisation-wide emails daily, encouraging staff to move around for a few minutes each hour; for example, go for a short walk or stretch.
» Negotiate a discount with health insurance providers for active employees.
» Ensure work hours are flexible so employees can include physical activity time within their workday; for example, have a longer lunch to attend a class and finish later.
» Establish a workplace health and wellbeing committee that provides recommendations to management relating to physical activity promotion (USDHHS, 1999).
» Negotiate discounted rates for employees at several physical activity facilities and program providers.
» Subsidise employee access to the above programs using workplace funds.

WORKPLACE INITIATIVES

Walking at work programs

Walking@Work is part of the Heart Foundation walking program, which is Australia's largest free walking network. Walking@Work offers a flexible approach to establishing and supporting active workplaces. The program encourages ways to incorporate physical activity into employees' everyday activities and create a healthy organisational culture.

Shutterstock.com/Andrey Arkusha

Walking@Work encourages workers to be more active during their work day.

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INVESTIGATION

Visit the Heart Foundation website to discover more about the Walking@Work program. You can link via http://vcepe12.nelsonnet.com.au.

Initiatives for a range of target groups

Table 15.8 summarises some of the initiatives targeting a range of population subgroups who often face significant barriers to being active.

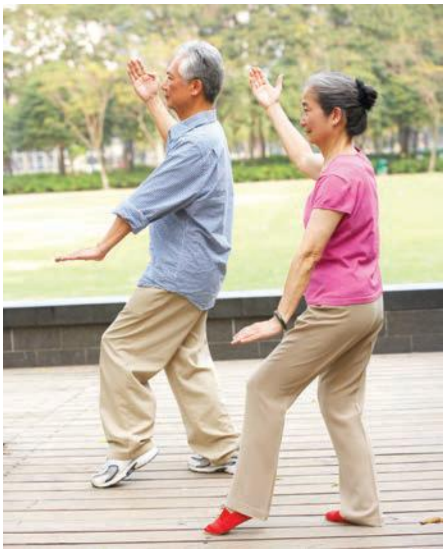

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TABLE 15.8 Examples of physical activity programs and sedentary behaviour reduction programs targeting a variety of population groups

Initiative	Target group	Description	Strategies
Five for Ten	Older people	SA Office for Recreation and Sport continues to supports the 5 for 10 program, run by Active Ageing Australia Metropolitan Adelaide, City of Onkaparinga and City of Victor Harbor. The 5 for 10 Program supports active lifestyle through participation in modified recreational sport. For just $10 older adults can try modified recreational sports at various locations around Adelaide for 5 weekly sessions.	Sports on offer for older adults include: » soccer » table tennis » basketball » tennis » bowling » croquet » rowing » golf » indoor bowls » dancing » tai chi » tennis.
Doncaster All Abilities Basketball Competition	People with disabilities	The Doncaster All Abilities Basketball (DAAB) Competition was developed in 2001 by a dedicated teacher of the Heatherwood School in Donvale. Over the past 15 years the DAAB competition has grown to a 200-player, 30-team competition with a championship and six other divisions.	Sponsored by Bendigo Bank and Manningham City Council, the competition was designed to provide young people who have an intellectual disability and disengaged young people and their families with an opportunity to come together and participate in weekly recreational basketball in a supportive social, inclusive and fun environment.

TABLE 15.8 (continued)

Initiative	Target group	Description	Strategies
AFL Kickstart Indigenous programs Weblink	Indigenous people	The Australian Indigenous Health*InfoNet* website showcases a wide range of physical activity programs for Aboriginal and Torres Strait Islander people. About 90 000 Aboriginal and Torres Strait Islander people participate in Australian Rules football. The Australian Football League (AFL) seeks to use Australian football as a vehicle to improve quality of life in Indigenous communities, not only in sport, but in the areas of employment, education and health outcomes. The AFL runs several programs under the AFL Kickstart banner.	» *Indigenous All Stars* – twice a year, up to 80 players participate in a camp that focuses on career development and leadership. During the week, players vie for selection to play in the Indigenous All Stars match against an AFL club. » *Indigenous academies* – the AFL has five Indigenous academies designed to increase school attendance, completion of Year 12 and Indigenous participation in sport. Each academy has its own program to respond to local opportunities and needs. Some academies are co-educational and offer sports in addition to football, such as netball, soccer, basketball, volleyball and rugby league. » There are many more examples of AFL Kickstart programs on the Australian Indigenous Health*InfoNet* website
Fair go, sport! – promoting sexual and gender diversity Organisations: Australian Sports Commission, Victorian Equal Opportunity & Human Rights Commission Weblink	Same-sex and gender-diverse groups	Research shows sport is a significant site of homophobic harassment, discrimination and exclusion. The Australian Sports Commission funded Fair go, sport! in 2010. This project aimed to: » increase awareness of sexual and gender diversity » promote safe and inclusive environments » develop a flexible model of engagement that can be adapted for other sporting codes and their governing bodies.	The project included four components: » Development of a peer mentoring approach to support project advocates. » Work with state sporting associations (hockey, basketball, cycling, football and Skate Victoria/Roller Derby) » Implementation of Fair go, sport! model in schools » Development of strategies for inclusion in school sport.
Craftercise – sensory physical activity experiences for preschoolers Weblink	Parents/adults and children (aged 6 months to 5 years)	Craftercise is a unique, contemporary and holistic community-based program for pre-school aged children in Melbourne that fosters learning through play. It combines the joy of creativity, the delight of imagination and the thrill of a movement and art adventure.	Children (under the supervision of their parent/carer) participate in a range of engaging, interactive and self-paced circuit-based activities using soft play, recycled equipment, musical instruments, sensory and play equipment. Weekly themes integrate activities across key learning areas including literacy, numeracy, art and craft, movement and physical activity. Each session includes messy play-based stations (optional) that children play in. This unique and contemporary program is tailored to each age group using developmentally appropriate activities inclusive of children of all abilities and learning styles. The program is conducted using a combination of state-of-the-art and safe physical activity, sensory and craft equipment in addition to recycled, rescued, reused and home-made materials.

INVESTIGATION

APPLYING MODELS TO TARGET GROUPS

Investigate an initiative/program aimed at improving activity levels for people with disabilities, people from different cultural backgrounds, older people and Indigenous groups.

Produce a report about the strategies implemented within the initiative/program. Also outline how these strategies relate to either the social-ecological model or the Youth Physical Activity Promotion model. You could use these models to identify which levels of influence have been addressed and which are missing. You could even design you own concept using these models to design an initiative/program for one of these target groups with the aim of increasing their physical activity and/or reducing their sedentary behaviour.

Newspix / Chris Hyde

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ELEMENTS OF AN EFFECTIVE INTERVENTION PROGRAM

Evaluation

Any intervention strategy must include an evaluation of the strategy's effectiveness, as dicussed in chapter 11. This should determine how effectively an intervention is delivered (process), what the short-term and immediate effects are (impact), and what the long-term effects might be (outcome).

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- **Process evaluation** can help keep track of what is happening in the program, and identify areas for improvement while there is still time to make corrections.
- **Impact evaluation** systematically gathers the information required to answer questions about the short- and medium-term effects of the intervention.
- **Outcome evaluation** involves the systematic gathering of information in order to answer questions about the long-term effects of the intervention (USDHHS, 1999).

When evaluating the effectiveness of a program in promoting physical activity, you will need to consider how this is determined. The research literature will refer to terms such as 'outcome evaluation' and 'impact of the program'. Table 15.9 outlines several levels of evaluation within the context of a school physical activity intervention program.

TABLE 15.9 Sample levels of evaluation for a school-based physical activity intervention

Level of evaluation	Description	Example
Formative evaluation	Ongoing assessment of the program activities with the goal of constantly improving the intervention strategies	Collect initial pre-test/intervention data (baseline) and then conduct regular assessments, e.g. every 2–3 weeks
Process evaluation	Collecting data about the implementation (delivery), e.g. reach, participant satisfaction with program and resources, how the program was implemented	Direct observation might be used to determine whether PE lessons were delivered by the teacher in the way they were intended
Impact evaluation	Achievement of program goals (immediate effects)	Increased moderate to vigorous activity during PE lessons, increase in number of students walking in playground at lunchtime and decrease in number of students sitting at lunchtime
Outcome evaluation	Assessment of the achievement of long-term goals is rarely carried out, given the long-term nature of goals	An observed increase in total physical activity 12 months post-intervention, reduction in number of obese students

These are the questions that need to be asked when evaluating a physical activity or sedentary behaviour reduction program or initiative:

1 Assess behavioural change – did physical activity (PA) and sedentary behaviour (SB) change over time from baseline to post-intervention? (Measurement of PA and SB at both time points is essential.)
2 Did the program reach the intended target group (population subgroup)?
3 If there was a change in behaviour, was it sustained over time (e.g. when followed up 12 months later)?
4 Were the strategies implemented at an individual or a population level?
5 Were the strategies implemented as they were intended (process evaluation)?

REAL WORLD APPLICATION

Walk the block to increase productivity

3 March 2014

Victoria Walks is calling on Victorian workers to step away from their desks and onto their feet to Walk the Block on Thursday 20 March. The event is aimed at combating physical inactivity at work and fostering healthier workplace cultures across the state.

'Many of us spend around a third of our day at work. This often involves sitting at a desk or in a relatively confined space for hours on end. This is not good for us, our families or employers,' said Dr Ben Rossiter, Victoria Walks Executive Officer. 'The level of sedentary behaviour common in many workplaces is concerning.'

Worryingly, 70% of Victorian workers do not get the minimum recommended 30 minutes of daily physical activity.

'A recent report from VicHealth found those who are most at risk from prolonged sitting are people working in offices, transportation and highly mechanised trades,' said Dr Rossiter.

The benefits of physical activity include increased energy levels, weight management, stress relief and social connectedness. Studies show that employers who encourage physical activity report less absenteeism, decreased work related accidents, reduced staff turnover and higher staff morale.

'Workplace physical activity has many benefits for business as it can reduce sick leave by up to 32% and increase productivity by up to 52%,' said Dr Rossiter, 'while poor employee health and absenteeism is costing Australian business $7 billion annually.'

'All we ask is that workplaces take 15 minutes out of their day to Walk the Block,' explained Dr Rossiter. 'The aim is to show Victoria's workforce how easy it is to incorporate physical activity into their daily routine,' he added.

'We urge everyone to Walk the Block and start talking about how they can make their employees healthier.'

Getty Images / Philipp Nemenz

REAL WORLD APPLICATION

Walk the Block is not a fundraising event and there are no fees involved. Workplaces that register receive resources to assist in promoting the event to colleagues and are provided with further resources to help keep staff moving beyond March 20.

Source: Victoria Walks, http://www.victoriawalks.org.au/

Question

Discuss what levels of the social-ecological model the 'Walk the Block' initiative addressed, or alternatively what constructs of the Youth Physical Activity Promotion (YPAP) model would be addressed if the concept was transferred to a school setting and students had to walk around a block of classrooms before transitioning to the next class.

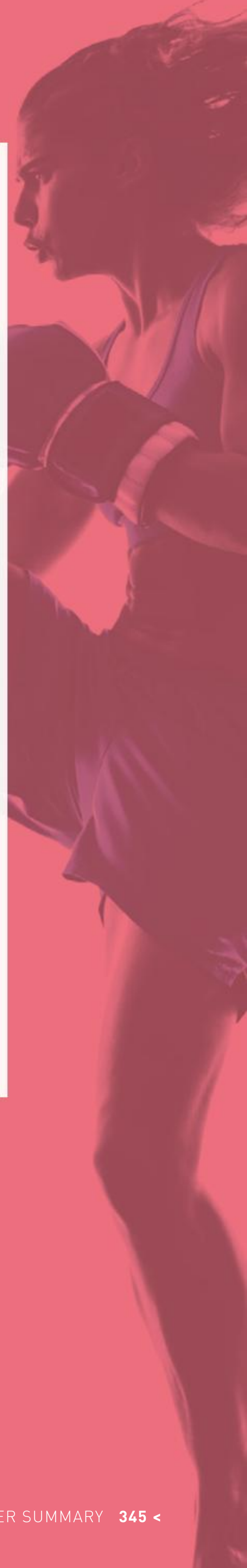
Video

QUICKVID

Watch a video of Professor Jo Salmon talking about settings-based approaches to physical activity promotion and reducing sedentary behaviour via http://nelsonnet.com.au. Log in using your code, and go to chapter 15, page 344.

CHAPTER SUMMARY

- A setting is typically a geographical area or institution containing a large, 'captive' audience, where health messages can be delivered efficiently. Settings offer practical opportunities and structures for the implementation of comprehensive strategies.
- Settings in which physical activity interventions could be adopted include community, workplace, family, transport, healthcare and school settings. Working across a range of settings means different population groups can be reached.
- A school setting has the potential to reach all children for some time in their life and, in particular, provides an opportunity to reach inactive children. Interventions in school settings have increased physical activity significantly. The most effective interventions used a 'whole-school' approach.
- Useful interventions in a school setting include combinations of social influences, strategies to change individual behaviour, provision of facilities, using physical activity in culture and leisure events, and incorporating activities into the formal school curriculum.
- Community settings can be broadly defined to include groups of people from the same suburb, town, city or country.
- Successful, coordinated community programs require infrastructure, funding and organisational structures to maximise their impact. Many community-based interventions have a focus on walking and transport. The development of environments that make it easy to be active is an important priority in the community setting.
- Workplaces provide a convenient and potentially influential environment to foster and encourage physical activity. Interventions include changing organisational structure and culture, highlighting physical activity opportunities and providing supportive environments.
- Effective workplace innovations include providing bike racks, showers and equipment; educational strategies; individualised exercise programs; lifestyle newsletters; company recreational events; flexitime (to allow employees to participate in physical activity); subsidised memberships; onsite group programs and workplace buddy systems; and promoting non-recreational, incidental activity (for example, through point-of-decision prompts to use the stairs).
- State and federal governments play a significant role in the promotion of physical activity. They provide funding to organisations such as VicHealth and the Heart Foundation, which in turn support governments in the promotion of physical activity at a state and national level.



CHAPTER REVIEW

Multiple-choice questions

1 The best name for a method or approach to target a change in policy, environment or organisation is:
   A a program
   B an intervention strategy
   C a policy change
   D all of the above.

2 Which of the following is an example of a population-level strategy to promote physical activity?
   A print media distributed at a general practitioner's office
   B change to policy
   C counselling
   D tailoring programs online

3 Which of the following would be an example of a social environment strategy that could be implemented within a school setting?
   A Installing traffic calming measures around the local area of the school to increase pedestrian safety
   B Establishing walking and bike riding paths around the school perimeter
   C Ensuring adequate supervision during lunch breaks
   D Introducing a bike shed or bike-lockable area with racks

4 The Fair go, sport! project funded by the Australian Sports Commission and the Victorian Equal Opportunity and Human Rights Commission focused on supporting which of the following target groups?
   A Older people
   B Same-sex and gender-diverse groups
   C Indigenous people
   D Parents of toddlers

Short-answer questions

5 Identify the characteristics of a workplace that make it a suitable setting for intervention.

6 Outline four benefits to employers of promoting physical activity in the workplace.

7 Describe five approaches that could be adopted in a workplace setting to promote physical activity.

8 Describe three strategies that have been employed within community-based 10 000 Steps programs.

9 Describe a physical activity program for a specific target group (e.g. Indigenous Australians).

10 Describe what 'walkability' refers to and how it is measured.

11 The Victorian Department of Education and Training introduced a mandate for physical and sport education.
   a How much physical education time does this policy recommend schools should be providing?
   b List five factors that could be potential barriers to classroom teachers delivering physical education classes in primary schools.
   c Describe three strategies that could be implemented to assist primary schools in meeting this mandate and overcoming some of the barriers identified in part b.

12 a What is the main advantage of using mass media over individual approaches to promote physical activity?
   b List six examples of media through which such a campaign could be delivered.
   c Describe three key roles of mass media in the promotion of physical activity.
   d Describe two methods the state government could use to evaluate the effectiveness of a mass-media campaign.

UNIT 2

PHYSICAL ACTIVITY, SPORT AND SOCIETY

AREA OF STUDY 2

WHAT ARE THE CONTEMPORARY ISSUES ASSOCIATED WITH PHYSICAL ACTIVITY AND SPORT?

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CHAPTER 16

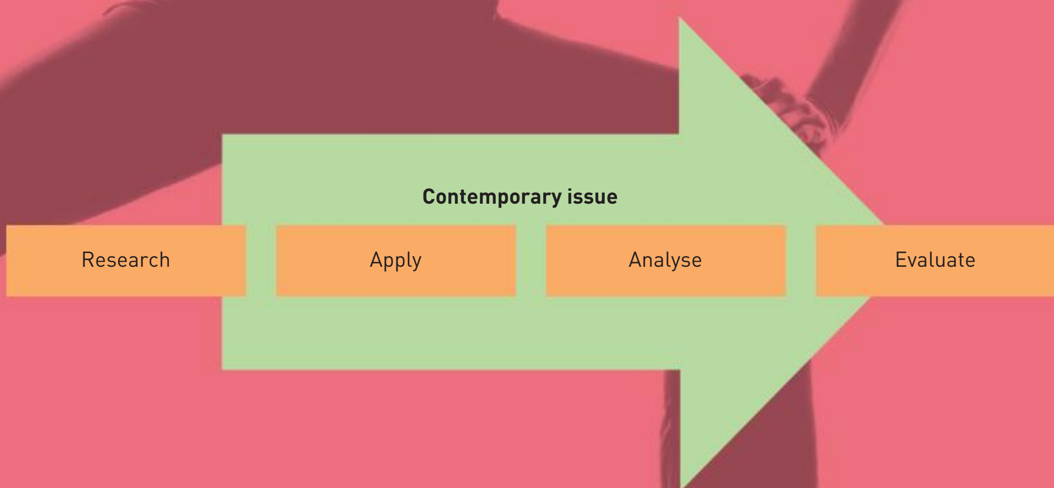
CONTEMPORARY ISSUES ASSOCIATED WITH PHYSICAL ACTIVITY AND SPORT

Key knowledge

- the role of the social-ecological model and/or the Youth Physical Activity Promotion model in evaluating physical activity promotion and sedentary behaviour reduction initiatives and strategies
- the key concepts associated with the selected contemporary issue associated with participation in physical activity and/or sport in society
- individual, social, policy and environmental influences on participation in physical activity and/or sport in reference to the selected issue
- local, national and/or global perspectives of the selected issue
- historical, current and future implications of the selected issue
- government, community and/or personal strategies or programs designed to promote participation in physical activity and/or sport.

Key skills

- identify contemporary issues associated with participation in physical activity and sport
- participate in and reflect on physical activities that illustrate the participatory perspective of the selected issue
- collect information on a selected issue related to physical activity and/or sport in society from a range of sources such as primary data, and print and electronic material
- analyse the historical, current and future implications of the issue identified
- apply the social-ecological model or Youth Physical Activity Promotion model to analyse and evaluate strategies and programs associated with the selected issue
- draw informed conclusions and report in a suitable format on the sociocultural and environmental influences that impact on participation in physical activity and/or sport based on research findings.



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The idea of Unit 2 Area of Study 2 is for you to select a contemporary issue associated with physical activity and/or sport that interests you. There are many issues associated with participation in physical activity and sport that can be researched. Often the newspapers are a good source of current and contemporary issues. Some broad topic areas that may be relevant include:

- declining levels of physical activity and/or sport
- active transport
- cultural diversity and inclusion
- professionalism in sport
- risk management and safety
- people with disabilities
- children and competitive sport
- sport in society
- gender equity in physical activity and sport.

See also the examples in the Unit 2 Area of Study 2 introduction (VCE Physical Education Study Design, page 15).

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There are many issues associated with physical activity and sport. What is currently in the news? What are people talking about?

This chapter will guide you through the process of identifying an issue, researching your issue, analysing the data and information collected, applying a social-ecological framework, evaluating your findings and drawing a conclusion that demonstrates your understanding of the sociocultural and environmental influences that affect participation in physical activity and sport.

There are a number of steps that need to be taken to complete the investigation into a contemporary issue:

Step 1 – Identify the issue

Step 2 – Research the issue

Step 3 – Analyse and evaluate the information

Step 4 – Draw a conclusion

Step 5 – Present your report.

Step 1 Identify the issue

PRACTICAL ACTIVITY

BRAINSTORM

1 As a class, using the first list on page 349 as a prompt, list as many issues as you can think of that are associated with participation in physical activity and sport.
2 Once your list is complete, group ideas that have similar themes. For example, you might have a number of issues associated with children (competitive sport, access to physical activity, angry parents at sporting events, etc.).
3 You will now have broad themes with more specific issues listed under them. In consultation with your teacher, select an issue of interest to you. This will be the focus of your investigation.

Kids Active poster from pre-2014. Used with kind permission of the AFL

Why might signs like this be needed at children's sport?

PRACTICAL ACTIVITY

PARTICIPATE

For each of the themes identified in your brainstorm, select an activity that reflects the participatory element of that theme. As a class, participate in that activity.

For example:

» children – participate in a range of modified sports
» active transport – organise and participate in a ride or walk to school day
» people with disabilities – participate in a game of goalball (rules and equipment can be found via http://vcepe12.nelsonnet.com.au) or wheelchair basketball
» cultural diversity – participate in a tai chi class.

At the completion of the activity, write a brief reflection on your participation and an observation of the involvement of the class. Reflect on aspects such as enjoyment, difficulty, purpose and benefit. This reflection can be used as a source of **primary data**.

Weblink

Getty Images / Fotosearch

Newspix / Chris Hyde

Ramps built into this playground (left) make it accessible to children in wheelchairs; (right) Indigenous children playing Australian Rules football

Step 2 Research the issue

To begin researching the issue, you will first need to decide from which perspective you will view the topic:

» local perspective – understanding the issue and how it relates to the community in which we live
» national perspective – understanding the issue and how it relates to all of Australia
» global perspective – understanding the issue and the links between our own lives and the lives of others throughout the world.

Choosing a perspective will help narrow the search for information. You may need to compare what is happening in your local community to what is happening at a national level; in this case you will need information on both perspectives.

It is important to consider the historical, current and future implications of the issue. Research what has happened in the past, what is happening now and what the predicted trends are for the future.

Where to go for information?

It is tempting to simply head straight for the internet and search for all the information you can find on your chosen issue. This may be a good starting point, but it is important to check that the websites you're referring to are reputable. Be discerning!

The Australian Bureau of Statistics is a good place to look for **secondary data**, particularly on participation rates in physical activity.

Weblink

Government departments may provide information on policy relating to physical activity and sport. For example:

» Australian Government Department of Health
» Victorian Department of Health and Human Services
» Clearinghouse for Sport
» Australian Sports Commission
» Australian Sports Anti-doping Authority
» Australian Institute of Health and Welfare.

You can link to these via http://vcepe12.nelsonnet.com.au.

Organisations may also have information that is relevant to your investigation. When contacting the organisation, whether in person, by phone or by email, ensure that you have a specific set of questions to ask. What is it that you want to know? Write these questions down and make notes as the person answers them. These notes will become part of your research and are another form of primary data. Make a note of the person's name, position in the organisation, and the date and time that you communicated. This information will be added to your bibliography.

Weblink

Some useful organisations for research might be:

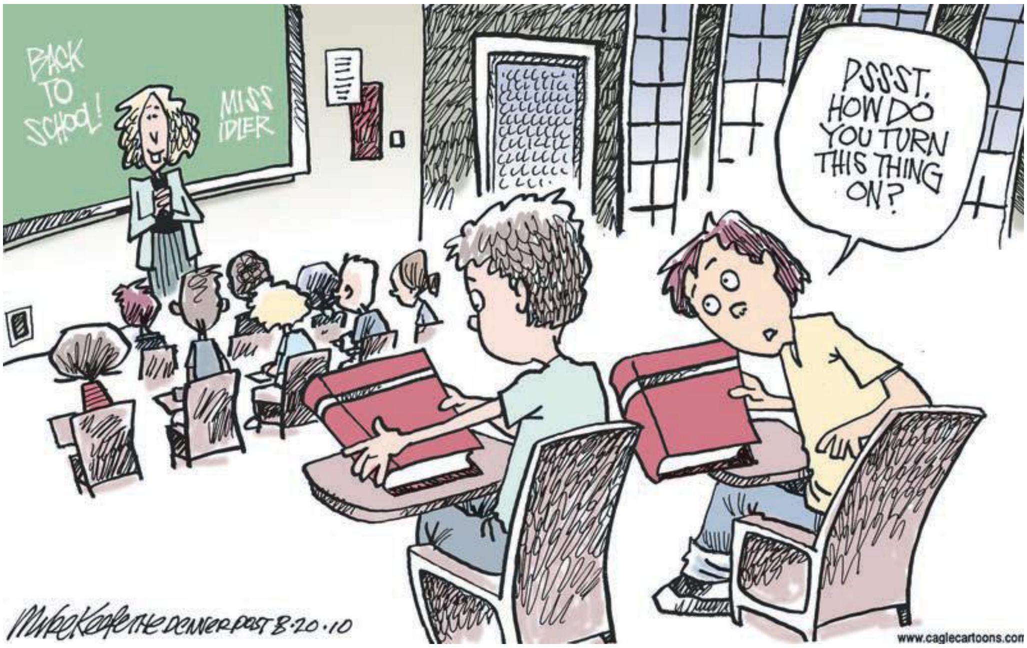
» Heart Foundation
» Cycling Victoria
» Breakthru
» YMCA Victoria
» Sports Medicine Australia.

You can link to these via http://vcepe12.nelsonnet.com.au.


CartoonStock.com / Jonny Hawkins

But I do exercise, Mum ... I surf the net!

There are many other ways to collect information. Identify the key stakeholders (people or groups who have an interest or concern about the issue) and contact them for an interview or to complete a survey. For example, if you are investigating the use of active transport in primary school children, you may talk to parents, the school and students to gain valuable information from each of these perspectives.



Cagle Cartoons, Mike Keefe

Libraries and books can be good resources too!

From your research, identify the key concepts associated with the issue. These will be the main points of focus for your analysis.

Step 3 Analyse and evaluate the information

The next step is to analyse the information and data you have collected. This is to be analysed from a social-ecological perspective. Individual, social, policy and environmental influences (see chapter 12 for more information) on participation in physical activity and/or sport must be addressed. A model or framework can be utilised to help understand the multiple factors that enable, or act as barriers to, an individual's physical activity participation.

In chapter 14 you learnt about the social-ecological model and the Youth Physical Activity Promotion model. Either of these can be used in your analysis and evaluation; however, the YPAP model is specific to children and youth. By applying a social-ecological model or framework, it is possible to identify existing opportunities to promote participation and to evaluate strategies. The model can be used to analyse and evaluate the influences on the behaviours of different population groups.

For example, opportunities to encourage active transport in a primary school may be different to those that exist in the community, as the influences on an individual's behaviour may differ.

The analysis would need to address factors at each of the levels of influence shown in Table 16.1.

TABLE 16.1 Levels of influence

Level of influence	Primary school children	Adults
Individual	Are they old enough to ride alone?	Does the individual have the knowledge and skills required to ride a bike?
Social environment	Are there children (peers) who can ride together?	Is there a community 'culture' of cycling? How are cyclists perceived by other members of the community?
Physical environment	Are there traffic calming devices around the school (40 km/h zones, speed bumps) to increase safety?	Are there accessible bike paths or cycling lanes within the community?
Policy	Is there an active transport policy in the school?	Are there environmental policies in place to reduce car usage in the community to reduce emissions?

Step 4 – Draw a conclusion

The next step is to draw an informed conclusion from your investigation. Your conclusion must draw on the multiple influences that impact on the issue, demonstrating an understanding of how the issue has evolved (historic, current and future implications) and evaluating the strategies or programs that are in place to increase participation in physical activity or sport.

The conclusion should link the whole investigation by synthesising the key concepts and highlighting the main findings, and may include a proposed solution to the issue.

Step 5 – Present your report

There are a number of different formats you could use to report the findings of your investigation, including:

» a visual presentation, such as a graphic organiser, concept/mind map, annotated poster or presentation file
» a multimedia presentation, including two or more data types (for example, text, still and moving images, sound) and involving some form of interaction or simulation
» an oral presentation
» a written report.

Regardless of the format you choose, you will need to present all of the findings of your research, analysis and evaluation. Keep in mind the following tips when completing your presentation:

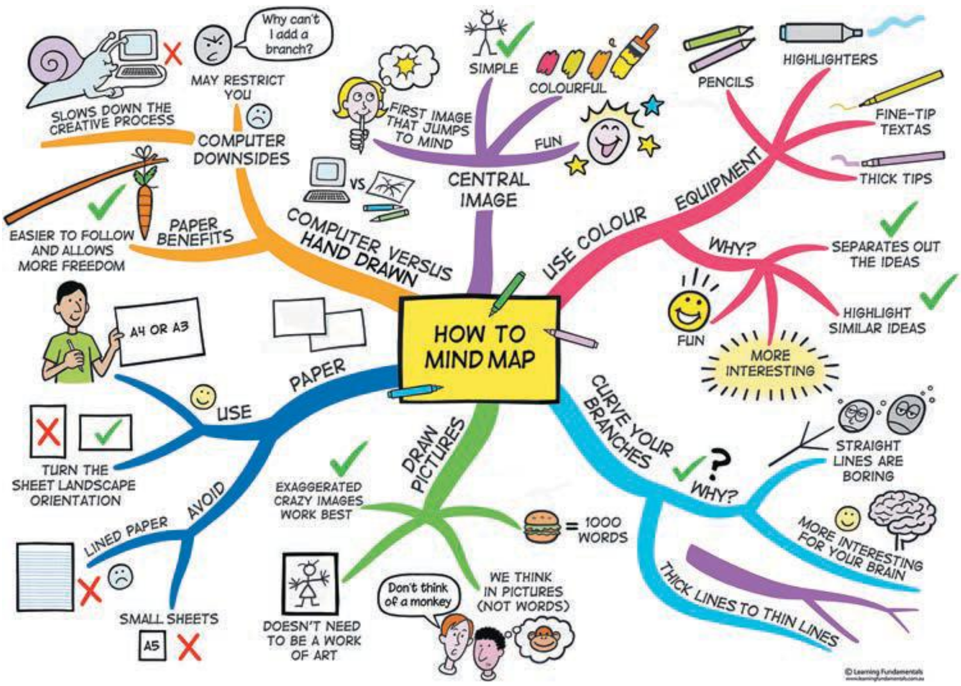
» Keep the text simple – use bullet points or short sentences to ensure the information is clear and concise.
» Use images and graphics where possible to convey information.
» Choose a font style, size and colour that allow the information to be read clearly.
» Proofread to check spelling and grammar.

Mind maps

Mind maps can be a great way to organise and present information. Follow these tips to produce an outstanding mind map!

1 Start in the centre of the page
2 Use an image or picture for your central idea.
3 Use colours throughout.
4 Connect your main branches to the central image and connect your second- and third-level branches to the first and second levels, etc.
5 Make your branches curved rather than straight-lined.
6 Use one key word per line.
7 Use images throughout.

Adapted from: Tony Buzan, '7 steps to making a mind map', 2013, accessed March 2016, http://www.tonybuzan.com/about/mind-mapping/



www.learningfundamentals.com.au

QUICKVID

Watch a short video in which the author explains in detail what you need to do for the contemporary issue you have chosen.
Go to http://nelsonnet.com.au and log in with your student code. Go to chapter 16, page 355.

Video

GLOSSARY

1RM
the maximum weight that can be lifted in one maximal exertion

A-band
the area found in the centre of the sarcomere containing both actin and myosin filaments

acceleration
the change in speed with respect to time, often measured in metres per second per second (m/s/s or m/s^2)

acetylcholine
the chemical responsible for the transfer of impulses from a neuron to another neuron or a muscle across the synaptic cleft or neuromuscular junction

acetylcholinesterase
the enzyme that breaks down acetylcholine

acquired ageing
characteristics commonly associated with ageing that appear at an earlier than normal age

actin
a thin protein filament, found in a sarcomere, that is responsible for muscle contraction

active transport
any form of human-powered transportation to get to and from work, school or specific destinations

acute
an intense, severe condition that usually lasts a short time (opposite of chronic)

adaptogen
a nutritional supplement that increases the body's resistance to stress

aesthetics
a branch of philosophy that studies what is beautiful or pleasing in appearance

agonist
the muscle primarily responsible for producing movement

altitude training
a performance-enhancing training practice that acclimatises an athlete to a lack of oxygen in the air

anabolic
protein-building

antagonist
the muscle that relaxes as the agonist contracts to allow ease of movement and minimise the risk of injury

arteriosclerosis
the stiffening or hardening of the artery walls because of the build-up of plaque, which can restrict blood flow

arthritis
a joint disorder that involves inflammation in one or more joints

articulating
of two or more bones, meeting to form a joint

asthma
a respiratory condition that narrows the airways and makes breathing difficult

atherosclerosis
the narrowing of the artery because of plaque build-up. Atherosclerosis is a specific type of arteriosclerosis

autologous transfusion
transfusion of a person's own blood

barriers
factors that block or impede participation in physical activity

biaxial
a joint with two axes of movement, such as the wrist joint, which moves from side to side and forward to back

biopsy
the removal of a sample of tissue for laboratory examination

bout
a period of time, usually the duration of an intense exercise session or activity; for example, a distance runner may sprint for a 5-minute bout at a high intensity

built environment
buildings and other infrastructure constructed by human beings, including indoor and outdoor places for living, working and playing, and transportation systems

cadence
a rhythm, such as the number of revolutions of a bike's pedals per minute or the number of steps taken per minute in running

cardiac output
a measure of the volume of blood pumped by the heart per minute

cholesterol
a fatty substance that is in the blood of humans and animals and in dairy products

chronic
a long-term condition (opposite of acute)

chronic obstructive pulmonary disease (COPD)
frequently reoccurring, or long-lasting, diseases that restrict the airways and prevent proper breathing

cognitive
involving attitudes, thinking and awareness

concentric contraction
the shortening of a muscle during an effort (opposite to eccentric contraction)

contraction
any movement resulting in tension being developed at a muscle

correlate
a mutual or complementary relationship between two or more factors, such as a cause and an effect, or a test result and an estimated rating

cross-bridges
oar-like projections from the myosin filaments that assist muscle cells to attach to others

deceleration
a decrease in speed or velocity (opposite of acceleration)

dementia
a disorder that affects the brain; symptoms include memory

loss and losing the ability to solve problems, do simple daily activities such as get dressed, and control emotions

determinant
a factor that decisively affects the nature or outcome of something

diastolic blood pressure
the pressure in the arteries just before the next heartbeat, when pressure is at its lowest; the 'resting blood pressure'

direct injuries
injuries caused by an external force on the body

disseminate
to distribute information, such as research findings, widely to the people, groups or organisations who would benefit from the information

distal
situated at a distance from the point of attachment or a central point (opposite of proximal)

eccentric muscular contraction
the lengthening of a muscle during an effort (opposite to concentric contraction)

emphysema
a disease that enlarges the lung's air sacs, causing a decrease in lung function and breathing difficulties

enablers
things that promote and encourage participation in movement or physical activity

enzymes
chemical substances that facilitate or speed up the rate of reactions occurring within the body

EPOC
excess post-exercise oxygen consumption; another term for oxygen debt

erythropoietin (EPO)
a polypeptide hormone produced in the kidneys; can also be synthetically produced to increase the quantity of red blood cells

fascicles
bundles of fibres that make up skeletal muscle

fast-twitch fibres
muscle fibres that perform explosive actions such as sprinting. Unlike slow-twitch fibres, they fatigue quickly

flexibility
the capacity of a joint or muscle to move through its full range of motion

functional movement
any action performed in daily life, usually involving multiple joints and muscles (e.g. picking up a cup)

fusiform
muscles that are typically spindle-shaped, with the muscle belly wider than the origin and insertion (e.g. biceps)

gait
the particular manner in which a person walks or runs

haematocrit
the percentage of red blood cells in the blood

haemoglobin
oxygen-carrying compound found in red blood cells

health
a state of overall wellness, including physical, mental and social wellbeing and not just absence of disease or infirmity

heart rate
the number of times the heart beats in one minute

homeostasis
self-regulating process by which a body system maintains stability while adjusting to changing conditions

homologous transfusion
a transfusion from a donor of the same blood type

hypertension
unusually high blood pressure

hypokinetic
related to too little movement; a lack of regular physical activity

hypoxic training
training in an environment with a diminished amount of available oxygen

H-zone
the centre of the A-band, which is free from the myosin cross-bridges

I-band
the area of myofibril containing actin

incidental activity
any activity that builds up in small amounts during the day, such as housework and walking for transport

indirect injuries
injuries caused by a sudden change in direction or intensity

inferior
relating to the heart, refers to the lower part

insertion point
the location where a muscle attaches to a bone that is pulled by the action of the muscle

isoinertial contraction
a muscle contraction where the muscles are responding to a constant load

isokinetic contraction
a muscle contraction where the speed of the contraction is held constant

isometric contraction
a muscle contraction where there is no change in the muscle's length; a static contraction

isotonic contraction
a muscle contraction where the length of the muscle changes through a range of motion

kinetic chain
the relationship between your nerves, muscles and bones

Lactate inflection point (LIP)
the point where maximal lactate production is balanced by maximal lactate removal; the person is at the top of their aerobic training zone

ligaments
soft tissue that connects bone to bone

leisure-time physical activity
activity over and above that which occurs within the workplace or at school

load
the amount of weight to be lifted

maximum heart rate
is age related and may be calculated by using the formula 220 minus age; for example, a 30-year-old's MHR would be 220 – 30 = 190 bpm

maximum tetanic tension
the maximum amount of force a muscle can generate

mediators
mechanisms through which an intervention (strategy) is believed to influence physical activity behaviour

metabolic promoters
supplements that improve oxygen utilisation and thus allow athletes to work at a higher intensity more efficiently

mitochondria
cellular structures containing enzymes responsible for the production of energy under aerobic conditions

mitochondrial efficiency
efficiency of converting energy

mobility
the ability to move without restriction

moderate-intensity physical activity
physical activity performed at a level that causes the heart to beat faster and some shortness of breath, but during which a person can still talk comfortably. An intensity that may last between 30 and 60 minutes

morbidity
the rates of illness in a population

mortality
the rates of death in a population

motor neuron
a nerve cell that conveys nerve impulses from the spinal cord or brain away from the central nervous system and towards a muscle

motor unit recruitment
the stimulation of motor neurone and muscle fibres needed to produce greater force

multi-joint activity
any activity in which two or more joints are involved, such as a squat

muscle belly
the main body of a muscle

myofibrils
the part of the muscle fibre encasing all actin and myosin filaments

myoglobin
a pigment similar to haemoglobin which transports oxygen to the mitochondria, where aerobic glycolysis takes place

myosin
a thick protein filament, found in a sarcomere, that is responsible for muscle contraction

neuromusculoskeletal system
the system of nerves, bones and muscles within the body

neuroplasticity
the adaptation of the human brain to changing demands by altering its functional and structural properties. This results in learning and acquiring skills and thereby enhances an individual's capacity to respond to new demands with behavioural adaptations

normobaric hypoxia
a barometric pressure equivalent to pressure at sea level

novice (at weight training)
a person with less than six months' consistent weight-training experience

obstructive respiratory diseases
diseases that restrict the airways and prevent proper breathing

origin
the site where a muscle is attached to a stable bone, which the muscle can pull against

osteoporosis
when bones become less dense, losing strength and becoming more susceptible to breaks

overuse injuries
injuries caused by the repetitive performance of a movement

oxygen deficit
temporary shortage of oxygen in cells, typically at the start of exercise, where oxygen demands are greater than the body's ability to supply the necessary levels

PAR-Q
Physical Activity Readiness Questionnaire

pennate
of a muscle, having fascicles or fibres that attach obliquely to the tendon (also known as penniform)

planes of movement
imaginary sections of the body used to 'split' it into front and back, left and right and top and bottom parts

play
to amuse oneself pleasantly in a light-hearted way with a recreation, game or exercise

precapillary sphincter
a band of smooth muscle that adjusts the blood flow into each capillary

preferential recruitment
when the body recruits muscle fibres according to the intensity of the activity about to be undertaken

primary data
original data collected by a researcher

processes of change
the types of strategies employed to encourage changes in physical activity levels

proximal
close to the point of attachment or a central point (opposite of distal)

psychosocial models
models based on social and psychological factors that influence physical activity

pulmonary diffusion
the gaseous exchange that occurs in the lungs

range of motion
the distance and direction your joints are able to move

reactivity
when individuals alter their behaviour because they are aware of being observed

reciprocal causation
the interaction between the individual and the environment

reciprocal inhibition
when muscles on one side of a bone or joint relax to accommodate contraction on the other side of the bone or joint

recreational activity
activity that diverts, amuses or stimulates the body and mind through enjoyment and relaxation

relaxation
absence of tension in a muscle

repetitions (reps)
the number of times a weight will be lifted in a sequence

sagittal plane
an anatomical division of the body into right and left halves

sarcomere
a basic unit of a striated muscle which causes it to contract

secondary data
data collected by someone other than the user

second-hand smoke
smoke, from a burning cigarette or exhaled by a smoker, that is inhaled by a non-smoker

sedentary
associated with low levels of energy expenditure, sitting for long periods of time, not moving around

sedentary levels
the proportion of sedentary behaviour exhibited by a population

self-efficacy
confidence in your ability to be active within specific circumstances (for example, even when you are tired)

sensory neuron
a nerve cell that conveys nerve impulses back to the spinal cord or brain from muscles, organs and cells

set
a group of repetitions performed without a rest

settings-based approach
a strategy in which promotional strategies are delivered within a defined setting (geographical area or institution)

single-joint exercise
an exercise in which only one joint is involved, such as a biceps curl involving only the elbow joint

slow-twitch fibres
muscle fibres that contract slowly and help to sustain activity over a long period

sphygmomanometer
an instrument used to measure blood pressure

sport
physical involvement in organised games or activities within an accepted set of rules

stabilisers
muscles that stabilise one part of the body while another part is moving. For example, the abdominal muscles act to stabilise the spine

steady state
the point during exercise when oxygen supply equals oxygen demand

stroke volume
the amount of blood ejected by the left ventricle per beat

submaximal
less than maximal effort and usually below 70–75 per cent of maximum heart rate

superior
relating to the heart, refers to the upper part

surveillance
Surveillance of population levels of physical activity using a standardised protocol is an important and necessary part of a public health response to current concerns regarding lack of physical activity in many populations. Surveillance of physical activity in populations is usually carried out using questionnaires, because these are relatively inexpensive and easy to administer compared to objective measurement techniques

synapse
the junction between two neurons or between a neuron and a muscle fibre

synovial joint
a freely movable joint, with a joint cavity; a space between articulating bones

systolic blood pressure
the pressure in the arteries just after the heart beats, when the pressure is at its highest; 'working blood pressure'

tachycardia
an abnormally fast heart rate

theoretical model
a model that allows us to understand a concept, such as participation in physical activity behaviour

theory
a set of ideas developed to explain facts or events

thermoreceptors
receptors that monitor the temperature of the blood and the external temperature, allowing the body to make adjustments when necessary

threshold
the level that must be reached for a physiological effect to be triggered

transverse
the horizontal plane dividing the top from the bottom

triglyceride
the optimum state of fatty acids in order to enable storage

uniaxial
a joint that only allows movement in one plane, such as back and forth movement. The elbow is an example of a uniaxial joint

validity
the degree to which a test or instrument measures what it purports to measure; for example, self-reporting of time engaged in vigorous-intensity activity can be validated against the time recorded by a heart-rate monitor or accelerometer

vasoconstriction
a decrease in the diameter of a blood vessel, resulting in a decrease in blood flow to the area supplied by the blood vessel

vasodilation
an increase in the diameter of a blood vessel, resulting in an increase in blood flow to the area supplied by the blood vessel

velocity
speed, e.g. how fast a weight is lifted

ventilatory threshold
the point where ventilation increases at a non-linear rate

vigorous-intensity activity
Physical activity performed at a level that causes rapid heartbeat and shortness of breath. An intensity that may last up to 30 minutes and no longer than 10 minutes when exceeding 9 METs

VO_2 max
the maximum amount of oxygen that can be taken up, transported and utilised per minute

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ANSWERS

CHAPTER 1: INTRODUCTION TO PHYSICAL ACTIVITY, SPORT AND EXERCISE

Chapter check-up p. 5

1 Active transport to school involves students walking, riding or scooting to school. Any of the following could encourage students to select these options:

- » Establish walking groups supervised by adults such as the 'walking school bus'
- » Provide secure areas for bikes/scooters to be stored on school property
- » Run education programs aimed at teaching safety and motor skills associated with riding/scooting
- » Make students/families aware of the health benefits associated with active transport
- » Reduce the speed of vehicles/increase student safety by putting in place traffic-calming devices such as speed humps, roundabouts, reduced speed zones, etc. around the school.

2 a Self-report on rate of perceived exertion
b GPS
c Heart rate monitor

3 a Exercise = Physical activity that is specifically planned, structured and repetitive and rarely involving any kind of competition
Sport = Involves physical activity and exercise using a set of rules, or goals to perform exercise as an individual or team.
Play = Activity performed for fun/recreation
b Exercise, sport and play are all different examples of physical activity.

Chapter check-up p. 8

1 There may be fewer opportunities for parents to participate in physical activity because of:

- » Needing to transport/support own children involved in their sport (less free time)
- » Having less disposable income to pay for sporting memberships, equipment, etc. that is taken up by costs associated with raising children.

2 Possible barriers may include:

- » Parents not modelling positive physical activity behaviours
- » Cultural lack of appreciation/support for participation in sports
- » Not being able to pay for coaching, equipment, lessons linked to sports
- » Language barriers around understanding benefits associated with physical activity or how to join in local activities.

3 Peer groups can positively influence participation in physical activity by:

- » Inclusion in team/group activities
- » Peers actively engaged in physical activity
- » Peers accepting different cultures, abilities, beliefs, etc.

4 By creating negative experiences during physical education or sport classes conducted within school settings. This might occur when:

- » Physical activity is used as a punishment
- » Minimal attention is paid to tailored delivery of sessions
- » Focus is on 'winning at all costs' rather than enjoyment and personal best efforts
- » Session structure is poor, which may result in less time spent on tasks such as activity/skill development.

5 She could:

- » Walk or ride to and from school
- » Join in a physical activity group during lunchtimes such as dance, fitness, various sports
- » Volunteer to increase physical activity around the house – doing chores such as gardening, vacuuming, washing the car/pet, etc.

Chapter check-up p. 11

1

CULTURAL ENABLERS	CULTURAL BARRIERS
1 Cultural values around participation in physical activity	1 Clothing requirements might restrict active participation in sport/ physical activity
2 Cultural activities/ gatherings that encourage recreational and competitive pursuits.	2 Religious observances may preclude participation in physical activity (religious holidays, praying, etc.)

2 » Regional males perform larger amounts of physical labour as part of their day-to-day lives and associated fatigue limits participation in physical activity

- » Limited infrastructure support in the form of transport – mainly affects non-driving age people

3 The natural environment might be:

- » Unsafe/dangerous – e.g. unstable rocks not suitable for rock-climbing/abseiling; rips not suitable for swimming
- » Excessively hot/cold – increased risk of hyperthermia or hypothermia – e.g. surfing without a wetsuit in cold seas
- » Remote/isolated – difficult to access in case of injury/emergency.

4 Unless such spaces are air-conditioned, it is unlikely students would be able to participate in physical activity for any considerable amount of time (30+ mins), due to high heat and humidity. Without air-conditioned gymnasiums, students would require longer recovery periods following physical activity and this would interfere with concentration and time spent studying.

Real world application pp. 12–13

Suggested answers

	FAMILY	PEERS	ACCESS TO FACILITIES	ACCESS TO EQUIPMENT	GEOGRAPHIC LOCATION	SOCIOECONOMIC STATUS
ENABLERS	Having active parents as role models	Friends who value regular physical activity participation	Having playing fields, playgrounds, basketball/ netball courts at school	Free/low cost equipment provided	Living close to the beach, park, playing field	Having funds to pay for sports lessons, equipment or membership
BARRIERS	Parents who don't like walking and drive children to school	Friends who prefer sedentary-based activities such as computer games	Living consid-erable distance from playing fields/courts/ natural environments	Not having Frisbees, kites, footballs, etc.	Not living close to bike paths	Not being able to afford dance/ swim lessons

CHAPTER REVIEW p. 16

Multiple-choice questions

1 C

2 C

3 D

Short-answer questions

4 Physical activity is a complex behaviour that is influenced by individual, social, environmental and policy-related factors. The more of these factors/levels that are incorporated, the more likely children are to engage in regular physical activity. Providing sporting goods without a place/space for these to be used is an example of not guaranteeing increased physical activity behaviour – this would apply to providing a cricket bat to a child living in a high-rise apartment without access to playing fields to use the bat. Providing children with a bike, even though they cannot ride it, is an example where physical activity increases would not occur automatically as a result of being provided sporting goods.

5 TV commercials are capable of reaching larger audiences than a mailout, thus influencing greater population groups/numbers. They target two senses – audio and visual – and potentially have a greater likelihood of getting the message across.

Brochures might be more effective than TV commercials because they can target local physical activity providers/ facilities. Additionally, brochures have the ability to be translated into various languages to target local communities. Every household has a mailbox, but not every household has a TV.

6 Higher education levels are linked to greater awareness of the benefits of being physically active and the harms associated with sedentary behaviours. Additionally, higher education levels are linked to higher incomes so these people may have a greater disposable income to spend on physical activity pursuits such as equipment, memberships, travel to activities/sports, etc.

7 Any three of:

- » Lack of access to certain activities/venues because of restricted mobility
- » Lack of opportunity to participate because of limited community teams/competitions that suit people with impairments
- » People with impairments have lower levels of fitness and this may contribute to increased fatigue and spending less time doing physical activities
- » They experience fear and increased loss/lack of confidence, which is linked to decreased participation rates in physical activity.

8 Schools, in contrast to workplaces and community settings:

- » Are compulsory for children under the age of 16, and in fact more and more students are completing secondary schooling – there are mandated amounts of physical activity for students to do per week
- » Provide access to multiple sporting facilities and opportunities – sporting teams, competitions and facilities/playing fields
- » Embed educational programs around the benefits associated with regular physical activity into day-to-day programs.

CHAPTER 2: STRUCTURE AND FUNCTION OF THE MUSCULOSKELETAL SYSTEM

Chapter check-up p. 27

1 By being smaller bones that are fused at full development, they initially allow a degree of flexibility and movement, but later on provide greater stability and strength than a single bone would.

2 They are both ball and socket joints, but the humerus at the shoulder joint is not as deeply set as the femur at the hip joint.

3 The ball and socket joint of the shoulder/hip allows more movements than the hinge joint found at the knee, so an incorrect operation such as this would result in severe problems such as instability at the joint, increased injuries of soft tissue (ligaments, tendons and muscles) and injuries to hard tissue (bones).

4 The appendicular skeleton is more likely to be injured because these bones are used in more of the skills, and the joints are those placed under greatest stress/forces during the game of football.

Chapter check-up p. 34

1 Any three of the following: biceps, sartorius, rectus abdominus, brachioradialis, tibialis anterior, iliopsoas, soleus, plantaris or palmaris longus.

2 Pennate muscles have a larger cross-sectional area and number of fibres than fusiform muscles and thus can generate more force and power. Pennation allows more fibres to be packed into any given length of muscle when compared to fusiform arrangements.

3 Fusiform muscles are able to generate greater contractile velocities, which are traded off for lower force outputs. This occurs because longer muscles can contract over a greater distance and develop higher shortening velocities.

4 a Ligaments connect bones to bones and if they are 'stretched' will often lead to immediate inflammation and pain at the site. This will often also be associated with joint instability because the 'fit' or 'bone association' has been compromised, and can lead to dislocations and further injuries because the joints are able to move in excess of their normal range of motion.

b Ligaments connect bones to bones, whereas tendons connect muscles to bones.

c Ligaments have poorer blood supply than tendons, and are often subjected to greater stress/force because they span a joint.

Chapter check-up p. 42

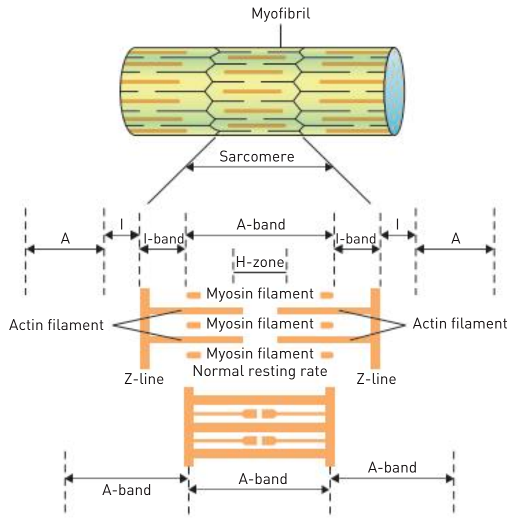
1 a False

b True

c False

d True

2



3 Nerve impulses, sent from the brain, travel quickly along motor neurons and along their axons to the axon end plate.

Acetylcholine (neurotransmitter) travels across synaptic cleft to the myofibril and the sarcoplasmic reticulum releases Ca^{2+} ions. ATP is broken down, and myosin crossbridges then attach to actin filaments and pull these to cause movements/contractions to occur.

4 Different forces are exerted during performances when different numbers of motor units are recruited within a muscle. For a fine motor skill, a small number of motor units are stimulated because low forces are required. For an explosive skill requiring maximal force, large numbers of motor units are activated and this calls upon large numbers of fibres all acting together to generate large forces.

5 When the electrical impulse reaches a certain threshold, all of the fibres of that motor unit will contract at the same time and as forcefully as possible. If the threshold is not reached, none of the fibres will be activated to contract.

Chapter check-up p. 47

1

TYPE OF CONTRACTION	I-BAND	A-BAND	H-ZONE
ECCENTRIC	Increases	Unchanged	Increases
CONCENTRIC	Decreases	Unchanged	Decreases

2 Isokinetic contractions occur with maximal resistance at every stage/range of movement, whereas the other two types of contraction only have a small stage/range of movement where maximal force occurs.

3 Fast-twitch A fibres are partially aerobic. This means that their aerobic characteristics respond to aerobic training.

4

CHARACTERISTIC	SLOW-TWITCH	FAST-TWITCH
Oxidative enzymes	High	Low
Myoglobin content	High	Low
Force produced	High	High
Susceptibility to fatigue	High	High
Mitochondria density	High	Low
Glycogen stores and glycolytic enzymes	Low	High
Phosphocreatine stores	Low	High
Motor neuron size	Low	High
Triglyceride stores	High	Low

CHAPTER REVIEW p. 50

Multiple-choice questions

1 B

2 C

3 i True
ii False
iii False
iv True

Short-answer questions

4 Any two of:

» Large numbers of oxidative enzymes – allow for more aerobic ATP production of ATP
» High capillarisation – greater amounts of blood, oxygen and fuels available for ST fibres to utilise
» High myoglobin concentration – greater amounts of oxygen can be transferred from blood to fibres
» Better ability to oxidise fats than FT fibres – increased amounts of aerobic ATP production

5 Nerve impulses, sent from the brain, travel quickly along motor neurons and along their axons to the axon end plate. Acetylcholine (neurotransmitter) travels across synaptic cleft to the myofibril and the sarcoplasmic reticulum releases Ca^{2+} ions. ATP is broken down, and myosin crossbridges then attach to actin filaments and pull these to cause movements/contractions to occur such as picking up a pen to write notes.

6 a Different forces are exerted during performances when different numbers of motor units are recruited within a muscle. For a fine motor skill such as a golf putt, small numbers of motor units are stimulated because low forces are required. For an explosive skill requiring maximal force, such as teeing off in golf, large numbers of motor units are activated and this calls upon large numbers of fibres all acting together to generate large forces.

b Motor neurons carry signals from the brain to related muscles to bring about actions for golfers such as putting, driving, chipping, walking, etc. Sensory neurons relay messages back from the environment after stimulating the senses and this provides the golfer with feedback on what they see, hear and feel. This feedback is compared to previous performances and the golfer is able to adjust and refine their next effort

7 a Eccentric contractions are associated with higher development of adaptations due to the greater catabolic effect compared to concentric contractions. If managed properly with adequate recovery allowing for repair and regrowth of muscle fibres, greater muscle gains in strength and power are possible.

b Weightlifting competitions involve isometric contractions to be performed while the weight is held above the head until the judges score the lift and deem it successful or not. Training needs to replicate what occurs in competitions.

c Improved weightlifting performances achieved by:

» Increased PC stores – to be able to perform repeated explosive efforts while training
» Increased FT motor unit coordination – to improve the neuromuscular coordination and the ability to exert maximal force
» Increased contraction speed – leads to development of greater force
» Increased fibre size – able to generate greater contractile force
» Increased contractile proteins – leads to stronger actin and myosin bonds and force production.

d Muscle spasms (uncontrolled twitching) are increasingly thought to be caused by 'altered neuromuscular control'. A muscle spasm (shortening) doesn't release on its own and requires manual stretching to help relax and lengthen the shortened muscle. It is thought that acetylcholine's action remains and doesn't dissipate because acetylcholinesterase doesn't break it down.

8 a Ankle dorsiflexion – tibialis anterior and ankle inversion – tibialis anterior

b Shoulder extension - deltoid and latissimus dorsi and shoulder circumduction - pectoralis major, deltoid and latissimus dorsi

c Elbow flexion – biceps brachii and elbow extension – triceps

d Hip adduction (adductor brevis, longus and/or magnus) and hip flexion – iliopsoas

9 a Shoulder: rotation
  Elbow: flexion
 b Hip: flexion
  Knee: extension
 c Shoulder: rotation
  Elbow: flexion
  Wrist: flexion

CHAPTER 3: PREVENTING MUSCULOSKELETAL INJURIES AND ILLNESSES

Chapter check-up p. 55

1 'Lifestyle disease' is an illness related to how a person (or group of people) lives.

2 Lifestyle diseases include atherosclerosis, heart disease, stroke and type 2 diabetes.

3 A proper warm-up activates acute responses responsible for delivering more oxygen to the working muscles, including increased respiratory rate and heart rate. Therefore, more oxygen is able to be taken in and transported, improving oxygen uptake. If oxygen uptake is increased, there will be a decreased reliance on the anaerobic energy systems and a corresponding decrease in oxygen deficits.

4 Examples of a direct injury for your sport need to have been caused by an external force such as a collision or direct blow from an implement. An indirect injury is usually caused by a change of either intensity or direction.

5 A haematoma (bruise) occurs when the wall of a blood vessel has been damaged and blood leaks into surrounding tissue.

Chapter check-up p. 63

1 Pre-activity screening is important to help minimise the risk of injury by identifying potential risk factors to a participant before they commence an exercise program.

2 Weight training can help reduce the risk of injury as improvements in muscle and tendon strength can help with body alignment.

3 Core strength training can help to improve running efficiency; help decrease the risk of injury; improve the transfer of power between the lower and upper body (and vice versa); and improve balance.

4 A proper warm-up enables the performer to prepare both physiologically and psychologically for the activity to follow.

Physiologically it enables the performer to bring about important acute responses such as increased breathing and heart rates, ensuring an increased supply of oxygen to the working muscles. It also ensures that muscle temperature is increased, thus improving muscle elasticity, reducing the risk of injury and potentially improving power.

Psychologically it enables the performer to improve focus and increase arousal levels.

5 Dynamic stretching should be performed during a warm-up as this relates to the principle of specificity. Dynamic stretching involves controlled movement of a joint replicating actions that will occur during the activity, such as a soccer player gently kicking their legs upwards.

Chapter check-up p. 65

1 Functions of taping include providing joint stability, providing kinaesthetic feedback to the brain and giving the individual confidence in a joint.

2 Bracing offers greater stability for a joint than taping but can also be more restrictive.

3 Players may choose to wear protective equipment to reduce the risk of injury or simply for the confidence it brings in its use, such as shin pads for ruckmen in the AFL. The main reasons that players will not wear protective equipment revolve around comfort and aesthetics.

Chapter check-up p. 70

1 Bone is primarily made from the protein collagen, as well as calcium and minerals.

2 Osteoporosis is a disease that causes bones to develop holes. It occurs when minerals such as calcium are lost from the bones faster than they can be absorbed.

3 Osteoarthritis is a degenerative disease of the smooth cartilage in a joint that often results from trauma (injury) to the joint or infection. Factors that contribute to the onset of osteoarthritis include joint injury, excess weight, repetitive joint-loading tasks and a sedentary lifestyle.

4 An autoimmune disease occurs when the immune system starts to attack the body's healthy tissues. An example is rheumatoid arthritis.

CHAPTER REVIEW p. 72

Multiple-choice questions

1 B

2 A

3 B

4 D

5 C

Short-answer questions

6 Vitamin D assists in bone calcium uptake.

7 Weight-bearing exercise is important for bone building and therefore its absence (zero gravity) will have the opposite effect.

8 The major costs associated with sports injuries include the time a person is absent from work while recovering and the healthcare costs directly associated with the injury.

9 Direct acute injuries are the result of an external force. An example is a bruise caused by being hit by a baseball. Indirect acute injuries are caused by the performer's own internal force. An example is straining a muscle.

10 a Rest, Ice, Compression, Elevation, Referral.
   b RICER should be applied immediately to sprained ligaments and strained muscles.

11 A 4–5 minute jog followed by 6 strides of 50 metres. The first stride should be at about 60%, then increasing by 10% per stride. Dynamic stretching if required.

12 One problem with static stretching is that any acute responses that have been initiated during light exercise to warm up will begin to reverse.

13 Dynamic stretching is taking a joint through its range of motion with controlled movement whereas ballistic stretching is taking a joint through its range of motion in an uncontrolled manner, increasing the potential for injury.

14 Resistance (weight) training will benefit a recreational sportsperson in a number of ways, including: reducing the risk of injury by strengthening muscle and tendons; helping body alignment; strengthening bone; improving neural pathways; enhancing strength and power.

CHAPTER 4: LEGAL AND ILLEGAL METHODS THAT ENHANCE PERFORMANCE OF THE MUSCULOSKELETAL SYSTEM

Chapter check-up p. 81

1 A legal method or practice may be anything from good nutrition to a training program to the consumption of nutritional supplements. Legal training methods that enhance the performance of the musculoskeletal system include resistance training, flexibility training, yoga and core training.

2 While there has been a dramatic increase in the practice of doping in some sectors of the community, it is not at pandemic level. In recent times, there has been increasing concern about young people turning to the use of banned substances, seeking a competitive edge. These young people see professional athletes using illegal substances or methods, and think that it is an acceptable practice. Doping is a sociocultural issue as research has shown that children's sociocultural context can have a significant influence on their development. This is also the case in the context of sport and physical activity. Our beliefs about accepted behaviours and practices in sport and physical activity are shaped at an early age. These beliefs can become ingrained, especially if these behaviours are allowed to run unchecked. What is required is a responsible education program specifically targeting young people, for the reasons outlined above. WADA and ASADA have education programs aimed to educate recreational, amateur and professional athletes about the risks of doping.

3 The World Anti-Doping Code is the core document that harmonises anti-doping policies, rules and regulations within sporting organisations and among public authorities around the world.

Chapter check-up p. 84

1 Resistance training is any form of exercise that causes the skeletal muscles to contract against an external form of resistance with the aim of increasing strength, tone, power, mass and/or endurance. The term resistance training can also refer to general weightlifting done to become either stronger, bigger or more toned, or to increase muscular endurance.

2 Hypertrophy can be defined as an increase or enlargement in muscle size as a result of specifically targeted training. The abnormally large muscles of a bodybuilder are an example.

3 Depending on the focus, resistance training can build muscle strength, muscle power and muscle endurance. To target muscle strength, heavy weights would be combined with a low number of repetitions. To focus on muscle endurance, lighter weights would be combined with a high number of repetitions.

Chapter check-up p. 87

1 One of the best ways to maintain flexibility is to stretch regularly. It is important to note that there is a difference between flexibility and stretching. Flexibility is the capacity of a joint or muscle to move through its full range of motion. Stretching is a form of exercise that can lead to an increase in flexibility. The four recognised methods of flexibility (or stretching) training are: static stretching, passive stretching, dynamic and ballistic stretching, and proprioceptive neuromuscular facilitation (PNF) stretching.

2 Static stretching is appropriate at the end of a training session or as an independent training method performed in isolation. Evidence suggests that it should not be performed during a warm-up preceding other activities, as this may increase the risk of injury.

3 Pilates uses coordinated breathing and movements to stretch and strengthen the body, targeting balance, posture, and core strength and stability. Balance and core strength are integral components of functional movements. These are two of the key elements of Pilates, which teaches how to better activate particular muscles. Pilates also increases flexibility (which is important as this decreases with age). Flexibility is important because it enables muscles to work efficiently and safely (i.e. helps to avoid injury). Pilates increases muscle control, which also guards against injury and may reduce pain in cases such as lower back pain.

Chapter check-up p. 92

1 A nutritional supplement can be defined as 'any pill, capsule, tablet, liquid or powder that contains vitamins, minerals, herbs or amino acids; intended to increase dietary intake of these substances.' (Crowe et al., 2014) Many individuals believe that taking nutritional supplements will enhance their physical performance.

2 Creatine supplementation is a method of improving performance for those engaged in high-intensity explosive power activity. Creatine improves performance most significantly during short-duration, high-intensity activities; it is not useful for endurance sports. Individuals whose training has a power focus may take creatine supplements to enhance creatine phosphate stores in working muscles. High levels of creatine phosphate enable the individual to train at higher intensity. Challenging the muscles to work at higher intensities means they are forced to adapt, enhancing the efficiency and performance of the musculoskeletal system.

3 A range of individuals use human growth hormone (HGH) to build lean tissue and enhance athletic performance. Some athletes believe that HGH will provide the benefits of anabolic steroids without the dangerous side effects. Hormones such as HGH and corticosteroids are used to increase muscle and bone development, to induce a state of euphoria, as an anti-inflammatory preparation, and to normalise the testosterone–epi-testosterone ratio used in dope testing.

CHAPTER REVIEW p. 94

Multiple-choice questions

1 C

2 B

3 C

Short-answer questions

4 An illegal method or practice is one that enhances performance and violates the WADA code, threatens the health or safety of the individual and provides a measurable performance enhancement. Illegal methods or practices allow an individual to gain an unfair advantage over their competitor. Such practices go against many of society's values, ethics and social norms, and challenge the notion of fairness. In sport, some consider this practice cheating, because the notion of a 'level playing field' is removed. An example of an illegal method is an anabolic steroid.

5 The Australian Sports Anti-doping Authority (ASADA) is Australia's national anti-doping organisation. Established in 2006 by the Australian Government, ASADA is consistent with the requirements of WADA and the World Anti-Doping Code.

6 WADA is responsible for developing and implementing uniform anti-doping standards worldwide, establishing lists of banned drugs and setting the penalties for misusing them. WADA publishes an annual 'List of Prohibited Substances and Methods', which details performance-enhancing substances, methods and practices that individuals participating in sporting competitions governed by WADA are not permitted to use. This is designed to establish a level playing field for all participants, as well as aiming to ensure a safe and fair environment for participation in sport.

For a substance or method to be prohibited, it must meet two of the following three conditions:

1 The substance or method has the potential to enhance or does enhance performance in sport.

2 The substance or method has the potential to risk the athlete's health.

3 The World Anti-Doping Agency has determined that the substance or method violates the spirit of sport.

The list of prohibited substances is reviewed annually and comes into effect on 1 January each year, with no amnesty period. The prohibited list ensures consistency across all sports and signatories compliant with the World Anti-Doping Code.

7 There are many types of resistance training equipment, including:

» free weights – dumbbells, barbells, weights benches

» resistance tubes and bands

» weight machines – resistance training devices that have cables, pin-loaded weight stacks or fixed lever arms

» kettlebells – a cast iron or cast steel weight. Typical kettlebell exercises build strength and endurance, particularly in the lower back, legs and shoulders, as well as increasing grip strength

» body weight – chin-ups, push-ups, or any other activity that uses body weight as the resistance. Body weight exercise requires minimal equipment, making it an affordable option.

Adding resistance training to a conditioning/training program increases lean body mass, development and maintenance of muscle strength and endurance, in addition to other benefits such as maximising and maintaining bone density. Progressive resistance training increases muscle strength and endurance, prevents and manages several chronic diseases, including cardiovascular disease, and can improve psychological wellbeing.

Resistance training strengthens both the axial (head, neck and trunk) and appendicular (upper and lower limbs) musculoskeletal systems. This improves biomechanics by making the musculoskeletal system more efficient at various movements, while also improving posture by strengthening core and back muscles. Increased range of motion is an additional benefit of resistance training. By taking the muscles and joints through a greater range of motion, resistance training can improve mobility, promote healthy joints and decrease the risk of injury. Resistance training can directly enhance performance in sport and general activity. For example, it could enable a soccer player to kick the ball further, and a boxer to throw a punch with greater force.

8 Flexibility is required in all activities of daily living, from getting out of bed to walking, bending down to pick something up, or lifting objects. Flexibility is specific to a particular movement or joint and the degree of flexibility can vary around the body. Being flexible helps to reduce muscle soreness and can improve posture. It allows muscles to remain mobile, enabling pain-free exercise. Tight muscles or a lack of flexibility can contribute to pain or difficulty in performing the activities of daily living. As people age, their lean muscle mass decreases. The muscles naturally lose strength and size, and can become less supple. This can affect the range of movement around joints, causing stiffness in the muscles and joints. This loss of tissue elasticity can cause muscles and joints to tighten up, resulting in changes in normal muscle function as well as increasing the chance of injury. A lack of general physical activity can also cause muscles to lose flexibility and become prone to strains, tears and general pain. It is important for people to include flexibility exercises as part of their daily routine. This is a vital component of health that many people neglect.

CHAPTER 5: THE CARDIOVASCULAR SYSTEM

Chapter check-up p. 102

1 a Homeostasis is the process that maintains the stability of the human body's internal environment in response to changes in external conditions.

b Haemoglobin in the red blood cells carries both oxygen and carbon dioxide, although most carbon dioxide is removed via plasma. If the process of carbon dioxide removal is slowed, concentrations will rise. This is quickly detected by the brain and the body then tries to increase oxygen uptake via deeper breaths.

2 Decreased plasma levels are directly related to increases in heart rate and systolic blood pressure because the heart has to work harder to pump 'thicker/more viscous' blood around the body. Potentially this results in less blood being sent to working muscles and more to the heart muscle itself; work-rates may tip over LIP and hence performances become more and more anaerobic and result in accumulation of metabolic by-products and a need to slow down; concentration/coordination levels decrease.

3 As soon as the brain detects any form of blood loss it will act quickly to constrict blood vessels at relevant sites and greatly reduce blood flow there. Additionally, platelets are directed to the area/site of bleeding in an effort to assist in blood clotting aimed at reducing further blood loss.

Chapter check-up p. 105

1 Males tend to have larger hearts, and more blood in their cardiovascular systems, compared to females.

2 Systolic blood pressure measures pressure on the arteries as blood leaves the heart and is being 'pumped' forcefully. This shows a linear increase with exercise intensity. Diastolic blood pressure is the pressure on the veins as blood returns to the heart after having been to all body parts, and much of the pressure has been reduced along this journey in the blood vessels.

3 Precapillary sphincters can 'turn on' and 'turn off' blood flow to specified areas of the body. If a major injury resulting in blood loss has occurred in the arm, precapillary sphincters related to this area will 'shut down' blood flow to this area and cause more blood to be pumped to alternative body sites and hence reduce the amount of blood loss from the injured site in the arm.

4 As soon as food is detected in the stomach, more blood is sent to it to assist in the digestion process. At the same time, less blood is sent to other sites, including muscles. Less blood to the working muscles used for swimming means there is less oxygen and fuels supplied to those working muscles, as well as less removal of waste products. This means that muscles responsible for swimming movements will be compromised in terms of normal functioning and could potentially place the swimmer at risk of struggling if they were required to swim at high intensities – e.g. to avoid a rip or in open/rough seas.

Real world application p. 107

1 Approximately 100

2 Suggested answer: The body needs to adjust to the donor heart and risk of rejection is highest in the first few weeks following the transplant.

Chapter check-up p. 111

1 Muscles shiver to prevent hypothermia and keep a core temperature of about 36.9 °C the brain monitors temperature very closely. If the surface temperature of the skin decreases, skin receptors send signals to the brain, which then instructs the muscles to start shivering. Shivering occurs when muscles contract and relax rapidly and a by-product of this is heat, which aims to return core temperatures to 36.9 °C.

2 Electrolytes such as sodium, chloride, potassium, and magnesium are necessary elements for muscle contraction and relaxation. In addition, electrolytes help maintain your body's fluid balance. Your body loses an increased amount of these minerals with water through sweating. See the fact sheet on your student website, http://www.nelsonnet.com.au/vcepe12 for more detail.

CHAPTER 5 continued

3 Meteorologists often say that the temperature is a certain figure but it 'feels like' a lower temperature as a result of of wind chill. Wind chill is the perceived decrease in air temperature felt on exposed skin due to the flow of cold air over it (wind). In cool environments where there are strong winds, exposed body parts will feel colder than the ambient temperature because of the flow of wind over them. This will make the core temperature decrease as a result and the risk of hypothermia is increased.

Real world application p. 113

1 This would delay the onset of elevated body temperature/dehydration and better allow the athlete to control their core temperatures, which would result in lower fatigue levels during the marathon.

2 A simulated hot environment, in most cases, removes the need to travel to host climates/countries, which can be very disruptive to training schedules. A simulated environment can be set to match exact temperature, humidity, etc., which cannot be done if left to the weather/climate itself. Recovery is more complete when removed from the simulated climate so training can better adhere to the principles of frequency and intensity, and a greater volume of training can also be undertaken.

3 Sport drinks are designed to either increase the rate of hydration (hypotonic), or the rate of replacing lost carbohydrates (refuelling) or replacing lost electrolytes, which allow neuromuscular functions to continue. They are flavoured to mask the salty taste of the electrolytes they contain and thus to make them more palatable.

4 Weight loss is directly related to fluid loss/dehydration and at a minimum, each gram lost in weight during performance should be replaced by 1 mL of fluid. Thus 1 kg lost in sweat should be replaced by 1 L minimum. Most coaches advocate a 1:1.5 ratio of lost fluid/weight for replacement fluids.

CHAPTER REVIEW p. 115

Multiple-choice questions

1 C

2 D

3 D

4 D

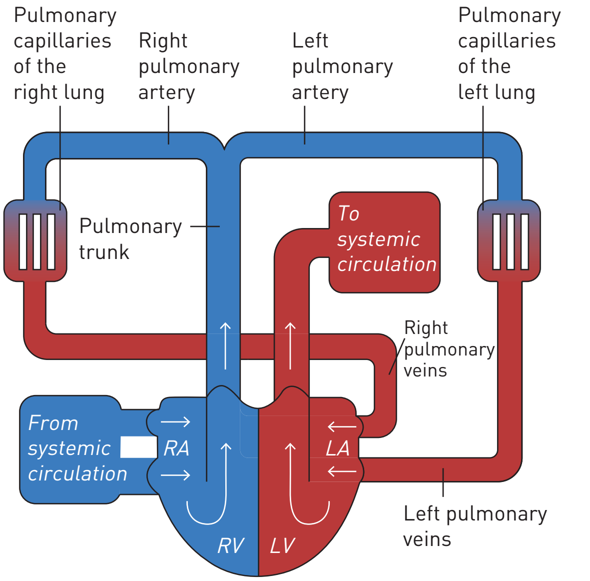
5 B or D

Short-answer questions

6 Both vasoconstriction and vasodilation occur as a result of three main factors:

- muscles contracting around blood vessels during an active recovery or deep tissue massage.
- alternating hot and cold via contrast therapies (showers, baths, etc.)
- The net result is that blood flow is increased both to and from muscles.

7



8 Acclimatisation needs to occur before actual exposure to new competition conditions. The easiest way to replicate competition conditions/environments would be to travel to the actual place of competition, but this is also the most expensive option and possibly not viable for the group of students.

The key would be to try to replicate the same temperature and humidity conditions, while training, in home environments/cities before competing in Darwin. This could be achieved by players wearing extra clothing, spray jackets, etc. during training to simulate hotter conditions and low cooling due to humidity.

9 a Blood-boosting practices aim to increase the amount of oxygen carriers in the blood, which greatly improve aerobic capacity and endurance performance – most of these target increased RBC production.

b By increasing RBCs, potential harms include:

- stroke
- heart attack
- increased blood pressure
- blood clots/thrombosis.

CHAPTER 6: THE RESPIRATORY SYSTEM

Chapter check-up p. 120

1 During inhalation, the diaphragm and muscles between the ribs (intercostals) contract, creating a negative pressure, or vacuum, inside the chest cavity. The negative pressure draws air into the lungs. During the second stage of breathing, called expiration, the diaphragm and intercostals relax and positive pressure is restored to the chest cavity, forcing air out of the lungs.

2 Being 'winded' temporarily incapacitates the normal contraction and relaxation rhythm of the diaphragm, which results in air needing to be 'sucked in' until normal functioning returns.

3 Performing a warm-up is typically done to reduce the risk of injury and to 'warm muscles up'. However, another important reason why warm-ups are conducted is related to the respiratory system and its contribution to improved performance. Warm-ups result in increased respiratory rate, tidal volumes and thus ventilation – they get more oxygen flowing to working muscles. Because of this, the balance between oxygen demand and oxygen supply when activity commences will be closer, resulting in lower oxygen deficits. This means the body can begin to work aerobically more quickly.

4 Increasing oxygen debt or EPOC, would typically happen when an active recovery is being performed to increase the rate of oxidation of waste products – i.e. faster removal of lactate and H+.

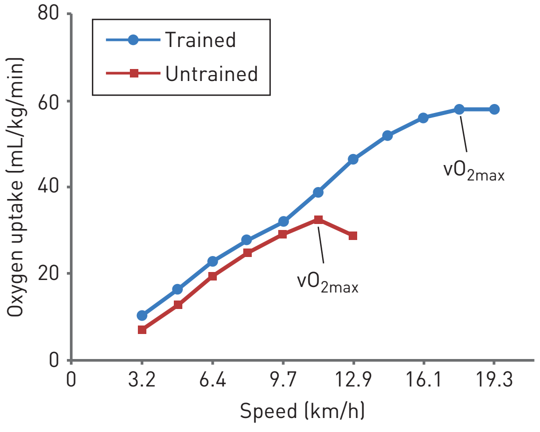
Data analysis p. 124

1 There is a direct linear relationship between these variables and exercise intensity – i.e. as exercise intensity increases, so too does blood flow, and oxygen consumption/arteriovenous oxygen difference.

2 The performer has reached a point where no further oxygen can be extracted from the blood, but the body is trying to supply more oxygen via increased blood flow.

3 The a-vO_2diff of the trained endurance runner would be higher than that of the untrained person throughout the test and they can keep going at higher intensities as they can extract greater amounts of oxygen than the untrained athlete (see graph below).

The maximum arteriovenous oxygen difference of a trained athlete usually exceeds that of an untrained person. The training effect may be due to adaptations in the mitochondria, increased myoglobin content of muscles, or improved muscle capillarisation.



4 During rest there are low demands for oxygen by muscles and hence low levels of gaseous exchange occurring both at the lungs and muscles. However, as the work-rate/intensity increases, the demand for oxygen also increases. The amount of oxygen taken in and carbon dioxide given off at the lungs increases and the same happens at the muscles, as evidenced by increased a-vO_2diff.

Real world application p. 126

1 Alveoli are the site of gaseous exchange at the lungs – if these are 'damaged' or compromised, this would result in lower levels of oxygen uptake and smaller amounts of carbon dioxide removal at the lungs. In an endurance event such as the triathlon, this would result in significantly lower levels of performance and slower completion times as the amount of aerobic ATP production would also be lower.

2 C-PAP is a treatment that uses mild air pressure to keep the airways open. C-PAP is mainly used by people who have breathing problems, such as sleep apnoea. It may be used to treat premature infants whose lungs have not fully developed, resulting in respiratory distress syndrome or bronchopulmonary dysplasia. By keeping the airways open, the C-PAP machine ensures uninterrupted and comfortable sleep.

3 Lower levels of oxygen in the blood may be caused by:

- dehydration resulting in less plasma
- damage to one-way valves in heart/blood vessels resulting in poorer venous return
- internal or external bleeding
- damage to alveoli (injury, smoking, defects) reducing surface area for gaseous exchange.

CHAPTER REVIEW p. 128

Multiple-choice questions

1 B

2 B

3 C

4 B

5 A

Short-answer questions

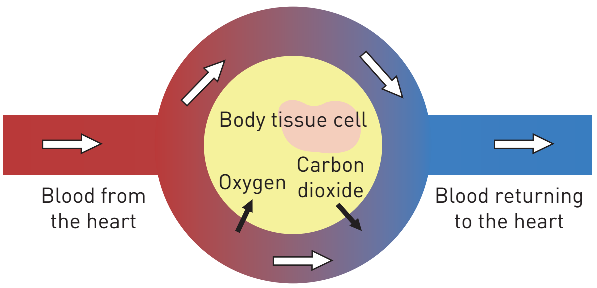
6 The arteriovenous oxygen difference is a measure of how much oxygen is being used by muscles. As the exercise intensity increases and oxygen demand also increases, the arteriovenous oxygen difference will also rise.

7 By jogging on the spot they are keeping their oxygen uptake higher than if they simply stopped. When the lights change, they will be able to meet the demands of running more quickly because there is a smaller oxygen deficit. Additionally, because the heart is pumping at higher levels than if resting, it is better able to supply oxygen and fuels to working muscles when the lights change.

8 Steady states accompany situations during the race where oxygen supply meets oxygen demand. The most obvious state is during rest before the race begins. About 3–4 minutes into the race there will be another steady state when the body's cardiovascular and

respiratory systems are able to meet oxygen demands. This remains until the intensity is increased and another oxygen deficit occurs until the body responds to meet increased oxygen demands and another steady state is reached.

9



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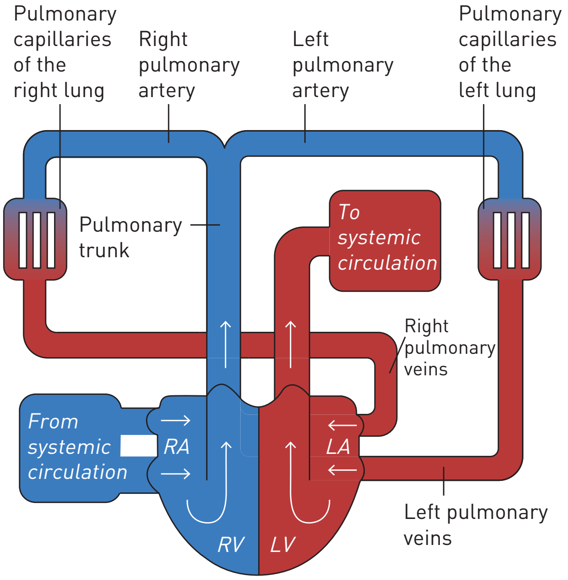
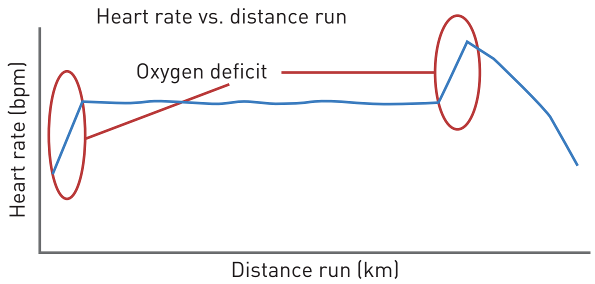


11 Increased alveoli contribute to more sites and surface area across which gases can be exchanged. As a result, more oxygen can be taken up at the lungs and more carbon dioxide exhaled, both contributing to better endurance performances.

Investigations

12 Asthma sprays essentially act as bronchodilators. This means that they act on the airways (bronchus and bronchioles) to increase their diameter and thus open the airways to enable larger amounts of air to get in and out of the lungs. If taken for athletic advantage, this would result in improved oxygen uptake and delayed fatigue resulting from hydrogen accumulation.

13



a Oxygen deficit can be seen when there is an increase in oxygen consumption and this is when the demand for oxygen exceeds the body's ability to supply it.
b Maximal heart rate = 220 minus age = 220 – 50 = 170 bpm.
c During steady state the arteriovenous oxygen difference also levels off and stops increasing when compared to previous levels.

CHAPTER 7: FACTORS AFFECTING THE CARDIORESPIRATORY SYSTEM

Chapter check-up p. 134

1 Hypertension = high blood pressure. Being overweight contributes to hypertension by:

» higher fat diets are more likely to cause the arteries to become thick and stiff and hence the heart has to pump harder to ensure blood reaches all parts of the body.
» having more fatty tissue which increases vascular resistance and in turn increases the work the heart has to do to pump blood throughout the body.

2 Surgeons can perform either of the following procedures in an effort to increase blood supply to the heart itself once a blockage is identified:

» insert a 'stent' that opens up the blockage and supports arterial walls so the opening does not close on itself (often accompanied with angioplasty, where plaque is forced against the arterial wall via a small balloon inserted into the blood vessel – the stent stops the plaque from forming a blockage again)
» perform a bypass, in which an artery is taken from another body part and used to redirect blood around the site of blockage.

3 The hormone progesterone relaxes the walls of blood vessels during pregnancy, resulting in decreased blood pressure during the first 4–5 months of any pregnancy. Blood pressure tends to rise gradually again from 24 weeks onwards as the developing child increases significantly in size and the body has made an extra litre of blood, which makes the heart pump harder to circulate it around the body.

Real world application p. 136

Answers could include:

1 Comorbidity refers to the presence of one or more additional disorders (or diseases) occurring at the same time as a primary disease or disorder.

2 Arthritis and cardiovascular disease often occur together because they both are related to aging – the longer a person lives, the more likely it is that these diseases will develop.

3 The risk of developing cardiovascular disease can be reduced via regular exercise, attention to a healthy diet, regular medical check-ups and early intervention when symptoms first occur. By doing this, the risk of developing arthritis is also greatly reduced.

4 Any three of the following will result in cumulative negative health effects that may not be seen for 10 – 20 years:

- » overeating
- » sedentary lifestyles
- » lack of activity that strengthens muscles and bones
- » smoking
- » living in areas with high levels of pollution.

Chapter check-up p. 138

1 A stroke is caused by blood/oxygen supply to the brain being interrupted. This may be caused by a blockage to major arteries supplying the brain, typically because of the build-up of plaque in the arteries. Urgent medical attention should be sought if someone is suspected of suffering from a stroke because the amount of brain damage that occurs can be limited and the recovery period decreased, enabling sufferers to return to as close to pre-stroke condition as possible.

2 Arthritis and aging greatly increase the risk of suffering from cardiovascular disease. Arthritis and back problems occur together more commonly than arthritis and cardiovascular disease.

3 Aboriginal and Torres Strait Islander people have higher rates of death from cardiovascular disease than non-Indigenous Australians because of any of the following factors:

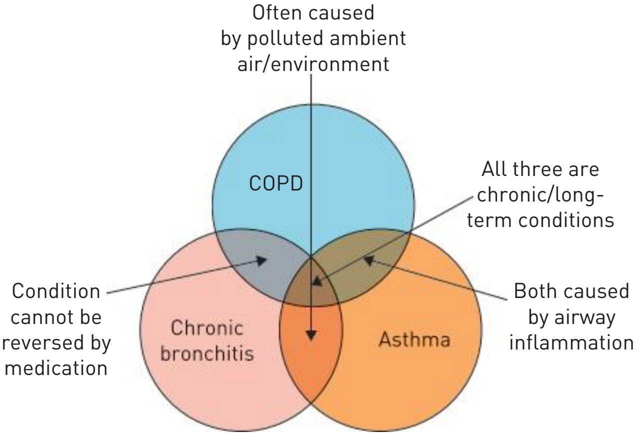
- » more are obese or overweight
- » more are likely to smoke
- » more are less likely to engage in leisure-time physical activity
- » the prevalence of type 2 diabetes is higher
- » lower levels of education
- » less likely to seek GP assistance
- » a lack of knowledge about the risk factors and associated symptoms of cardiovascular disease.

4 Males have higher rates of being overweight than females so are potentially more likely to suffer from cardiovascular diseases such as hypertension, angina and stroke. Additionally In addition, men are more likely than women to:

- » smoke
- » engage in less physical activity
- » not consult or listen to advice from a GP
- » suffer from stress.

Chapter check-up p. 141

1



2 This advice is contrary to what most medical experts would offer.

To prevent exercise-induced asthma, suggestions include:

- » Make sure that your asthma is being well managed, as this will make exercise-induced asthma less likely to occur.
- » Always carry your reliever medication and spacer with you.
- » Reliever medication should be taken up to 15 minutes before warming up.
- » Warm up before exercise as usual.
- » During exercise, watch for asthma symptoms and stop and take reliever medication if symptoms appear. Only return to exercise if asthma symptoms have been relieved. If asthma symptoms appear for a second time during exercise, take reliever medication again until symptoms have been relieved. It is not recommended that you return to the activity under these circumstances.

A sedentary lifestyle is associated with many negative health effects, including:

- » low levels of fitness
- » increased likelihood of cardiovascular disease
- » hypokinetic disease
- » difficulty maintaining low percentage body fat
- » lower self-esteem
- » decreased brain function
- » poorer flexibility
- » shortened lifespan.

3 Too much physical activity is detrimental/harmful when it:
  » occurs without sufficient recovery time in between sessions/repeat bouts
  » leads to injury
  » does not take into consideration existing fitness levels
  » is not tailored
  » becomes a part of an obsessive behaviour and overrides other aspects of a person's life
  » leads to decreased immunity levels/increased illnesses and susceptibility to diseases.

CHAPTER REVIEW p. 143

Multiple-choice questions

1 C

2 C

Short-answer questions

3 Sample answer: Maintenance staff are more likely to be engaged in higher levels of on-the-job physical activity as part of their daily work. Office staff may be engaged in incidental physical activity, but this would be significantly less than that of the maintenance team. Therefore, the maintenance team have a greater cardio-protective effect resulting from their day-to-day work compared to the office staff.

4 Answers will vary, but could include:
  » Bones are living tissues.
  » Old bone cells are being absorbed into the body and new bone cells are being produced.
  » During the first two decades of life, there is a continual increase in bone mass, due to the bone formation phase occurring at a faster rate than bone resorption.
  » By approximately 20 years of age, bones have reached their peak bone mass (density) and strength.
  » For the next 15 years, bone mass remains constant as bone resorption occurs at the same rate as bone formation.
  » From about 40 years onward, bone resorption occurs at a faster rate than bone formation and there is a resultant loss of bone mass. In women, the rate is accelerated through the first five years of the menopause.

  It is important for our bones to achieve peak mass at around 20 years of age. This is assisted by careful attention to diet and inclusion of strengthening exercises. This peak will remain until 40 years of age when it will start to decrease. Having a higher bone mass will delay bone-related conditions such as osteoporosis and also decrease the risk of weak bones and related injuries and lifestyle restrictions.

CHAPTER 8: LEGAL AND ILLEGAL METHODS THAT ENHANCE PERFORMANCE OF THE CARDIORESPIRATORY SYSTEM

Real world application p. 149

1 The Collingwood players were found to have an average increase in total haemoglobin mass of 3.6% after living for 19 days at moderate altitude.

2 Collingwood Football Club assessed performance by comparing 21 athletes who travelled to altitude with a group of nine who stayed at home and completed their pre-season training in Melbourne. All of the athletes were training extremely hard, and all the athletes improved their running performance, which was measured with a 2-kilometre time trial. However, the athletes that participated in the altitude training camp had a 2.1% greater improvement than those who stayed in Melbourne. This was a very promising result for the overall efficacy of the altitude training camp.

3 The underlying thinking is that when athletes return from the altitude camp with an increased physiological (and running) capacity, they are able to train harder during the post-altitude period, allowing for greater training adaptations that allow them to train harder in the following weeks, and so on. Here the athletes are essentially 'training to train', which all athletes are doing during preparatory phases of the season, building each week's work on top of another to gradually improve their performance. For AFL players, this means getting a boost during their pre-season so they can train harder during the late pre-season and carry these improvements into the playing season itself.

4 An increased physiological (and running) capacity. Players are able to train harder during the post-altitude period, allowing for greater training adaptations that allow them to train harder in the following weeks.

5 The nature of team sport means that the effort of physical exertion is intermittent in nature for positional play – the game will ebb and flow in terms of high-intensity efforts interspersed with low-intensity efforts for all players. If a club or coach can specifically train the relevant energy systems to enable the player to better cope with the game day play (improving metabolic by-product tolerance), the individual player will be able to stay involved in the contest for longer and be able to contribute constructively for longer. In turn, performance will improve and the team will benefit.

Chapter check-up p. 151

1 Altitude training generally occurs in a natural environment and can be classified as a legal method of performance enhancement. There are many variations of altitude training that can be employed, and the purpose of altitude training will vary according to the individual. For many, the purpose is to improve sea-level performance. It is generally agreed that, in order to achieve results, altitude training needs to take place above 2000 metres – ideally closer to 2500 metres. It usually takes an athlete three weeks of altitude training to achieve a greater oxygen capacity than could be attained at sea level.

2 'Live high, train low' means athletes live at high altitude, but train at a lower altitude, enabling them to train with greater intensity while still reaping the benefits of being at altitude. It is important to note that there are many variations of altitude training that can be employed, and the purpose of altitude training will vary according to the individual. For many, the purpose is to improve sea-level performance.

3 Endurance athletes such as marathon runners, triathletes and road cyclists would benefit most from altitude training.

4 Hypoxia occurs when there is not enough oxygen in the tissues, or low oxygen in relation to metabolic needs. Hypoxic training is a legal cardiorespiratory performance enhancer, and is ethically sound. Hypoxic devices such as hypoxic tents can provide an alternative to altitude training, which is not accessible to all, meaning its use is fair and equitable. By increasing accessibility for those who cannot afford natural altitude training, hypoxic devices may help level the playing field. As with altitude training, further research is required to refine hypoxic training possibilities.

Real world application p. 153

1 EPO is a naturally occurring polypeptide hormone produced in the kidneys that regulates the body's production of red blood cells. As red blood cell production increases, the amount of oxygen supplied to the muscles also increases. A synthetic EPO can be used to treat patients with low levels of red blood cells resulting from conditions such as anaemia, kidney disease and various cancers. Athletes seeking to improve their endurance abilities inject EPO so their bodies produce higher amounts of red blood cells, enhancing performance.

2 Blood doping is a dangerous practice – those who engage in it risk contracting blood-borne viruses such as hepatitis B. Athletes using blood doping, regardless of the type chosen, all risk developing problems, including:

- » stroke
- » hypertension
- » body rejection
- » infection/transmission of diseases
- » autoimmune diseases
- » heart attack.

3 There are a few quite substantial risks of blood doping. The most common is a blood clot, which can lead to heart attack, stroke, or even sudden death in your sleep. Increasing the blood count makes it more viscous, which is called 'sludging'; this can slow down your heart rate and cause clots.

Chapter check-up p. 154

1 Athletes seeking to improve their endurance abilities inject EPO so their bodies produce higher amounts of red blood cells, in an attempt to enhance performance.

2 Blood transfusions can be of the athlete's own blood (autologous transfusion), or from a donor with the same blood type (homologous transfusion). Several units of blood (approximately 500 mL each) are removed and the red blood cells are harvested, stored for up to six weeks and later reinfused into the veins.

3 There are a few quite substantial risks of blood doping. The most common is a blood clot, which can lead to heart attack, stroke, or even sudden death in your sleep. To avoid sludging, the heart has to keep pumping. Some doping athletes wake up in the middle of the night and do star jumps or other vigorous movements to keep the heart pumping.

CHAPTER REVIEW p. 155

Multiple-choice questions

1 D

2 C

3 B

Short-answer questions

4 The primary purpose of altitude training is to improve the amount of oxygen the body can take in, transport and utilise, gaining aerobic benefits associated with blood cell changes. High altitudes present significant challenges to normal athletic performance, because the body finds itself in serious oxygen deficit. The human body has a built-in protective mechanism to counter the effects of high altitude. When the brain senses that the body is not receiving normal levels of oxygen, the kidneys release a hormone called erythropoietin (EPO). EPO stimulates bone marrow to produce and release more red blood cells to transport oxygen to tissues and organs. This produces an increased concentration of oxygen-carrying cells within the blood, as well as a rise in the individual's haematocrit, resulting in improved aerobic capacity.

5 Students could select hypoxic devices such as hypoxic tents as an alternative to altitude training. By increasing accessibility for those who cannot afford natural altitude training, hypoxic devices may help level the playing field.

As with altitude training, further research is required to refine hypoxic training possibilities. There is also a variation to altitude training. Some coaches and athletes decide to use hypoxic training at sea level by utilising hypoxic chambers, houses or even home-based hypoxic tents. This means the athlete can spend several hours per day (including sleeping) in a low-oxygen environment while continuing to train in their normal sea-level environment. This eliminates the need to acclimatise to higher altitudes

6 Gene doping can only be detected via a 'biological passport' which WADA has trialled and will soon make mandatory.

CHAPTER 9: PHYSICAL ACTIVITY CONCEPTS

Real world application p. 166–7

1 Physical activities in the case study are popular as they are convenient, can be done anywhere, with anyone and fit into busy lifestyles around work, rest, play and even holidays

2 'One-size-fits-all' approaches associated with boot camp-style programs tend to lose people after a while because activities and programs are not tailored to meet the needs, interests and abilities of people at the individual level but are aimed at a group level, which can quickly lead to dropping out or injury.

Chapter check-up p. 168

1 Physical activity: Any bodily movement produced by skeletal muscles that results in energy expenditure (expressed as kilocalories).

Exercise: Involves planning, structure and requires physical effort to sustain or improve health or fitness.
Organised sport: A physical activity that provides an active diversion that requires bodily exertion and structured competition.
Play: Generally consists of no formal rules, no set time or defined playing area and may be spontaneous or sporadic in nature. As winning is not the priority, there is a sense of fun rather than pressure.

2 Inactivity is defined as not engaging in any regular physical activity beyond daily activities, or a lack of moderate-intensity physical activity. If a person had a low level of energy expenditure of less than 50 kcal/week, they would be considered inactive.

In contrast, sedentary behaviour is defined as tending to stay in the same place for much of the time and expending low amounts of energy.

3 Any three of:

» If regularly performed, will result in numerous health benefits.
» Should be performed daily.
» Can easily integrate into your everyday life and routines.
» May be considered light activity when you are young but may equate to a moderate intensity when you are older.
» Are easy to perform regardless of fitness or skill level, and are therefore popular among adults.
» Should expend more energy than you would normally do at rest.
» May be performed throughout the lifespan.
» Usually require minimal equipment.
» Can be performed anywhere, anytime, even on holidays.
» Can be performed either by yourself or with one or two others.
» Are often of light to moderate intensity. Moderate-intensity activities are more attractive than vigorous-intensity activities to most people.

4 Lifestyle physical activities should be the most common form of daily physical activity; these activities form the base of the physical activity pyramid and should be performed on most days of the week, if not daily. In contrast, sedentary behaviours should be minimised wherever possible.

Chapter check-up p. 173

1 10 minutes.

2 Talk test, perceived exertion, heart rate and metabolic equivalent (MET).

3 1 MET represents the energy expended at resting levels. A MET value of 5 represents activity expending five times the energy expenditure of that at rest.

4 Vigorous intensity leads to a substantial increase in heart and respiratory rates and has a person working at 7 METs or more and above 70 % of maximum heart rate. Running, swimming laps and playing squash are examples of vigorous physical activities.

Data analysis p. 177

1 Yes, Bailey did meet the guidelines. He accumulated at least 60 minutes per day of moderate- to vigorous-intensity physical activity every day. He also engaged in activities to strengthen muscle and bone. He participates in a range of aerobic activities including vigorous physical activity each week.

CHAPTER REVIEW p. 181

Multiple-choice questions

1 B

2 A

Short-answer questions

3 a Leisure time, occupational, active transport, household/garden

b Increasing the number of people walking or riding bikes to work results not only in many health benefits, but also reduced congestion on the roads, reduced greenhouse gas emissions and increased productivity within the workplace.

4 a Answers will vary. Example answers might include: walking, swimming, cycling and golf.
  b Any four of the following:
  » If regularly performed, will result in numerous health benefits.
  » Should be performed daily.
  » Can easily integrate into your everyday life and routines.
  » May be considered light activity when you are young but may equate to a moderate intensity when you are older.
  » Are easy to perform regardless of fitness or skill level, and are therefore popular among adults.
  » Should expend more energy expenditure than you would normally do at rest.
  » May be performed throughout the lifespan.
  » Usually require minimal equipment.
  » Can be performed anywhere, anytime, even on holidays.
  » Can be performed either by yourself or with one or two others.
  » Are often of light to moderate intensity. Moderate-intensity activities are more attractive than vigorous-intensity activities to most people.
  c Lifestyle physical activities such as swimming, bike riding, dancing, golf, tennis and kayaking can also be sports. They can either be performed meeting the criteria of a lifestyle physical activity or in a more structured and competitive way, in the form of organised sport.

5 A person of healthy weight can meet their recommended 30 minutes of activity a day by accumulating three 10-minute bouts of at least moderate-intensity physical activity.

6 a Any three of: talk test, perceived exertion, heart rate and metabolic equivalent (MET).
  b Individual methods vary, but common methods include heart rate, talk test and perceived exertion.
  c The number of METs required to work at a moderate intensity decline with increasing age for males.
  d This will depend on exactly what activities are selected. Refer to table Table 9.6 on page 171.

7 Sedentary behaviour is defined as the amount of time spent sitting or lying down (with the exception of sleeping), engaged in non-active activities. Examples include watching television, using a computer or reading.

CHAPTER 10: PHYSICAL, SOCIAL, MENTAL AND EMOTIONAL BENEFITS AND HEALTH RISKS OF INACTIVITY

Text analysis p. 185

1 As a child, when his bones were developing, Bob spent a lot of time playing hopscotch and jumping from a height, both of which are considered high-impact activities that would have laid a solid foundation in terms of bone density.

2 Gardening is a lifestyle physical activity that is of moderate intensity resulting in a wide range of health benefits. Gardening is easily incorporated into everyday life.

3 Bob has never had a driver's licence and has to walk everywhere, using public transport and active transport. This would have kept Bob very active for his whole life.

Real world application p. 189

1 Dr Burton said that even if you don't suffer from depression, anxiety or a serious mental illness, you can enhance your wellbeing and vitality. She said exercise boosts mood, concentration, alertness and even the propensity to look on the bright side.

2 The Dutch study found that doing exercise reduced the risk of developing a mood or anxiety disorder.

3 Some possibilities include:
  » Helps you sleep better.
  » Gives you an improved sense of control, coping ability and self-esteem.
  » Provides distraction from negative thoughts and a chance to have new experiences.
  » Offers an opportunity to socialise and get social support if done with others.
  » Changes the levels of chemicals in the brain that can block pain and enhance feelings of wellbeing.

4 A manic phase for people with bipolar disorder

Chapter check-up p. 191

1 Any three from the figure/table on page 184. For example:
  » Stronger heart muscle fitness and health
  » Lower heart rate
  » Improved self-concept.

2 There are many social benefits associated with participation in physical activity. For example, playing in a team, going to the gym to do a workout, or even walking the dog, often means you would have to interact with other people.

  Walking groups are very popular because they allow participants an opportunity to walk and talk.

3 Research has shown that people who are more active have a lower risk of suffering from dementia.

4 Sedentary death syndrome (SeDS) is a complex condition associated with sedentary living. SeDS is a series of symptoms including low cardiovascular fitness, weak skeletal muscles and poor metabolic fitness (high blood sugar and fat levels, obesity, and high blood pressure at rest).

5 Cardiovascular diseases include the following:
  » Coronary heart disease (CHD): diseases affecting the heart muscle and blood vessels inside the heart that supply it with oxygen (including heart attack).
  » Coronary occlusion: a blockage to the coronary blood vessels, commonly known as a heart attack.
  » Arteriosclerosis: a hardening of the arterial walls due to conditions that cause a thickening of the arterial walls. Arterial walls also become hard and non-elastic.

- » Atherosclerosis: a build-up of deposits along the arterial walls (is a form of arteriosclerosis). The deposited materials restrict blood flow through the arteries and therefore result in reduced blood flow to working muscles.
- » Angina pectoris: chest pain caused by a lack of oxygen to the heart muscle.
- » Peripheral vascular disease: a lack of oxygen to the working muscles in the limbs due to decreased blood flow around the body.

CHAPTER REVIEW p. 197

Multiple-choice questions

1 D

2 B

Short-answer questions

3 a Having stronger muscles decreases the risk of injury and reduces lower back problems.
 b Muscles, tendons and ligaments
 c Osteoporosis and fractures

4 a Depression
 b Neuroplasticity, also called brain plasticity, is the process in which the brain's neural synapses and pathways are altered as an effect of environmental, behavioural and neural changes.
 c The potential psychological mechanisms underlying the relationship include:
 - » distraction or time out from stressful contexts and negative thoughts
 - » enhanced feelings of control and mastery
 - » improved self-esteem and physical worth
 - » behavioural activation.

5 a Type 2 diabetes results from too much sugar in the blood. This occurs because the body either doesn't produce or properly use insulin. Insulin is produced within the pancreas and is used by the body to convert sugar and other foodstuffs into energy.
 b Low physical activity levels and poor cardiorespiratory fitness are both predictors of mortality (death) related to type 2 diabetes
 c Healthy range of BMI for adults is 18.5–24.9.

6 a Interacting with others increases a person's sense of connectedness within a community; the community could be within a suburb, sporting club or school. Socialising when you are active, whether with friends, family, companions, personal trainers, work colleagues or coaches, can:
 - » increase enjoyment of physical activity
 - » improve self-concept
 - » improve quality of life and sense of wellbeing
 - » enhance engagement
 - » increase sense of belonging and attachment
 - » decrease social isolation
 - » enhance social networks to buffer against stress and enhance coping.

 b 60%
 c Type 2 diabetes and obesity

7 120/80 (less than 120 systolic and less than 80 diastolic) is normal blood pressure for adults

8 Even if you are meeting the Australian guidelines for physical activity, this may not help reduce the risks associated with excessive sitting time.

9 Physical benefit: Reduced blood fat, including low-density lipids (LDLs)

 Social benefit: Improved self-concept
 Psychological benefit: Fewer stress symptoms
 Emotional benefit: Improved mood, increased relaxation

10 No. A 4 year old should be participating in at least three hours of physical activity, spread throughout the day.

11 None.

CHAPTER 11: ASSESSMENT OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

Chapter check-up p. 207

1 Physical activity surveillance involves the systematic collection, analysis and interpretation of health data on an ongoing basis. This data is essential to the planning, implementation and evaluation of public health policy and services

2 Formative evaluation involves the ongoing assessment of a program's activities, with the goal of constantly improving the intervention strategies. In contrast, process evaluation involves the collection of data about the implementation (delivery) of a program (e.g. reach of the program, participant satisfaction with program and resources, how a program was implemented).

3 Moderate-intensity physical activity generally consists of sustained rhythmic movements. At this level you should feel some exertion but still be able to carry out a conversation comfortably. Vigorous-intensity participation leads to a substantial increase in heart and respiratory rates. At a moderate intensity, a person would be working at 3–6 METs and vigorous intensity is above 7 METs.

4 A person is working at a moderate intensity, expending five times the energy consumed at rest.

5 The more accurate a measure is, generally, the less practical it is or less feasible to use in the assessment of physical activity with larger numbers.

Real world application p. 217

1 Answers may include: Boys generally engage in more moderate to vigorous physical activity than girls. Girls tend to spend more time in smaller groups socialising and talking; boys tend to play sports such as football in larger groups.

2 Answers should include: More children are able to participate in physical activity during lunch breaks compared to before and after school, when many children are not at school.

Chapter check-up p. 225

1 A recall measure requires a person to remember and report on how much physical activity they engaged in the previous day, week, fortnight or month etc. A diary requires a person to write down, usually at the end of the day, what physical activity they engaged in that day.

2 Direct observation: diary, log, recall survey (either self-report if 10 years and over or proxy report if under 10 years).

3 Any two of the following:

» difficult to use with large populations
» intrusive
» highly labour-intensive and time-consuming
» the presence of an observer may bias the behaviour of those being observed (reactivity)
» time-intensive in terms of training to establish between-observer and within-observer reliability.

4 SOPLAY was designed to assess the physical activity of groups of people. This observational instrument can be used to assess physical activity in school settings during recess and lunch breaks and before or after school. In contrast, the System for Observing Fitness Instruction Time (SOFIT) is designed to assess physical activity during structured activity sessions such as physical education, sport classes or fitness sessions.

5 Pedometers provide wearers with immediate feedback of steps taken, raising people's awareness of physical activity levels, and ultimately encourage behavioural change.

Real world application p. 227

1 Modern pedometers have improved accuracy and more features, including inbuilt memory functions that are downloadable.

2 Pedometers are inexpensive, unobtrusive, easy to wear and accessible.

3 Wearing a pedometer can lead to behavioural change because it can increase awareness of your activity level and provide immediate feedback. This type of information can be motivational and allows daily goals to be easily adjusted.

Real world application p. 231

1 A combination of measures allows data to be collected about all dimensions, including type, intensity, duration and frequency, in a range of contexts.

2 Small, wearable, multisensor and wireless monitors, which can be worn like a band-aid or on clothing, are the future of activity monitors, allowing for pattern recognition in addition to measurement of frequency, intensity and duration of activities.

CHAPTER REVIEW p. 236

Multiple-choice questions

1 C

2 D

Short-answer questions

3 Any three of:

» To document the frequency and distribution of physical activity in defined population groups
» To monitor the achievement of physical activity guidelines and population trends over time
» To study the relationship between physical activity and health conditions (for example cardiovascular risk factors, Type 2 diabetes, obesity, cancer and mental health)
» To determine the amount or dose of physical activity required to influence specific health parameters
» To identify the biological, psychological and environmental factors that influence physical activity
» To evaluate the effectiveness of large-scale physical activity intervention programs.

4 At least 150–300 minutes a week of moderate-intensity physical activity on most, preferably all, days. If you can, also enjoy some regular vigorous activity for extra health and fitness.

5 Uniaxial accelerometers measure physical activity intensity by counting movement counts within a given period of time, e.g. over one minute or over five seconds. Triaxial accelerometers measure activity in *g*-force.

6 Two advantages are:

» A good alternative to self-reporting physical activity by children (as children under 10 cannot accurately recall their behaviour)
» Can assess physical activity that is difficult to capture (e.g. children's physical activity, incidental/light-intensity physical activity and sedentary time)

7 Direct observation

8 Generally, physical activity and sedentary behaviour are measured separately, therefore although an individual could spend many hours sitting in front of a television or reading or engaging in other sedentary behaviours, if they engage in at least moderate-intensity physical activity for at least 30 minutes most days they would still meet the guidelines. Children and young people, however, can still meet the physical activity guidelines even if they exceed the sedentary behaviour guidelines.

CHAPTER 12: SOCIOCULTURAL INFLUENCES ON PARTICIPATION IN PHYSICAL ACTIVITY

Written analysis p. 239 (top)

1 A 'knocker' is someone who criticises. The implication of having 'no knockers' is that all Australians love sport and that no one criticises sport in Australia.

2 To be Australian, according to the author, one must have an interest in sport, by playing, watching or reading about it.

3 Historically, Australia has done well in international competition, providing role models and national sporting heroes who have helped shape the nation into what it is today and how it is perceived by others.

Chapter check-up p. 244

1 Three of: peers, family, friends, work colleagues, health professionals, pets

2 Without social support, older adults may not feel comfortable participating in physical activity. Social isolation can limit opportunities to be active.

3 Student answers will vary but may include designated play spaces, shade protection of play spaces, access to sporting facilities during lunch, and resources.

4 No, proximity is only one factor that may influence participation in physical activity. There may be financial, personal and social barriers that limit a person's access to facilities.

Chapter check-up p. 247

1 Age, sex, ethnicity, genetic factors

2 SES can be a positive or negative influence on physical activity participation. High SES may provide greater opportunities and access to physical activity resources and facilities.

3 People from non-English speaking backgrounds are less likely to participate in regular physical activity.

4 Self-efficacy is one's confidence in one's ability to perform specific behaviours in specific situations. For example, having greater self-efficacy with regard to physical activity behaviour may lead to the confidence to participate in physical activity even when tired or in challenging situations.

Chapter check-up p. 255

1 Motor skill competence in children may lead to greater self-efficacy and confidence to participate in and play different sports, leading to higher levels of physical activity participation.

2 Availability of equipment, connectivity (grid network communities), access and availability of facilities (e.g. close to shopping centres to encourage walking).

3 Suggested answers:

- » Lack of time – get up 30 minutes earlier to walk the dog each day
- » Dislike of exercise – try a variety of different activities
- » Feeling too tired – exercise in 15-minute blocks
- » Lack of company – join a local cycling group
- » Lack of money – go for a walk or run.

4 Children and young people have many role models including elite sportspeople, parents, siblings, friends and peers. Children often want to replicate what they see their role models doing. Adults and older adults see fewer people their age participating in physical activity.

CHAPTER REVIEW QUESTIONS p. 257

Multiple-choice questions

1 B

2 B

3 D

Short-answer questions

4 Yes. For example, being overweight might prevent one person from being active because they are too embarrassed to be active in public, whereas being overweight may motivate someone else to be active so they can lose some weight.

5 Any three of: age, sex, ethnicity or cultural background, genetic or inherited factors, level of education, SES, self-efficacy.

6 Self-efficacy is one's confidence in their ability to perform specific behaviours in specific situations. Generally, the more self-efficacy you have, the more active you are, and in turn the more active you are, the more your self-efficacy is enhanced.

7 Physical environment: Bike paths, sporting equipment, local parks and playgrounds.

Social environment: Peers, parental support or encouragement and dog ownership.

8 a Parental support might include paying fees for competitions or memberships, paying for equipment and driving children to training, to competition, or to the local park. Parental support may also be in the form of playing with the child.

b Research has shown dog owners are likely to walk more each week. Dogs are considered a form of social support because they can increase a person's confidence to go for a walk and decrease their fear of walking alone. Most dogs love going walking and this can motivate an owner to go walking to keep their dog happy and fit.

9 a Barriers are generally considered factors that make it difficult to do something.

b Trying to manage part-time work, study and family means there is less time to be active. For a student these demands can make it hard to fit in regular physical activity. Possible solutions may be to get up earlier, commit to a team or friend to be active on a regular basis, or learn to say 'no' to extra shifts at work etc.

c Factors include:

- » Lack of local activity facilities, or transportation to important destinations, e.g. fitness centre, shops, parks or beach.
- » Cost of programs and access to facilities.
- » Poor weather, hilly terrain or lack of safety.

10 Commonly reported barriers include:
- » Feeling self-conscious.
- » Lack of energy.
- » Dislike of the discomfort associated with strenuous exercise.
- » Lack of financial resources.

11 a Factors can include:
- » There are fewer sports facilities and healthcare providers in remote areas, making access difficult. This also makes it difficult to access information about health.
- » Limited access to public transport to get to physical activity venues and programs.
- » Many physical education programs are not tailored to the needs and interests of Indigenous youth.

b Potential barriers include:
- » Pain/illness: Many older people suffer from chronic pain associated with conditions such as arthritis, osteoporosis, hypertension, cardiovascular disease, loss of function, strength, balance and flexibility associated with degeneration.
- » Limited resources: Some older people have very limited resources. While a pensioner may receive discounts to most physical activity programs and facilities, they still may not be able to afford to access many activities.
- » Transport: Many older people may have to give up driving, or may not feel safe on crowded public transport, particularly during peak hours. Unless activities are located conveniently, many older people would not have access to suitable transport to participate regularly.
- » Lack of social support: Unfortunately, many older people no longer have the people who have been their key forms of social support; they may lose their spouse, siblings or friends from illness or old age. Many older people feel isolated and lack the necessary social support to be able to get somewhere like a swimming pool to do exercises to music, or be able to go for a walk by themselves in case they feel unwell or fall. Falls are a common problem for older people.

c Barriers include:
- » Being too tired.
- » Having too much homework.
- » Preferring sedentary activities.
- » Inadequate facilities.

Sample answer: A common layout for streets in a new housing areas is the cul-de-sac, in contrast to the traditional grid network formation. A cul-de-sac design generally has poor connectivity, which makes walking to specific destinations via the shortest distance very difficult.

12 a Access to facilities and equipment, role models, social support, financial support. By having exposure and access to a variety of opportunities to be physically active, Patrick is more likely to develop good motor skills and increase his self-efficacy to allow him to participate in regular physical activity. The support he receives from his parents, and the behaviours they demonstrate, encourage and allow him to participate in physical activity.

13 Kimiko has competing demands on her time (children, mother-in-law) as well as having a language barrier. These factors affect the likelihood of Kimiko being active. Unfamiliarity with the physical environment may also act as a barrier to her taking up running again in Australia. Kimiko may benefit from joining a running group to meet new people (social support) and be shown around the local area (where the running tracks are).

CHAPTER 13: PREVALENCE AND TRENDS IN PHYSICAL ACTIVITY, SPORT AND SEDENTARY BEHAVIOUR IN THE POPULATION

Real world application p. 260

1 Australian Capital Territory

2 Northern Territory

3 18–24 years

Real world application pp. 263–5

1

A	B	C	D	E	F
	Mozambique New Zealand	Kenya Mexico Nigeria	Australia Canada Columbia England Finland Ghana Ireland South Africa USA		Scotland

2 Australia is in column D

3 See chapter 10 (pages 193–195) for the Australian physical activity and sedentary behaviour guidelines current at the time of publication.

4 a Australia rated poorly in active transport, sedentary behaviours, family and peers, and government strategies and investments.

b Australia rated well in community and built environment, school, and organised sport participation.

5 a There has been a global decline in participation in active transport to and from school.

b Australia is well below nations such as Switzerland, the UK and Brazil in terms of active transport.

6 a Just over 60%

b Less than 29%

c Two-thirds

d Approximately one third

Data analysis p. 266

3 There are more health benefits associated with being active daily or at least most days than with only being active two days per week on weekends.

4 'Sufficient physical activity' is defined as 150 minutes or more of moderate and/or vigorous activity per week.

Data analysis p. 270

1 a Walking for fitness generally increases throughout the lifespan until about the age of 75 and over, when there is a decline.
  b As people age, other forms and sources of physical activity decline and walking becomes the major source of physical activity.

2 a Walking for transport declines slightly over the lifespan, particular 75+ years.
  b The decline in walking for transport is associated with increased reliance on cars for transport, particularly once a person has children. In addition, the use of public transport associated with active transport declines once people retire.

Real world application p. 271

1 10 000 steps

2 Australian adults average 7400 steps per day, which is lower than Switzerland but higher than the USA and Japan.

3 The wrist-worn devices provide continuous feedback and act as a motivator to accumulate more steps via this heightened awareness.

4 Generally people walk more on work days as they need to travel to their workplaces via active transport, public transport or walking from their car park to their workplace.

5 5000 steps per day is approximately 4 kilometres.

Data analysis p. 272

1 Based on average per day, the 5–8 year olds accumulated the most steps. However if we separate out by weekdays, the 9–11 year olds average the most steps per day

2 On weekdays, young people are at school and accumulate steps during recess and lunch and also during transitions between classes, during curricular classes for PE and sport, training sessions and lunchtime activities – and for some young people, active commuting to and from school.

3 Generally, overweight individuals accumulated a lower step count average per day.

4 a Generally, people who meet the guidelines averaged a higher daily step count.
  b As for part a.

5 Among males, approximately 40% of 9–11 year olds and 32% of 5–8 year olds exceeded the daily 12 000 step recommendation. In all other age groups for males and all age groups for females, 15% or fewer met the 12 000 daily step count recommendation.

6 The 35–44 year olds average the most steps, perhaps because they are often working, are responsible for household/garden chores, and attend activities for their children, in addition to their own activities.

7 Daily steps display an increase across the age groups until about the age of 45, after which there is a decline across the age groups in the proportion of adults meeting the 10 000 average step count per day.

8 With the exception of the 45–54 year olds, a higher proportion of males than females accumulated the 10 000 steps per day recommended for adults.

Real world application p. 280

1 a Just under 60 % of Australian adults participated in sport in 2013-14.
  b There was a decrease in the proportion of people participating in sport and recreation two years earlier.

2 The most popular physical activities for females include walking; for males it is going to the gym.

3 There has been a downward trend in walking, swimming and cycling since 2011. The proportion of people participating in tennis, golf and cricket also declined.

CHAPTER REVIEW p. 282

Multiple-choice questions

1 C

2 B

Short-answer questions

3 Generally, participation rates in sport decline across the lifespan.

4 Generally, participation in physical activity declines across the lifespan

5 a 'Surveillance' means observing people to understand what they do. Surveillance of physical activity in populations is most often undertaken using questionnaires, as these are relatively inexpensive and easy to administer compared to objective measurement techniques.
  b Yes, this is the most economical way to get a snapshot of activity levels.
  c Lifestyle, or lifelong, sports are among the most popular physical activities adults engage in and therefore need to be a part of physical education programs to maximise engagement.

6 a Epidemiology is the study of the distribution and determinants of health-related states or events (including disease), and the application of this study to the control of diseases and other health problems. Various methods can be used to carry out epidemiological investigations: surveillance and descriptive studies can be used to study distribution; analytical studies are used to study determinants.
  b Females

7 The only way to examine a trend in sedentary behaviour is to measure how much sedentary behaviour occurs over a series of multiple time points; if there is a trend, the change in behaviour will consistently go in one direction.

8 a A major limitation of this method is associated with people's inability to remember.

b A major limitation could include social desirability bias, whereby the respondent answers in a way they think they should rather than recalling exactly what they did.

CHAPTER 14: CHANGING BEHAVIOUR: THE SOCIAL-ECOLOGICAL MODEL AND THE YOUTH PHYSICAL ACTIVITY PROMOTION MODEL

Real world application p. 293

1 Individual level, (for example biological and cognitive factors such as age or weight status and physical activity preference or motivation); the social level, such as social networks and influences (for example, family and peers); the cultural level (for example, ethnicity); the physical level (for example, the presence of a nearby park or access to public transport); the policy environment (for example, restricting dog walkers on a beach to certain hours of the day); and the economic environment (for example, funding provision for development of new sports complexes).

2 The Transform Us! study was based on an ecological framework and incorporated changes to the physical environment inside and outside the classroom, changes to pedagogical practice, and engaged teachers and parents in supporting children's active play during school and active homework after school hours.

CHAPTER REVIEW p. 300

Multiple-choice questions

1 B

2 B

Short-answer questions

3 a Building a set of bike racks on an unused car parking space would be a change to the constructed environment, as a car park is constructed.

b Examples include:

» Installation of shower and changing facilities to promote active transportation to the workplace

» Placing signage near elevators encouraging people to take the stairs. This can raise awareness of the easy ways to increase incidental physical activity

» Installing bicycle racks to encourage active transportation to work

» The installation of gymnasium equipment such as exercise bikes and treadmills

» An 'activity room' containing table tennis, which may act as a physical activity prompt for employees.

c To support the environmental change of installing bicycle racks, employers could conduct a quality bicycle education program within the workplace. This might include information about safe routes to work, road safety, cycling technique and bicycle maintenance.

d A policy to accompany the environmental changes proposed in part b could involve allocating one day per week when those who have used active transportation to get to work can finish work 20 minutes earlier.

4 Tailoring allows a counsellor or personal trainer to prescribe a physical activity plan to meet the individual needs of each person. Individual factors to consider include social support, access to walking trails and other facilities, work hours and settings, whether the person is a morning person, when and what they eat throughout the day, cultural factors, family structure, fitness levels and climate. So it is too simplistic to think you could just write a one-size-fits-all physical activity program just because you know what the individual's goals are.

5 Man-made environments include constructed features such as playgrounds, walking trails and roads. In contrast, the natural environment relates to what exists naturally, such as rivers, coastlines, mountains and weather.

6 Reciprocal causation is the interaction between the individual and the environment. In other words, individual behaviour can influence the environment and the environment can influence the individual behaviour.

7 a Individual factors, interpersonal factors, physical environment and policy

b Any three from each category from Table 14.3, pp. 289–290

c An example could include: The natural environment can play a large role influencing physical activity behaviour, for example if a walking trail or bike path is positioned along or near a waterway such as a beach, river or lake this will provide a very attractive venue for people to be active.

CHAPTER 15: PROMOTING PHYSICAL ACTIVITY AND REDUCING SEDENTARY BEHAVIOUR

Chapter check-up p. 310

1 Professions or occupations include:

» personal trainer
» general practitioner (GP)
» physical activity adviser
» fitness instructor
» psychologist.

2 Methods of delivering physical activity advice include: booklets, brochures and handouts, material available online.

Health professional counselling: Advice provided by GPs is often highly regarded by their patients, and research indicates that more than 80 per cent of the Australian population sees a GP at least once each year. Counselling provided by GPs can include verbal advice, written materials, activity diaries or calendars, informational videos or DVDs, or other resources that promote physical activity. GPs sometimes prescribe physical activity via what is known as a 'green script'. Instead of a prescription for medication, this is a prescription to be active and specifies a dose to be undertaken (e.g. walking three times per week for 35 minutes).

3 Six strategies used in physical activity counselling include:
   - Assessing motivational readiness – one of the first steps when counselling someone to be more active is to assess their motivational readiness to become more active. Once we know what stage of change the person is in we have an understanding of their motivational readiness to become more active. This information then allows us to match an individual's motivational readiness with the processes appropriate to change their behaviour.
   - Matching processes of change with motivational readiness
   - Identifying opportunities to be active – before you can identify time slots during the day that you could potentially turn into opportunities to be more active, you have to be aware of how often you move. You may be surprised by the amount of time you spend sitting each day getting to school, in class and after school. Modern technology has greatly minimised the need to move and people today sit for longer periods of time than in previous generations
   - Contracting
   - Enlisting social support
   - Reminder systems.

4 Two cognitive processes: increasing knowledge and understanding about the benefits of physical activity; increasing awareness of opportunities to be active.

   Two behavioural processes: rewarding oneself for being physically active; making plans and commitments to be physically active in the future.

5 Cognitive strategies involve increasing awareness and knowledge of the benefits of physical activity and encouraging a recognition of the consequences of inactivity on family and others.

   Behavioural strategies can include developing a reminder system and encouraging the use of rewards for being physically active.

Chapter check-up p. 315

1 Examples of population-level approaches to physical activity promotion are:
   - Mass media
   - Policy
   - Environmental change.

2 The natural environment includes such things as terrain, climate and vegetation. The constructed environment is anything man-made, such as roads and buildings.

3 Policies may be defined as laws, regulations, formal and informal rules and understandings that are adopted on a collective basis to guide individual and collective behaviour.

4 Key roles of mass media in the promotion of physical activity include:
   - Increase awareness of physical activity as a public health issue
   - Provide information about the health benefits associated with regular physical activity
   - Provide information about other non-health benefits of being active
   - Provide information about the consequences of inactivity
   - Increase interest in physical activity participation and raise awareness of community-based programs
   - Motivate individuals to take action towards physical activity participation.

Real world application p. 318

1 School, community, through sport and in the home.

2 Refer to pages 16–42 of VicHealth, 2014, *Active for Life*, Victorian Health Promotion Foundation, Melbourne, Australia. You can view this via http://vcepe12.nelsonnet.com.au.

Weblink

3 Physical activity is greatest during school lunch break, followed by before and after school and at recess; screen time peaks in the evening, between about 6 and 8 p.m.

Real world application p. 323

1 The government could monitor this mandate via annual survey or auditing of annual reporting. Funding should be tied to meeting the mandated time for physical education.

2 Three strategies include:
   - Allowing the classroom teachers access to professional learning opportunities to learn about the importance of physical activities and a range of practical options for implementation.
   - Providing teachers with adequate resources to allow children to participate in physical activity, including ample activity equipment per class e.g. 25 skipping ropes rather than two.
   - Ensuring there is a clear articulated expectation and timetabling of physical education classes per week and someone actually checking this is being implemented.

Real world application p. 327

1 After 2.5 years of program delivery, compared to usual practice, children who received the program spent approximately an hour more being physically active in recess and lunch breaks, and 2.8 hours less time sitting across the school week.

2 Refer to the table on pp. 325–6, which links the program objectives to a range of constructs (first column). For example, at the individual level within a social-ecological model, students developed their ability to self-monitor and use contracting (column 2) by learning how to set goals, contract with others and use rewards (column 3).

3 The benefits of standing desks include increased energy expenditure, increased health outcomes, reduced weight. The limitations are the cost and ensuring students have an opportunity to rest.

Chapter check-up p. 327

1 The Australian Department of Health is responsible for monitoring and promoting health behaviours and this encompasses physical activity. The Australian Government commits millions of dollars to the establishment of a national monitoring, evaluation and research system and to the promotion of physical activity.

2 Examples of major physical activity initiatives that could be implemented in schools include: standing desks, active role models at lunchtime, walking groups, mandated time for PE, increasing equipment and facilities for physical activity, removal of seating in the school yard, traffic calming improved to maximise pedestrian safety.

3 A school setting has the potential to reach large numbers of children within the one local area for a significant proportion of their lives. It provides access to at-risk groups such as inactive children.

4 Answers may include:

- » Change teaching and learning methods across subject areas and modify the learning environment to integrate elements of physical activity within the existing school curriculum.
- » Create schools as hubs for sport and dance programs. This can make these activities more accessible to more children by reducing travel times, particularly if they are scheduled to complement school hours.
- » Rethink the places where sport is played and how it is played so it is more inclusive, more accessible and less structured. Enable sport programs and games to be better integrated into the school, community and home settings.

Real world application p. 344

The answer depends on research completed and the model selected. An example strategy in relation to the social-ecological model is to have a policy that all staff must walk the block at 11 a.m. each day. However, if they formed walking groups, that would be a social strategy; if there were reminder systems in place that pop up on staff calendars to remind them to walk the block at certain times, that would be an example of an individual-level strategy.

CHAPTER REVIEW p. 346

Multiple-choice questions

1 B

2 B

3 C

4 B

Short-answer questions

5 Workplaces are an ideal setting for intervention because the majority of the adult population works either part-time or full-time for a significant proportion of their adult lives. During this time, adults also spend a large proportion of their waking hours within workplace settings. Workplace settings bring together large groups of people, who can provide each other with social support or share environmental resources.

6 Increased productivity, improved staff wellbeing, decreased number of staff sick days and reduced staff turnover.

7 Any five of:

- » Have participants record the daily number of steps in a step log and/or on the 10 000 Steps website.
- » Use incentives such as prizes and giveaways (for example, water bottles, T-shirts, stress balls, hats).
- » Invite participants to a breakfast launch.
- » Promote the challenge via the internet, emails, posters, newsletters, mass media.
- » Use a map to track the teams' progress across Australia.
- » Provide discounted pedometers or use a pedometer loan scheme (for example, the local library could lend out pedometers).
- » Use a team format for social support.
- » Get senior management involved to be role models for others.
- » Conduct come-and-try events and support activities (group walks).
- » Distribute weekly newsletters.
- » Provide certificates for all participants and prizes for the highest number of steps.
- » Spray running shoes gold or bronze to make trophies.
- » Encourage the most inactive individuals to focus on achieving personal bests rather than 10 000 steps per day.

8 Sample answer: Introduction of signage denoting distances to places as prompts, workplace competitions, and pedometer loan schemes.

9 Refer to Table 15.8 on pp. 339–40

10 In urban design, 'walkability' is the measure of the overall walking conditions in an area. Factors that commonly make up walkability indices include shade, aesthetics, lighting, crossings, access to footpaths, traffic calming, driver behaviour, safety, crime.

11 a All government schools are expected to timetable:

- » Prep to Year 3: 20–30 minutes of physical education per day
- » Years 4–6: 3 hours a week of physical education and sport with a minimum provision of 50 per cent for physical education
- » Years 7–10: 100 minutes per week each for physical education and sport.

b Crowded curriculum, teachers' lack of confidence teaching physical education, lack of resources such as equipment, lack of space and covered area in heat and rain, lack of accountability.

c Offer professional learning opportunities to support teachers to deliver quality PE, adequately resource schools, classes and teachers with plenty of equipment, build all-weather areas and facilities to foster physical activity all year round.

12 a The main advantage of using mass media to promote physical activity is that it can reach very large numbers of people.

b

- » Social media
- » Online formats
- » Television broadcasts
- » Radio broadcasts
- » Billboards
- » Print media (e.g. newspapers, pamphlets, brochures, newspapers)
- » Commercials at cinemas

c Key roles of mass media in the promotion of physical activity might include:

- » Increase awareness of physical activity as a public health issue
- » Provide information about the health benefits associated with regular physical activity
- » Provide information about other non-health benefits of being active
- » Provide information about the consequences of inactivity
- » Increasing interest in physical activity participation and raise awareness to community-based programs
- » Motivate individuals to take action towards physical activity participation.

d They could conduct a cross-sectional study of adult physical activity levels using the Active Australia Survey before and after the campaign was conducted; they could assess respondent recall of the mass-media campaign messaging.

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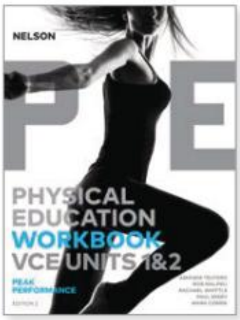

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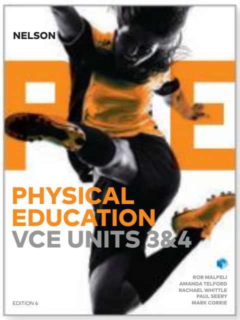

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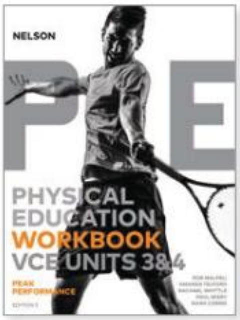

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