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CAMBRIDGE Health and Movement Science

Stage 6 Year 12

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Contents

About the authors v
How to use this resource vi
Introduction viii

Health in an Australian and global context 1

Chapter 1 **Health of Australians** 2
Introduction 4
1.1 Current health status of Australians 4
1.2 Groups experiencing inequities in health: Aboriginal and Torres Strait Islander Peoples 15
1.3 Groups experiencing inequities in health: People living in rural and remote areas 35
1.4 Health status of Australia compared with that of other OECD countries 45
1.5 Chronic conditions, diseases and injury in Australia 52
1.6 Ageing population and Australia's health 66
End of chapter materials 74

Chapter 2 **Australia's healthcare system** 78
Introduction 80
2.1 Effectiveness of Australia's healthcare system 80
2.2 Responsibility for the health system 92
2.3 Person-centred healthcare 95
2.4 Impact of health expenditure on the population 97
2.5 Complementary healthcare 109
2.6 How to be a critical health consumer 112
2.7 Changes and challenges to the healthcare system 115
End of chapter materials 116

Chapter 3 **Impact of technology and data on Australia's health system** 118
Introduction 120
3.1 Relationship between technology and health 121
3.2 New technologies and treatments 123
3.3 Digital health 129
3.4 Big data and the health of Australians 131
End of chapter materials 136

Chapter 4 **Promoting and improving the health of Australians** 138
Introduction 140
4.1 SDG 3: Good health and wellbeing 141
4.2 SDG 4: Quality education 143
4.3 SDG 10: Reduced inequalities 145
4.4 SDG 11: Sustainable cities and communities 147
4.5 Using SDGs 3, 4, 10 and 11 to improve a community's health status 150
End of chapter materials 151

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Training for improved performance 153

Chapter 5 **Personalising assessment and exercise prescription** 154
Introduction 156
5.1 Pre-exercise questionnaire and health screening 156
5.2 Performance and fitness testing 159
5.3 Developing fitness programs with the assistance of exercise assessment 165
End of chapter materials 168

Chapter 6 **Influence of training on movement and performance** 172
Introduction 174
6.1 Types of training and training methods 174
6.2 Applying the principles of training 203
6.3 Principles of training, physiological adaptations and improved performance 209
End of chapter materials 215

Chapter 7 **Training for individual and group sports** 220
Introduction 222
7.1 Aspects to consider when designing a training session 223
7.2 Yearly training programs 231
7.3 Psychological strategies to improve participation and performance 239
7.4 Application of strategies and tactics 251
End of chapter materials 256

Chapter 8 **Impact of sleep, nutrition and supplementation on movement and performance** 258
Introduction 260
8.1 Dietary requirements of athletes 260
8.2 Reducing fatigue and influencing movement and injury prevention 271
8.3 Using supplements and other products to improve performance 279
End of chapter materials 293

Chapter 9 **Training for sustained movement and performance** 296
Introduction 298
9.1 Biomechanics 298
9.2 Recovery strategies 306
9.3 Technology 310
9.4 Management and prevention of sporting injuries 318
9.5 Impact of drug use on injury management and improving performance 336
End of chapter materials 345

Depth studies 348

Chapter 10 **Depth studies** 349

Glossary 353
Index 355
Acknowledgements 362

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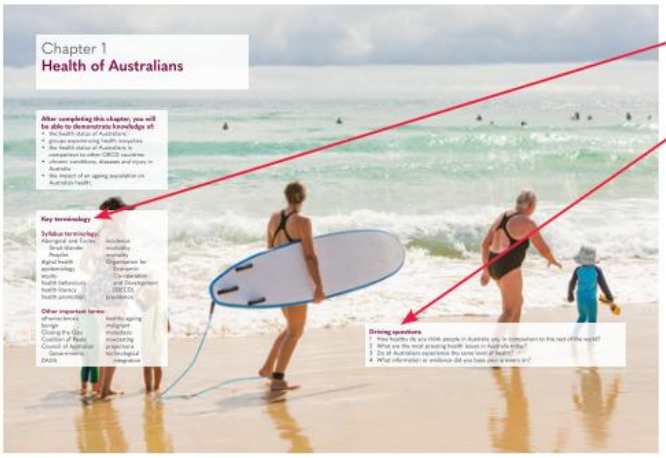
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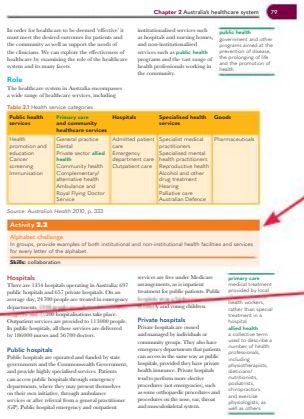
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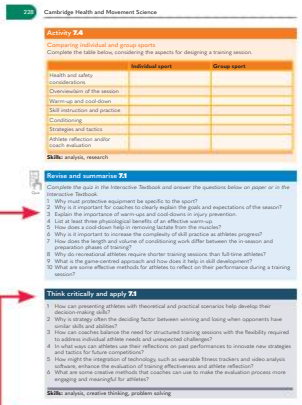
Chapter openers include a list of key terminology, and some driving questions to introduce the topic.



Every chapter subsection opens with a **Learning objective**.



A variety of Activities encourage engagement with the content and the skills that underpin the syllabus (collaboration, analysis, communication, creative thinking, problem solving and research). The skills addressed in the activity are listed at the end of the activity.

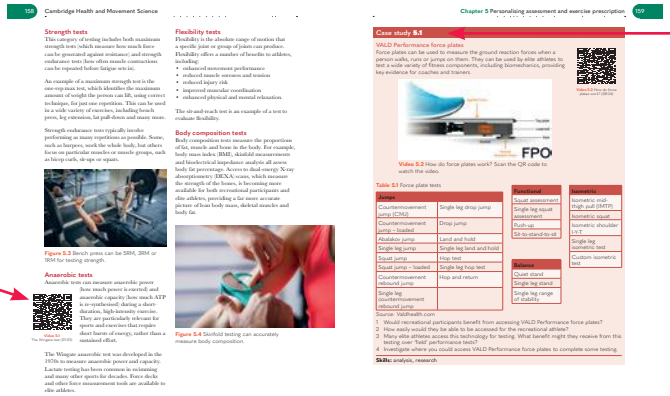


At the end of each chapter subsection, you can check your recall and understanding of the material by completing an automarked **Quiz** in the Interactive Textbook, as well as a set of **Revise and summarise questions**, which you can answer in your notebook or in the Interactive Textbook platform.



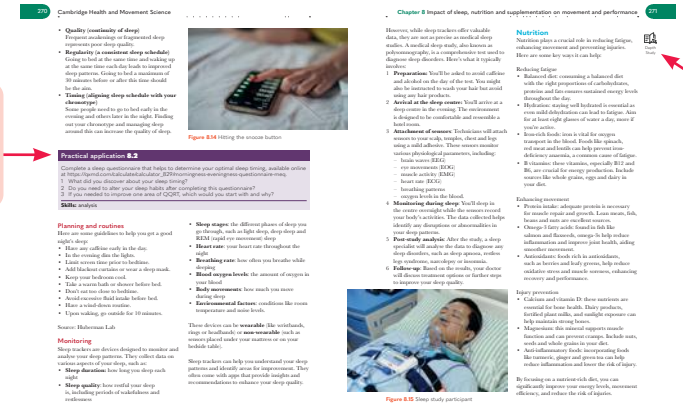
The **Revise and summarise** is followed by a **Think critically and apply** activity, which encourages you to engage more deeply with the content. The skills addressed are listed at the end.

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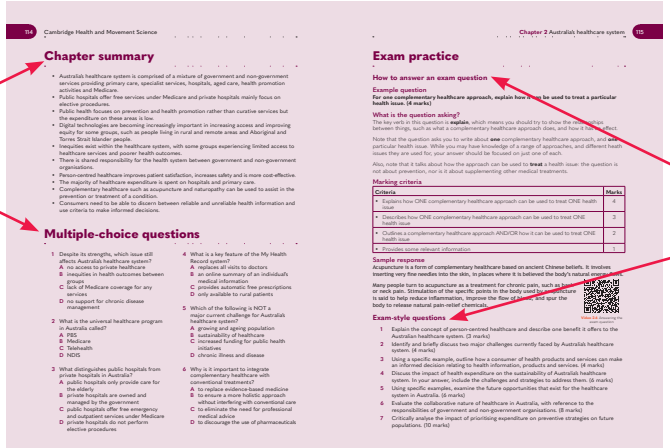
Where appropriate, videos have been included in the Interactive Textbook. These can also be accessed directly from the print book by scanning the QR code.

As required by the syllabus, **Case studies** are integrated throughout the chapters. The skills addressed are listed at the end.



As well as Case studies, **Practical applications** are integrated throughout the chapters.

Another syllabus requirement is to complete a minimum of two **depth studies**. Throughout the book, the authors have included icons to indicate activities, case studies, and general content, that they feel could be meaningfully extended into a depth study.



Each chapter finishes with a summary, a set of multiple-choice questions and some exam-style questions.

The Interactive Textbook also includes a Scorcher challenge at the end of each chapter.

There is also an Exam practice section, where you are shown an example question, the marking criteria and a sample response, as well as a video explaining it.

Finally, there are further exam-style questions you can use for your own practice.

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Introduction

To the student

Congratulations on choosing the *Cambridge Health and Movement Science Year 12* textbook. This textbook has been written to meet the requirements of the current Stage 6 Health and Movement Science Syllabus in New South Wales. It also aims to make your life easier by following the syllabus and providing relevant activities that will prepare you for the actual HSC examination.

Health and Movement Science has evolved from the previous PDHPE syllabus. Students who study Health and Movement Science enjoy a challenging yet rewarding subject and gain knowledge that will benefit them as athletes, professionals and people, now and into the future. Health and Movement Science allows you to explore your own health and the health of Australians and to develop an understanding of social justice. It explores the issues that can contribute to improved performance, for you personally or within a guiding role such as coach, personal trainer, PDHPE teacher or health professional.

This book is a comprehensive resource that extends on the knowledge and skills introduced in the compulsory Stage 4 and 5 course, as well as Year 11 in Stage 6. It covers all content areas of the Year 12 course.

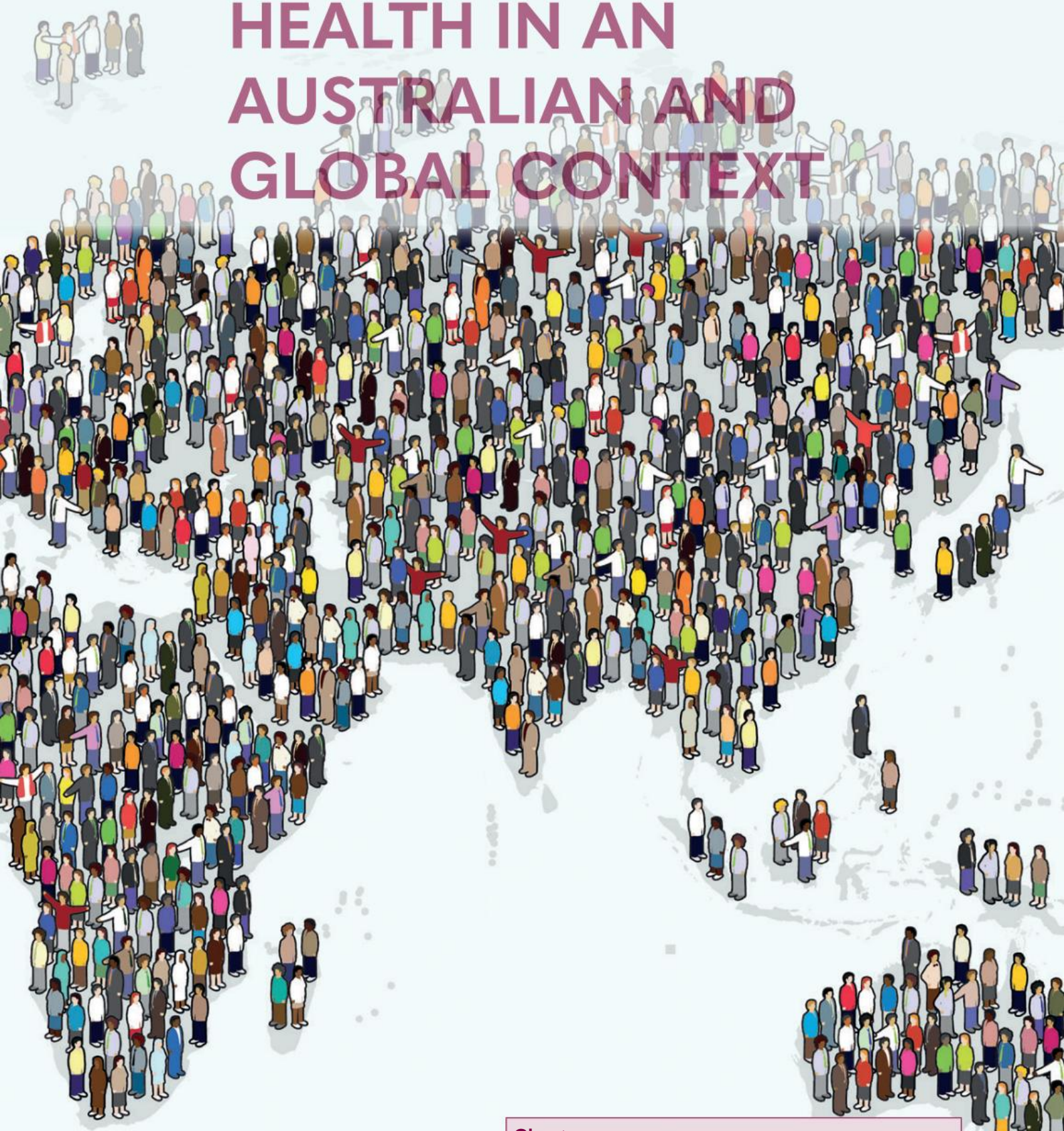
You will discover a wealth of engaging material that critically examines the focus areas of *Health in an Australian and global context* and *Training for improved performance*. You will gain an insight into various issues with relevant and engaging activities, case studies, practical applications and research tasks. The revision and application questions at the end of each chapter section, and the exam-style questions in each chapter, will give you the best opportunity to succeed in your exam. There is also support material for the depth study, which is a new component in the Health and Movement Science syllabus.

Good luck in your studies and we hope you enjoy Year 12 Health and Movement Science!

Gareth Hawgood

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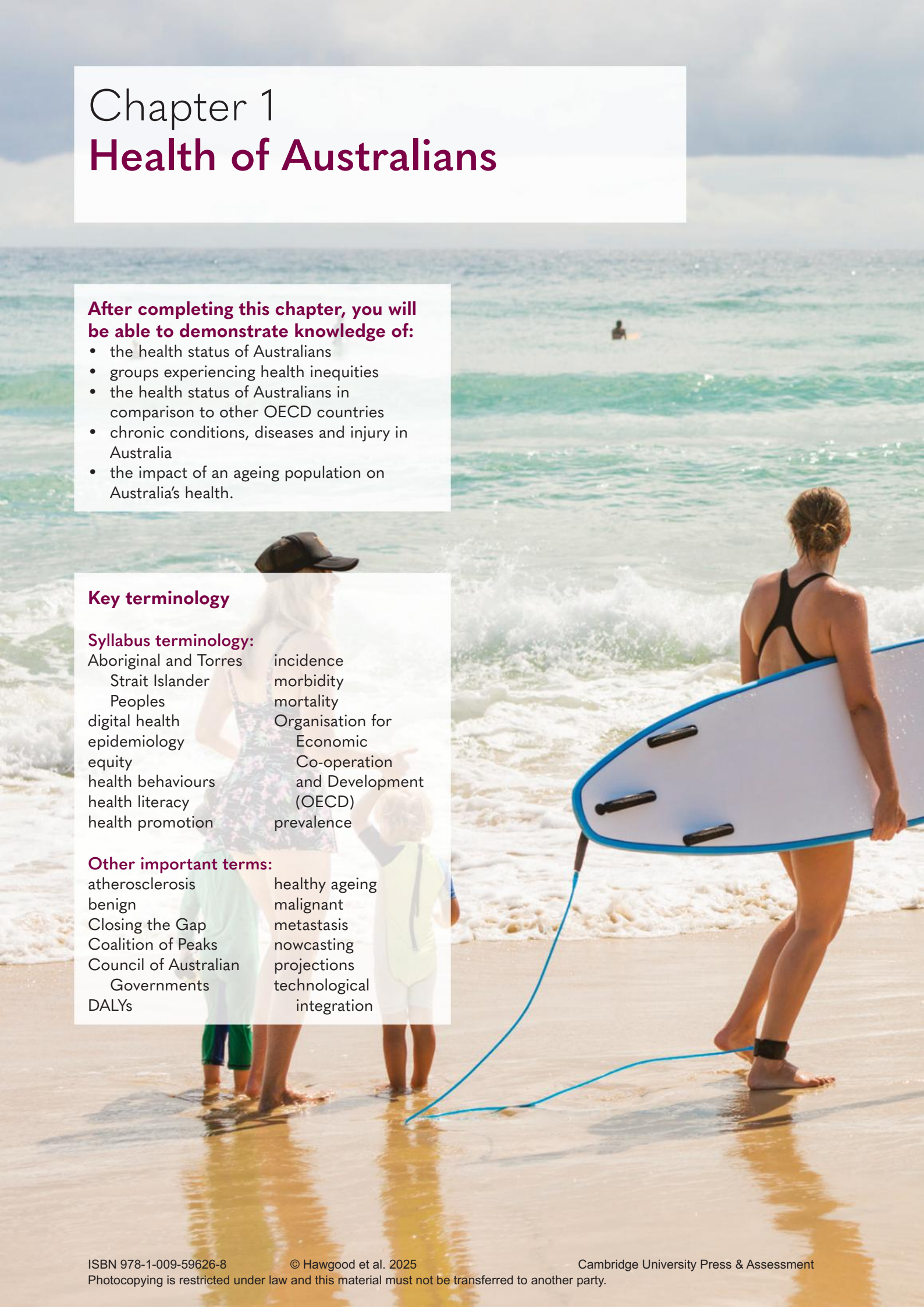
HEALTH IN AN AUSTRALIAN AND GLOBAL CONTEXT



Chapter
Chapter 1: Health of Australians
Chapter 2: Australia's health care system
Chapter 3: Impact of technology and data on Australia's health system
Chapter 4: Promoting and improving the health of Australians

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Chapter 1
Health of Australians



After completing this chapter, you will be able to demonstrate knowledge of:

- the health status of Australians
- groups experiencing health inequities
- the health status of Australians in comparison to other OECD countries
- chronic conditions, diseases and injury in Australia
- the impact of an ageing population on Australia's health.

Key terminology

Syllabus terminology:

Aboriginal and Torres Strait Islander Peoples
digital health
epidemiology
equity
health behaviours
health literacy
health promotion
incidence
morbidity
mortality
Organisation for Economic Co-operation and Development (OECD)
prevalence

Other important terms:

atherosclerosis
benign
Closing the Gap
Coalition of Peaks
Council of Australian Governments
DALYs
healthy ageing
malignant
metastasis
nowcasting
projections
technological integration

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Driving questions

1 How healthy do you think people in Australia are, in comparison to the rest of the world?
2 What are the most pressing health issues in Australia today?
3 Do all Australians experience the same level of health?
4 What information or evidence did you base your answers on?

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Introduction

Compared with many other countries, most Australians experience relatively high levels of health. Above-average rates of employment, education, household income, environmental quality, social connection, civic engagement and life satisfaction all contribute to relatively high levels of wellbeing.

But the news is not all good. While many Australians enjoy higher rates of employment, we also have significantly higher work hours than many other countries. Health issues such as obesity are on the increase and, despite the overall positive picture of the health of Australians, there are many groups within our population that experience severe disadvantage, particularly Aboriginal and Torres Strait Islander people, who continue to face systemic barriers to healthcare access, rooted in the ongoing impacts of colonisation and institutional racism.

1.1 Current health status of Australians

Learning objective 1.1
ANALYSE the current health status of Australians.

Health data

The gathering and interpretation of health data is crucial for understanding the health of a nation. Accurate, up-to-date, comparable and comprehensive data is vital for evidence-based decision making in relation to health issues, for the understanding of health behaviours, identification of major health issues, provision of healthcare and identification of inequities.

Health data is collected from a variety of different sources, including:

- health service records (e.g. hospital admissions and records from the Pharmaceutical Benefits Scheme)
- surveys and population censuses (e.g. Australian Institute of Health and Welfare National Drug Strategy Household Survey, Mission Australia's Annual Youth Survey and the National Health Survey)
- clinical registries and research (e.g. Australia and New Zealand Dialysis and Transplant Registry)
- surveillance monitoring systems (e.g. National Notifiable Diseases Surveillance System and the National Ambulance Surveillance System).

This data is then used to develop a sound understanding of the health of the nation and the effectiveness of the healthcare system.



Figure 1.1 Hospital admissions records are one source of health data.

Key bodies that are responsible for the gathering and interpreting of health data within Australia include the Australian Bureau of Statistics (ABS) and the Australian Institute of Health and Welfare (AIHW), which provide valuable and reliable information that helps assist in establishing the direction of the healthcare system.

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Data that is gathered can create a picture of:

- the major contributing health determinants, such as:
  - broad features of society
  - environmental factors
  - socio-economic characteristics
  - health behaviours and
  - biomedical factors
- major causes of morbidity and mortality
- success of intervention and prevention activities
- performance of the healthcare system.

Gathering data over time can also help establish a picture of how the health of Australians has changed over time, and this can help to create future projections. The use of **nowcasting** and projections is possible with a comprehensive set of data over time. This can assist in providing up-to-date estimates of current health issues and forecasts of statistics even when the data is a few years old.

Many of the data sets collected by the ABS do not include information about people with gender variations, including trans, non-binary and gender-diverse people. For example, some graphs generated from the National Health Survey 2022 come with a note that 'Due to small numbers and the need to protect privacy, people who reported sex at birth as a term other than male or female are not reported separately or included in the total Persons category'.

This means some communities are not represented in the statistics. Health policies and services based on this data might not meet everyone's needs. People may also feel invisible or excluded from national conversations about health.

nowcasting a 'forecast' for today. It is the use of real-time data and statistical analysis to estimate the current state of a health-related event or condition

Activity 1.1

Revising Year 11 content

1 What are the main measures used in epidemiology?
2 Define the term 'burden of disease'.
3 Look through the latest *Australia's health* report, available from the AIHW website. Is all the health data from the last year or so?
4 Why is it that health data is often several years old?
5 What do the terms 'nowcasting' and 'projections' mean? How reliable are these techniques? In what instances are they effective? What might be some limitations?
6 Consider the boxed text above, about data on people with gender variations.
   a How does missing data impact real people's lives?
   b Can data still be called representative if it leaves people out?

Skills: analysis

Figure 1.2 The Australian Bureau of Statistics is a key body for the gathering of health data.



Figure 1.3 Gathering data can help establish a picture of how the health of Australia has changed over time.

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Morbidity and mortality

A picture of the health status of Australians can be created by examining reports such as the biannual *Australia's health* report, the National Drug Strategy Household Survey and the National Health Survey. These reports present data highlighting the major health issues affecting Australians, their prevalence, contributing risk factors and the determinants that contribute to health outcomes. This data can also be compared with data nations to gain an understanding of where Australia fits in terms of international health status.

DALYs: disability-adjusted life years

The effects of disease and injury on the community are often measured in terms of disability-adjusted life years (**DALYs**). This measure is used to assess and compare the fatal and non-fatal effects of disease on a population and allows for effective comparison between diseases. The World Health Organization (WHO) has provided a definition of a DALY:

> One DALY represents the loss of the equivalent of one year of full health. DALYs for a disease or health condition are the sum of the years of life lost to due to premature mortality (YLLs) and the years lived with a disability (YLDs) due to prevalent cases of the disease or health condition in a population.

Therefore, the more DALYs, the greater the burden. This measure is used to assess and compare the fatal and non-fatal effects of disease on a population, and allows for effective comparison between diseases.

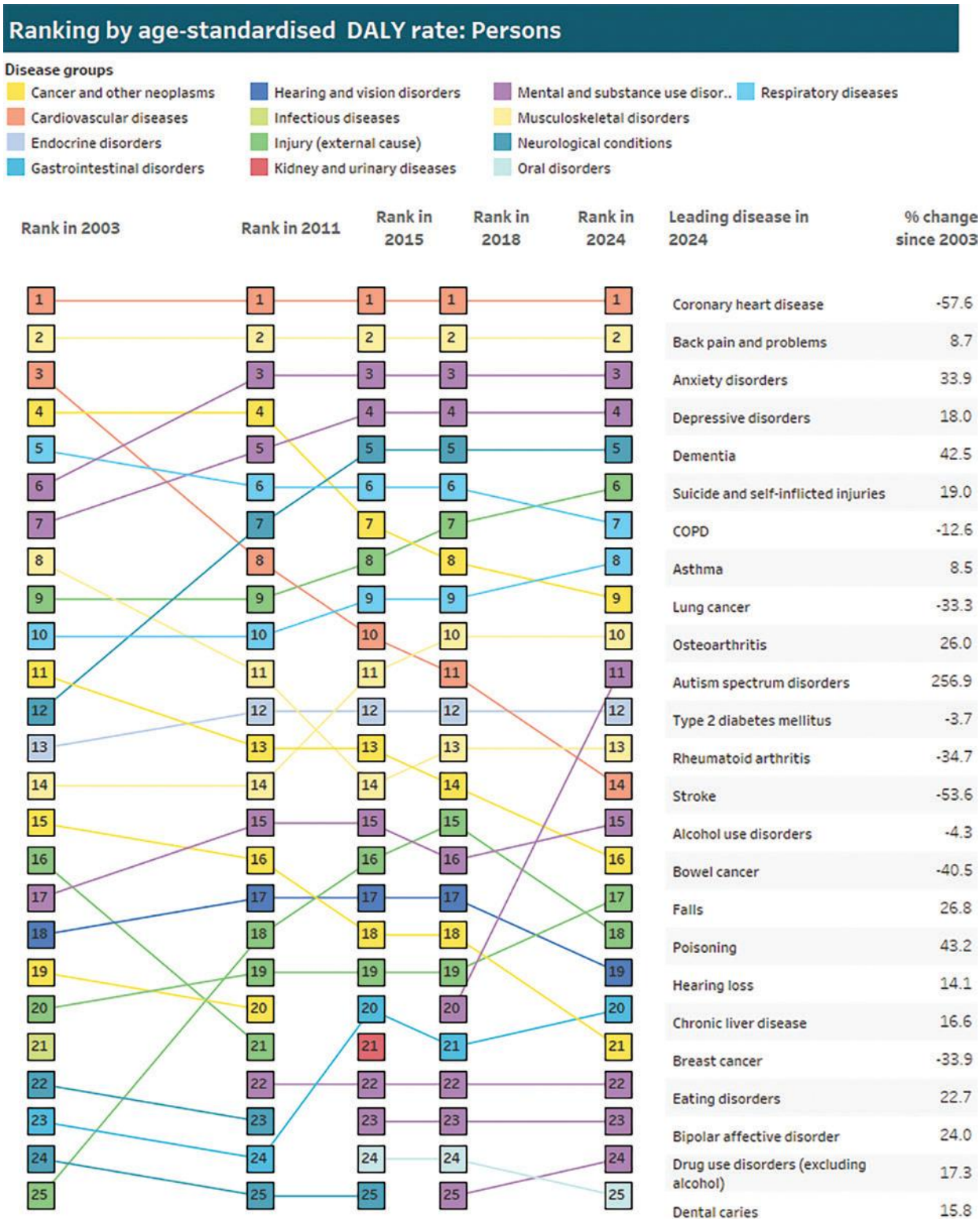


Figure 1.4 DALYs, or disability-adjusted life years, is a measure of the overall burden of disease.



Figure 1.5 One DALY represents the loss of the equivalent of one year of full health.

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Notes
Diseases ranked in the leading 25 in a single year, which are not in the leading 25 in any other year, will not have connecting lines and rankings. This includes COVID-19 which is only included for 2024.

Figure 1.6 Major causes of burden of disease and their rankings 2003–24. Source: Australian Burden of Disease Study 2024.
You can see an interactive graph online at https://cambridge.edu.au/redirect/11378.

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Long-term health conditions

Figures 1.7 and 1.8 look at the most common long-term health conditions in 2022. The graphs are adapted from the AIHW analysis of data from the ABS.

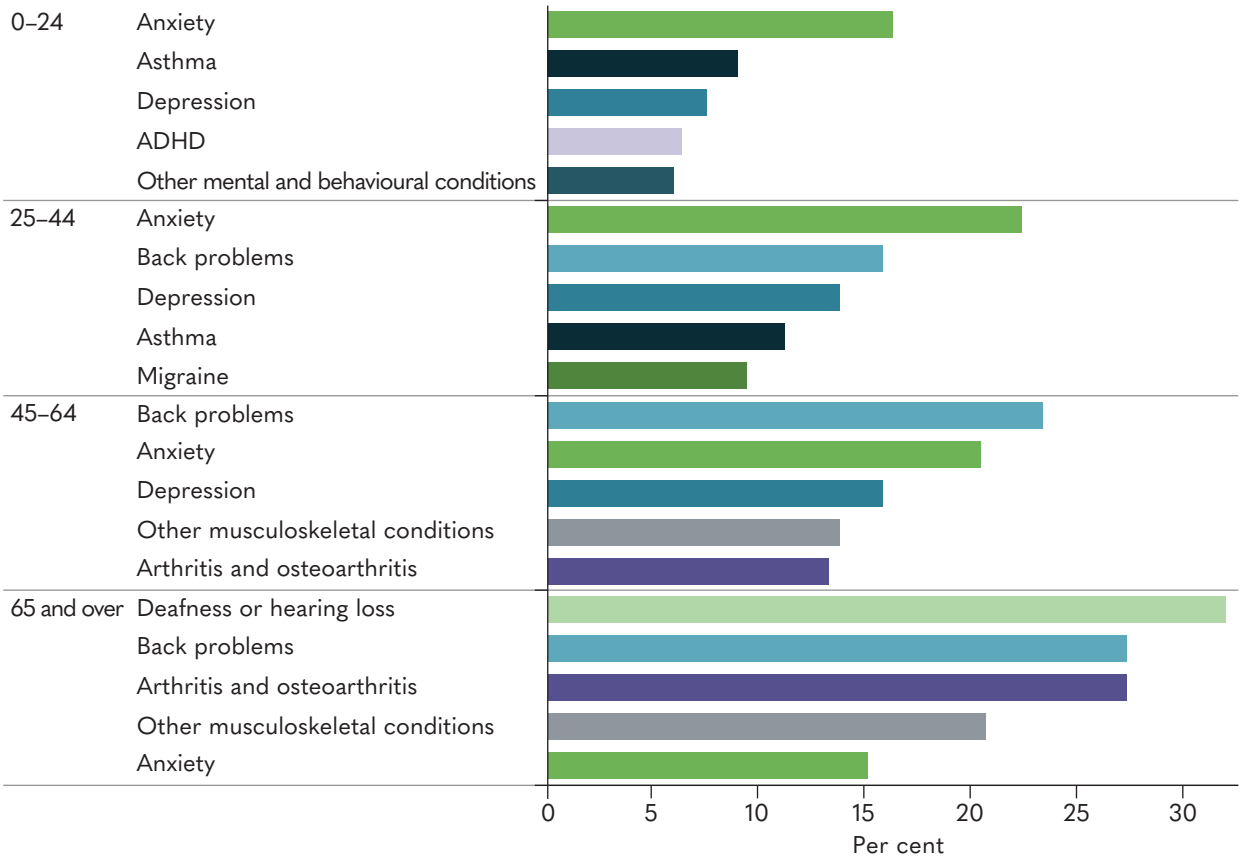


Figure 1.7 Most common long-term health conditions by age, 2022

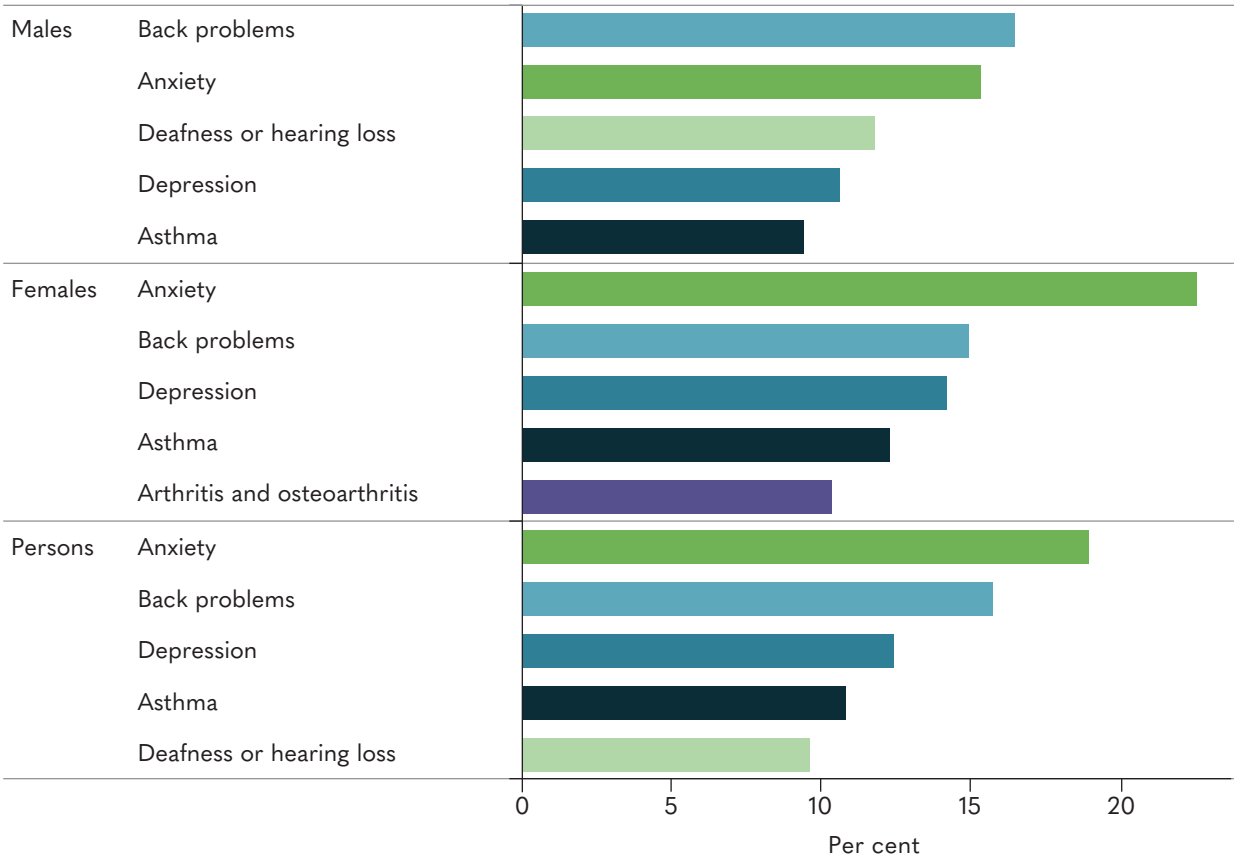


Figure 1.8 Most common long-term health conditions by sex, 2022

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Leading causes of death

The leading causes of death are different for males and females. Figure 1.8 shows the five leading causes of death for Australians in 2022. The graph is adapted from *Australia's health 2024*.

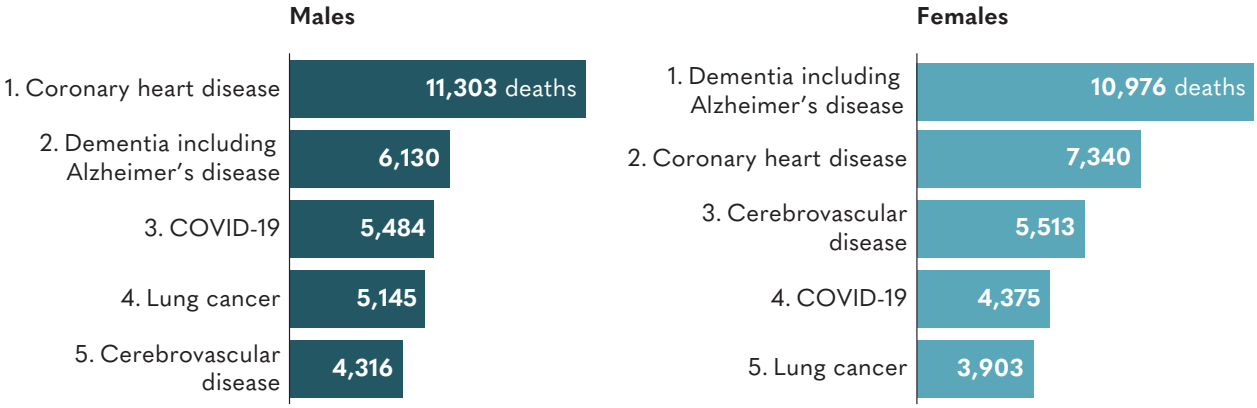


Figure 1.9 Leading causes of death among males and females in 2022

Activity 1.2

Major causes of mortality and morbidity

1 From Figures 1.7 and 1.8 and using the burden of disease interactive graph at https://cambridge.edu.au/redirect/11424, identify:
   a the major causes of morbidity for males, females and the general population
   b the major causes of mortality for males, females and the general population
   c the major causes of morbidity for the following age groups: 0–24, 25–44, 45–64, 65 and over.
2 Visit the 'burden of disease' section of the AIHW website at https://cambridge.edu.au/redirect/11379. Access graphs and data that show the most recent statistics on burden of disease in Australia.
   a What are the three main disease groups contributing to the burden of disease?
   b Which single condition contributes most to the burden of disease?
   c Is the burden of these conditions increasing, decreasing or staying the same?
3 For one of the top three disease groups that contributes to the burden in the interactive graphs, compare the DALYs for males and females. Are there any significant differences? Can you provide any possible reasons for the differences or lack there of?

Skills: analysis

Life expectancy

Life expectancy is the measure of how long a person can be expected to live based on the current age and death rates for their gender.

Improvements in life expectancy over the last century have been vast. Advancements in medicine, technology and infrastructure, improvements in the understanding of the human body, the implementation of health promotion and preventive strategies and greater control of infectious disease have all contributed significantly.

As can be seen in Figure 1.10, trends in life expectancy have been fairly steady since the 1970s. The first drop in life expectancy since the 1960s was experienced in 2020–22, with a decrease of 0.1 year for males and females. This decrease was predominantly due to the impact of COVID-19 and the increase in number of deaths that resulted.

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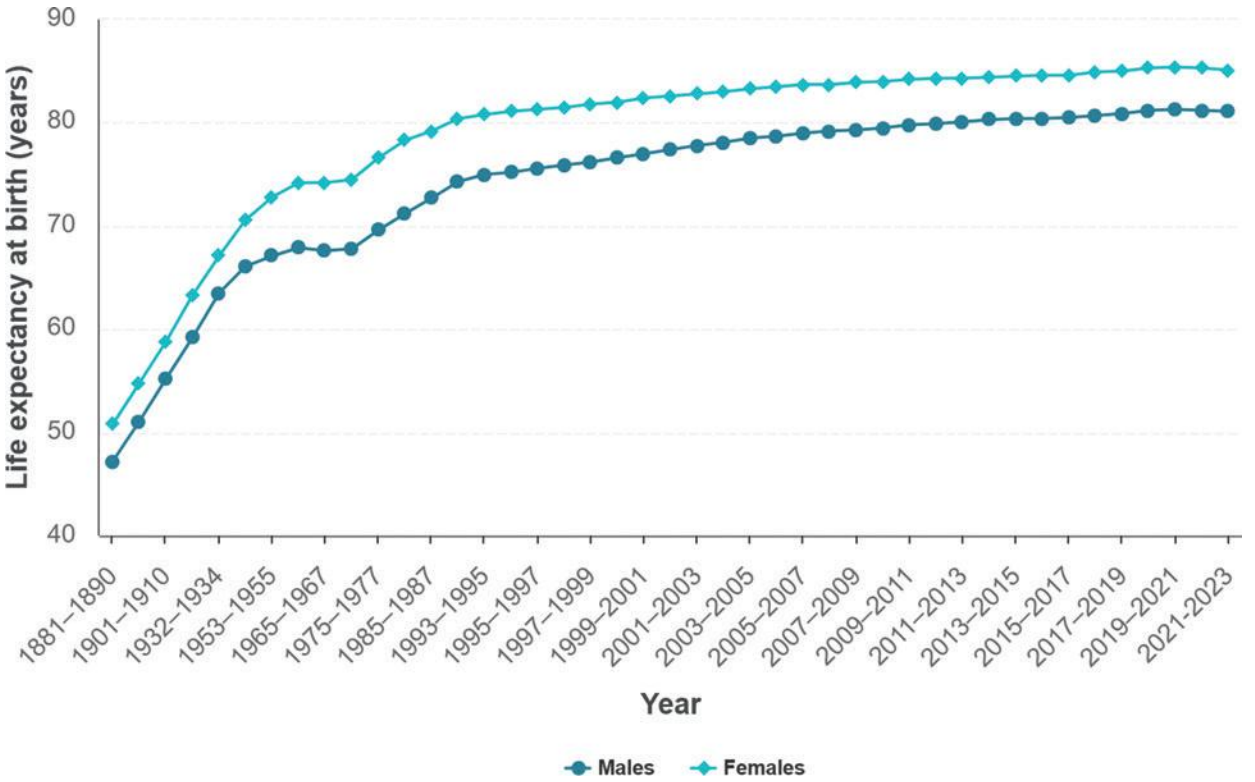


Figure 1.10 Life expectancy (years) at birth in Australia, by sex, 1891–1900 to 2021–23

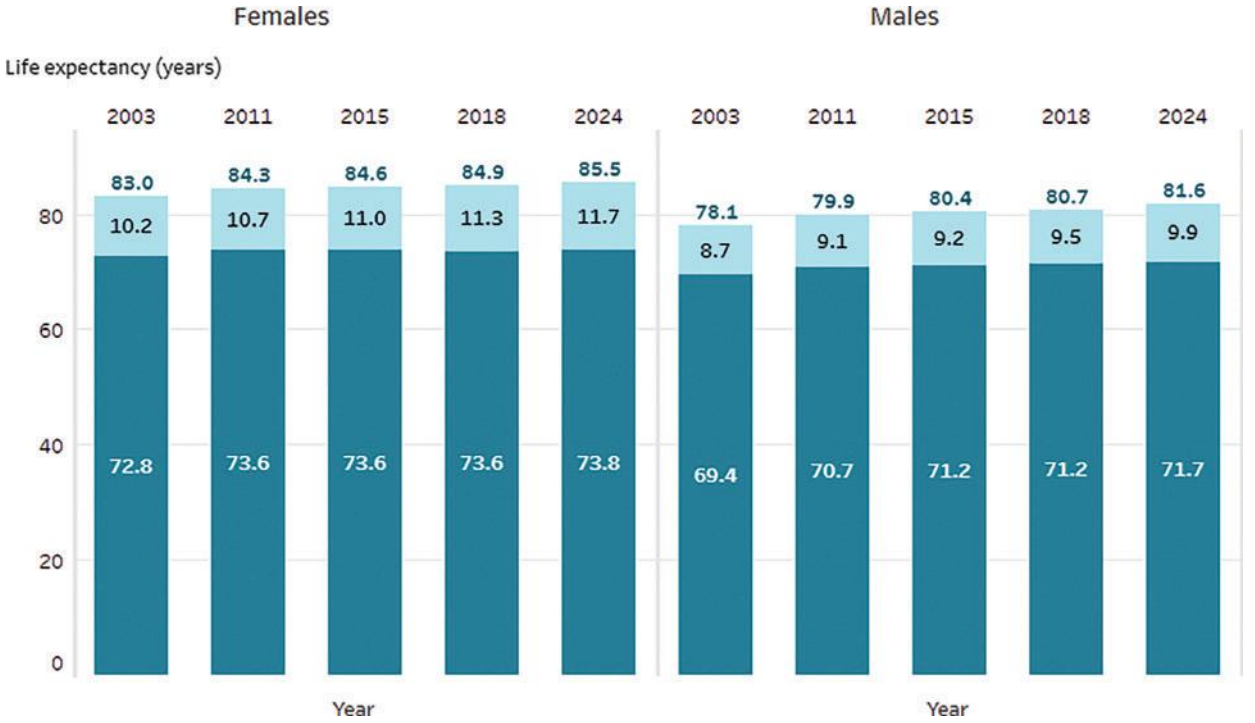


Figure 1.11 Life expectancy and years spent in ill health, 2003–24. Source: Australian Burden of Disease Study 2024. You can see an interactive graph online at https://cambridge.edu.au/redirect/11380.

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Activity 1.3

Life expectancy over time

Examine Figures 1.10 and 1.11.

1 Compare the life expectancy of a boy at birth in 1981 with the life expectancy of a 25-year-old man and an 85-year-old man at the same time. Propose reasons for the difference.
2 Compare the life expectancy of people in the periods 1960–62 and 2020–22. Identify and explain factors that have contributed to these increases.
3 Over the past century there have been significant decreases in infant mortality rates. Discuss the impact that this would have had on overall life expectancy rates.
4 Figure 1.11 shows the percentage of remaining life expectancy spent in full health and ill health. Describe the influence that an increase in life expectancy may have on quality of life in later years.

Skills: analysis

Activity 1.4

Debate

Is it more important for public health policies to prioritise increasing life expectancy or enhancing quality of life?

Skills: collaboration, communication, analysis

Risky health behaviours

The reasons that people engage in risky health behaviours are varied and complex and include influences from broader society. As covered in year 11, these may include factors such as:

- social relationships and social interactions
- culture
- media
- government.

Many of these risky behaviours contribute directly to the development of major disease and illnesses. For example, a young apprentice may engage in smoking and vaping due to the culture in his workplace and pressures to conform. Similarly, a family who are predominantly overweight or obese due to not prioritising physical activity and eating a diet consisting largely of takeaway foods high in fat and salt, may increase their risk of developing lung cancer, diabetes and cardiovascular disease (CVD). Sociological causes of risky health behaviours can be challenging to address due to their complex nature.

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Activity 1.5

Risky health behaviours

1 Think about behaviours and environments that can affect people's health over time. These could include things like stress, unsafe housing, limited access to healthcare, or being exposed to discrimination. Now, think about what social factors (such as racism, poverty or body shaming) might influence those health impacts.
2 In groups select one of the following case studies:
   - Anja, a 35-year-old single mother of three, lives in a low socio-economic neighbourhood. She works at two part-time jobs to support her family and has limited access to healthcare. Anja began smoking as a teenager due to peer pressure and as a way to cope with the stress of financial hardship and continued using it as a way to manage anxiety. While she knows smoking can affect her health, the lack of support services and ongoing stress make it hard for her to quit.
   - Alvin is a 19-year-old university student from a small town who has moved into the city in order to attend university. He is keen to fit in with his peers who drink heavily and use recreational drugs at parties. Wanting to be accepted and not confident enough to refuse, Alvin joins in. Over time he starts to rely on substances as a way to manage feelings of disconnection and homesickness. These behaviours begin to affect his health and academic performance.
   - Amina is a 45-year-old South Asian woman who recently migrated to Australia. She lives with her extended family and cooks food from her culture, which is an important part of her identity and care for her family. She has been diagnosed with hypertension, and her doctor suggests dietary changes. Amina feels pressure to stop eating the foods she grew up with, even though these meals bring her joy and connection. She also experiences racism in healthcare settings, which makes it harder to get respectful, culturally safe advice. She finds it difficult to change her dietary habits due to cultural traditions and family expectations.
   - James is a 42-year-old senior marketing executive who lives in an affluent suburb and has access to high-quality healthcare and a gym membership. Despite this, James frequently works long hours, skips meals, and consumes high amounts of caffeine and energy drinks to stay alert. On weekends, he drinks heavily at social events and uses recreational drugs occasionally. Although James is aware of the health risks, he believes his lifestyle is manageable because he exercises regularly and has no current health conditions. He has normalised these behaviours within his social circle, where similar choices are common and rarely questioned.
   - Alex is a 16-year-old high school student who actively engages on multiple social media platforms. On these platforms Alex follows influencers and celebrities who promote specific body images and diets. Alex is becoming increasingly dissatisfied with their body due to the comparisons they are making to what they see online. Alex begins severely restricting eating, following extreme diet and exercise plans and has lost an excessive amount of weight, placing Alex in the underweight category.

For the chosen case study, perform the following tasks:

a Identify the sociological causes of the risky behaviour.
b Discuss the impact of these causes on the individual's health.
c Propose strategies to address these sociological factors from an individual, community and government level.
d Present your case study to the class.

Skills: collaboration, communication, problem solving

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Inequalities

In Australia, many people enjoy long lives and good health. However, these outcomes are not experienced equally.

Some communities face higher barriers to health and wellbeing because of ongoing social, economic and political disadvantages. These groups include:

- Aboriginal and Torres Strait Islander Peoples
- people living in rural and remote areas
- socio-economically disadvantaged people (see Figure 1.13)
- culturally and linguistically diverse communities
- people living with disabilities
- older people.

The reasons for the disparities in health are complex and varied.

If the inequities that exist are better understood and barriers identified, then there are greater opportunities to address them. Addressing inequities requires involvement from all levels, including individuals, communities, governments and non-governmental organisations.



Figure 1.12 Many people living in rural and remote areas experience lower health outcomes.

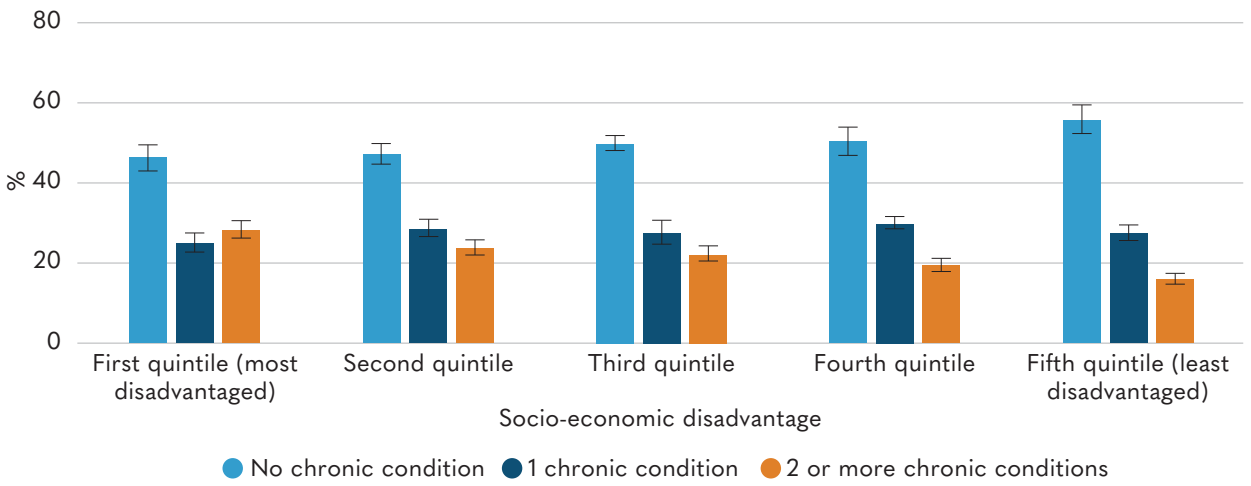


Figure 1.13 Proportion of people with chronic conditions by level of socio-economic disadvantage, 2022. Source: Australian Bureau of Statistics, Health conditions prevalence 2022

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Practical application 1.1

Community research task

1 Consider Figure 1.13, which shows the proportion of people with chronic conditions by level of socio-economic disadvantage.
2 Students are allocated a specific neighbourhood or community that demonstrates socio-economic diversity. For their area they are to gather information on:
   a health resources available (e.g. hospitals, clinics, fitness centres, grocery stores with fresh produce, community groups)
   b public services, such as transportation and clean water access
   c living conditions, including housing quality and neighbourhood safety
   d environmental factors, such as air quality, green spaces and pollution
   e health behaviours such as smoking rates and rates of obesity.
3 Students create a brief summary.
4 Students share their findings in small groups and compile the data to identify patterns of health inequities related to the availability of healthcare resources, living conditions and environmental factors. Ensure that students include a range of socio-economic groups.
5 Each group selects one major inequity they identified. They then develop a targeted action plan that includes:
   a a clear description of the health inequity they chose and its impact on the community
   b a list of specific interventions or programs that could help reduce this inequity, such as:
      i increasing access to healthcare through mobile clinics or community health workers
      ii developing partnerships with local organisations for food security programs
      iii advocating for policy changes like rent control or environmental cleanup
   c a timeline and list of resources needed for implementation
   d proposed stakeholders to involve, such as local government, nonprofits, healthcare providers or community leaders.
6 Each group presents their action plan to the class.
7 The class discusses:
   a the feasibility and potential impact of the proposed solutions
   b the role that both policy and community involvement play in tackling these complex issues and the importance of tailoring solutions to specific community needs.

Skills: research, collaboration, problem solving


Quiz

Revise and summarise 1.1

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What are the major causes of morbidity for males, females and the general population?
2 What are the major causes of mortality for males, females and the general population?
3 What is the life expectancy for males, females and the general population?
4 Identify three risky health behaviours and their sociological causes.
5 Identify three inequities in health that exist in the population.

Think critically and apply 1.1

1 Propose a strategy to address each of the three health inequities you identified in the revise and summarise section above.
2 Discuss the role that both policy and community involvement play in tackling health inequities and the importance of tailoring solutions to specific community needs.

Skills: analysis

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1.2 Groups experiencing inequities in health: Aboriginal and Torres Strait Islander Peoples

Learning objective 1.2
ANALYSE groups experiencing inequities in health.

The syllabus requires you to analyse two groups experiencing inequalities in health, one of which must be Aboriginal and Torres Strait Islander Peoples (First Nations people).

Aboriginal and Torres Strait Islander Peoples are the first peoples of this continent, having inhabited the land for thousands of years before European colonisation. First Nations Peoples are diverse and distinct. Rather than being a single group, they comprise hundreds of Nations, each with their own language, cultural practices and histories. These cultures are grounded in deep, continuous relationships with Country that have existed for tens of thousands of years.

For tens of thousands of years before invasion, Aboriginal and Torres Strait Islander Peoples lived in complex, sophisticated societies with deep knowledge systems connected to land, waters and sky.

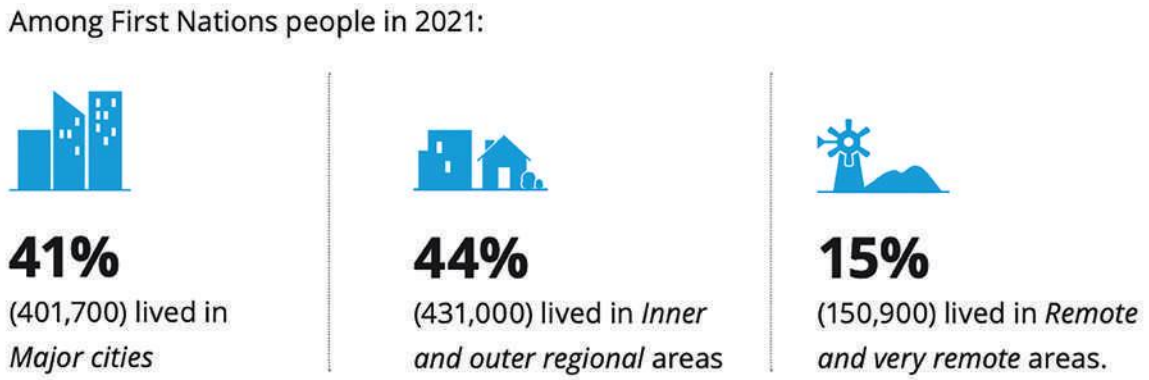


Figure 1.14 Proportion of First Nations people by geographical location, 2021.
Source: Australia's health 2024

The invasion and ongoing colonisation of these lands has disrupted the cultures, communities and relationships to Country of Aboriginal and Torres Strait Islander Peoples. These disruptions have had long-term impacts on holistic wellbeing and have contributed to systemic inequities in health, education and justice. When interpreting health data relating to Aboriginal and Torres Strait Islander Peoples, it is important to understand that outcomes are shaped by ongoing colonial dispossession, structural racism and other complex sociocultural factors, not by cultural deficit or individual choice. Remember this when comparing data sets.

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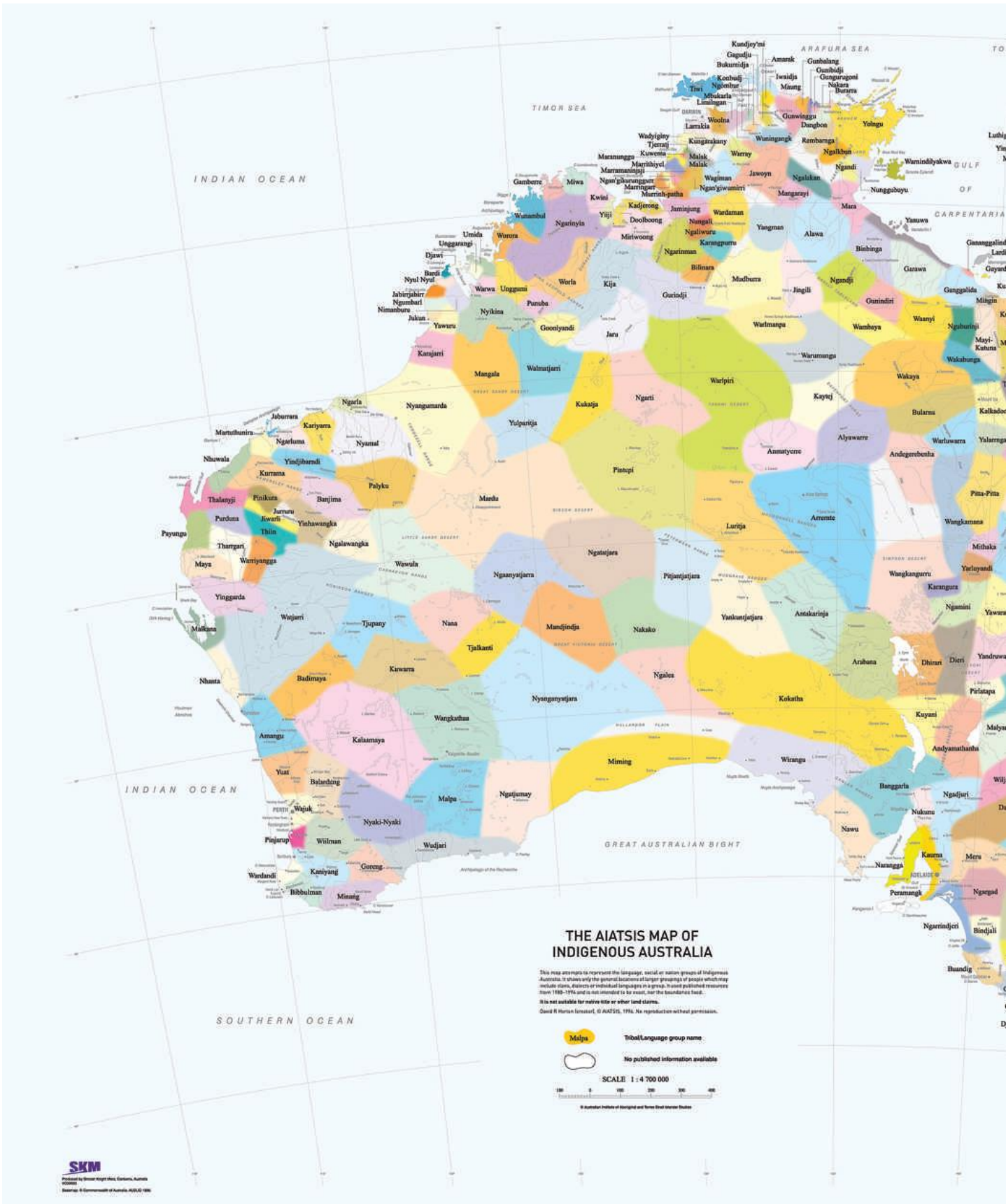


Figure 1.15 Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) map of Indigenous Australia. This map attempts to represent the language, social or nation groups of Indigenous Australia. It shows only the general locations of larger groupings of people which may include clans, dialects or individual languages in a group. It used published resources from 1988–94 and is not intended to be exact, nor the boundaries fixed. It is not suitable for native title or other land claims. David R. Horton (creator). © AIATSIS, 1996. No reproduction without permission. A high resolution version of this map can be accessed via the Interactive Textbook.

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What does the data tell us?

The data shows significant differences in health outcomes between Aboriginal and Torres Strait Islander Peoples and non-Indigenous Australians. When looking at this data, it is important to remember that these differences are the result of ongoing colonial structures that continue to shape access to care, resources and safety. Lower life expectancy and higher rates of hospitalisation, suicide and illness reflect generations of dispossession, systemic racism and the failure of systems to meet the needs of First Nations Peoples.



Figure 1.16 The gap between Indigenous and non-Indigenous health, although lessening, is a major cause for concern.

Life expectancy

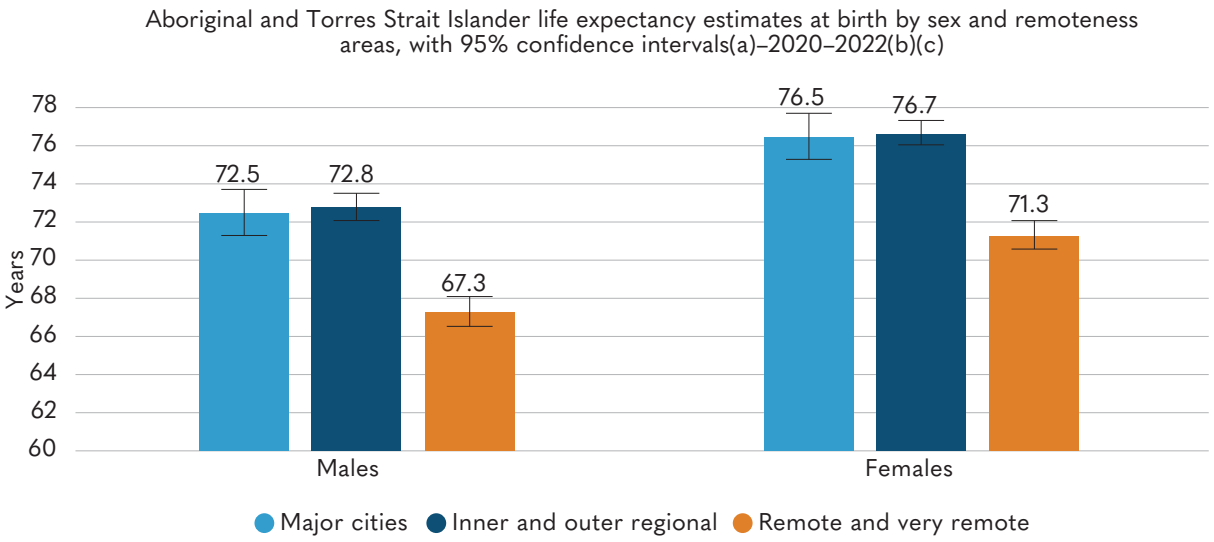


Figure 1.17 Life expectancy estimates of Aboriginal and Torres Strait Islander people at birth by remoteness. Source: Australian Bureau of Statistics, Aboriginal and Torres Strait Islander life expectancy 2020-2022

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These patterns are visible in the age distribution of the population. The median age of Aboriginal and Torres Strait Islander Peoples is 24 years, compared with 38 years for non-Indigenous Australians. This difference reflects the higher rates of premature death caused by structural injustice.

While individual health behaviours can play a role, this gap is primarily the result of structural injustice and the legacies and ongoing impacts of colonisation.

Life expectancy also varies depending on where people live. Aboriginal and Torres Strait Islander Peoples in remote and very remote areas are expected to live around five years less than those in major cities. These differences are shaped by uneven access to healthcare, safe housing, employment and culturally safe services.

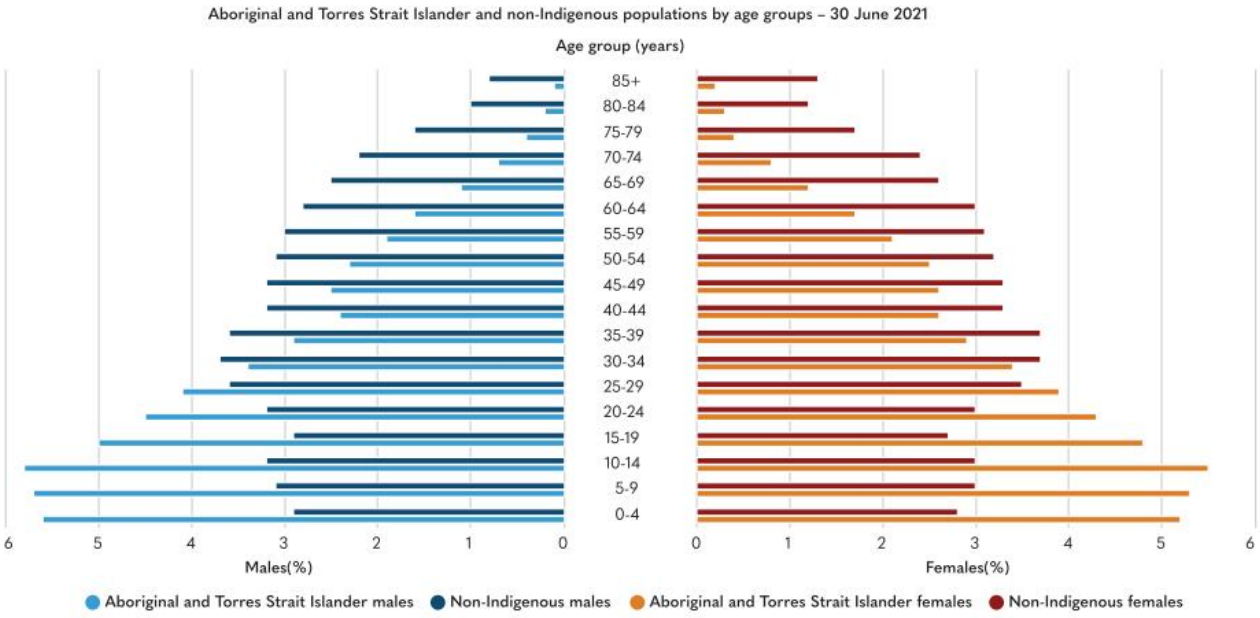


Figure 1.18 Aboriginal and Torres Strait Islander and non-Indigenous populations by age group. The lines show the age and sex percentage of each total population group (Aboriginal and Torres Strait Islander people; non-Indigenous people). Source: Australian Bureau of Statistics, Estimates of Aboriginal and Torres Strait Islander Australians 30 June 2021

Activity 1.6

Population by age group

Use Figure 1.18 to answer the following questions.

1 Approximately what percentage of Indigenous people are under 25 years of age?
2 Approximately what percentage of non-Indigenous people are under 25 years of age? How does this compare with the Indigenous pyramid?
3 Approximately what percentage of non-Indigenous people are over 60 years of age? How does this compare with the Indigenous pyramid? What does this mean?

Skills: analysis

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Burden of disease

Systemic injustice also leads to Aboriginal and Torres Strait Islander Peoples continuing to experience a significantly higher burden of disease than non-Indigenous Australians. The rate of potentially avoidable death is three times higher for Aboriginal and Torres Strait Islander Peoples than for the rest of the population. These are deaths that, with appropriate care and access to prevention, should not occur.

Despite available strategies, this rate has not improved for First Nations Peoples over the past 10 years, while it has decreased by 13% for non-Indigenous Australians. Potentially avoidable deaths account for 64% of the deaths of Aboriginal and Torres Strait Islander Peoples. These include coronary heart disease, diabetes, suicide and self-inflicted injuries.

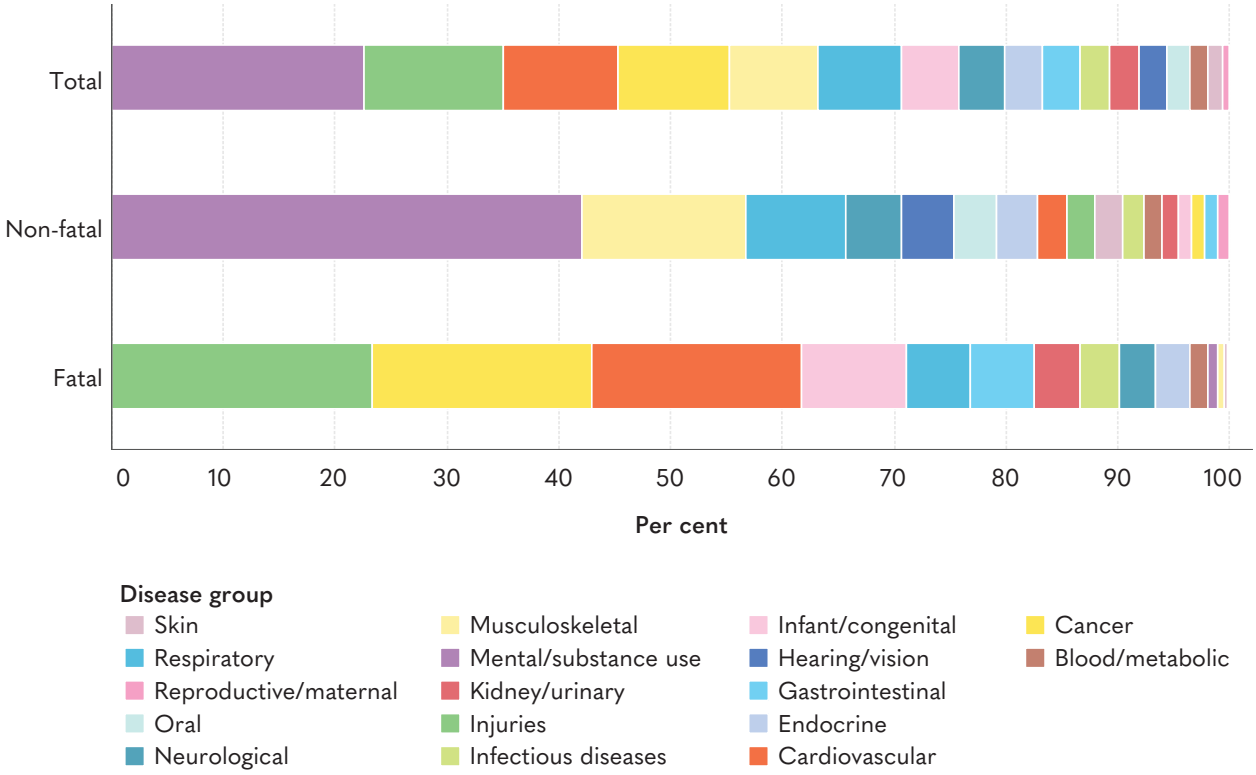


Figure 1.19 Disease group contribution to total, fatal and non-fatal burden among First Nations people, 2018. Source: AIHW 2022.

Compared with non-Indigenous Australians, Aboriginal and Torres Strait Islander Peoples experience higher death rates from all causes.

They are:

- 2.1 times more likely to die from suicide
- two times more likely to die from respiratory disease
- 4.7 times more likely to die from diabetes
- two times more likely to die from injury and poisoning
- 2.1 times more likely to die during the first four years of life
- 1.5 times more likely to die from cardiovascular disease (2.3 times more likely for those living in remote areas)
- nearly three times more likely to be hospitalised for intentional self-harm.

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First Nations: Leading underlying causes of death in Australia, 2021–2023

Rank	Persons	Males	Females
1st	Coronary heart disease (11.0%)	Coronary heart disease (12.8%)	Diabetes (8.9%)
2nd	Diabetes (7.2%)	Suicide (6.8%)	Coronary heart disease (8.9%)
3rd	COPD (6.2%)	Diabetes (5.8%)	COPD (6.9%)
4th	Lung cancer (6.0%)	Lung cancer (5.7%)	Lung cancer (6.4%)
5th	Suicide (5.0%)	COPD (5.6%)	Dementia including Alzheimer's disease (4.9%)

Non-indigenous: Leading underlying causes of death in Australia, 2021–2023

Rank	Persons	Males	Females
1st	Coronary heart disease (9.8%)	Coronary heart disease (11.3%)	Dementia including Alzheimer's disease (13.0%)
2nd	Dementia including Alzheimer's disease (9.7%)	Dementia including Alzheimer's disease (6.7%)	Coronary heart disease (8.2%)
3rd	Cerebrovascular disease (5.5%)	Lung cancer (5.4%)	Cerebrovascular disease (6.5%)
4th	Lung cancer (4.9%)	Cerebrovascular disease (4.6%)	Lung cancer (4.3%)
5th	COPD (4.0%)	COPD (4.1%)	COPD (4.0%)

Disease group

Cancer · Cardiovascular · Endocrine · External causes · Neurological · Respiratory

Notes:

1. Mortality data by Indigenous status are restricted to those 5 states are territories where information on Indigenous status is considered of sufficient quality and completeness of reporting: New South Wales, Queensland, Western Australia, South Australia and the Northern Territory.
2. Deaths are counted according to year of registration of death, and state or territory of usual residence.
3. Causes of death for 2021 are based on the revised version; and deaths registered in 2022 and 2023 are based on the preliminary version and are subject to revision. Interpret deaths due to suicide with caution. For more information, see Methodology in ABS Causes of death publication.

Source: AIHW National Mortality Database; Table S7.1.

Figure 1.20 Leading underlying causes of death in Australia, by Indigenous status and sex, 2021–23

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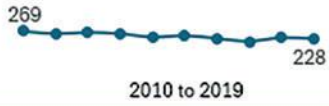
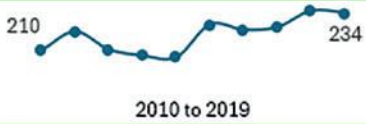
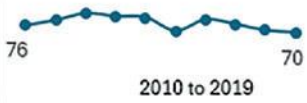
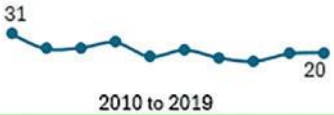
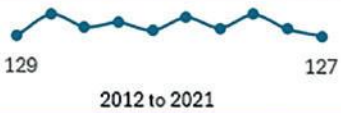
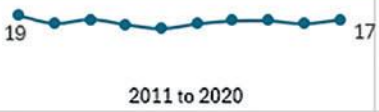
Activity 1.7

Burden of disease of First Nations people

Consider Figures 1.19 and 1.20. When answering these questions, remember that the responsibility for these outcomes does not lie with the Aboriginal and Torres Strait Islander communities. This data is evidence of systemic failure, as is discussed later in this section.

1 What are the top three leading causes of the burden of disease among First Nations people?
2 What are the top three leading fatal causes of burden?
3 Of these, how many are preventable?
4 Discuss the implications of these statistics.

Skills: analysis

Measure	Change over time	Progress	
		First Nations	Rate difference
Cardiovascular (circulatory) disease (measure 1.05)			
Decrease in the death rate due to cardiovascular disease (age-standardised per 100,000 population)		√	--
Cancer (measure 1.08)			
Increase in the death rate due to cancer (age-standardised per 100,000 population)		×	×
Diabetes (measure 1.09)			
No significant change in rate of death due to diabetes for First Nations people (age-standardised per 100,000 population)		--	--
Kidney disease (measure 1.10)			
Decrease in death rate due to kidney diease (age-standardised per 100,000 population).		√	--
Social and emotional wellbeing (measure 1.18)			
Increase in the suicide rate (age-standardised per 100,000 population).		×	×
Infant and child mortality (measure 1.20)			
No significant change in the rate of child deaths (0–4 years) (age-specific per 100,000 population).		--	--
Perinatal mortality (measure 1.21)			
No significant change in the rate of perinatal deaths (crude per 1,000 births).		--	--

√ Improved × Worsened -- No change

Figure 1.21 Key changes in health status and outcomes for First Nations Peoples over time

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Activity 1.8

Aboriginal and Torres Strait Islander Health Performance Framework

Access the Aboriginal and Torres Strait Islander Health Performance Framework via this link: https://cambridge.edu.au/redirect/11381.

1 Allocate the tier 1 measures to pairs or groups. Read through the information and answer the following questions:
   a What are the negative statistics associated with the condition?
   b What are the positive trends (if any) associated with the condition?
   c Are these rates improving or worsening?
   d How do these rates compare with those of non-Indigenous Australians?
   e Why are these statistics important? What determinants contribute to these conditions?
2 Present your findings in an infographic, a table or a brief presentation and share with the class.

Skills: analysis, collaboration, communication

Determinants of health

Determinants of health, such as the broad features of society, environmental factors, socio-economic characteristics, health behaviours and biomedical factors, all interact in a complex and multidirectional way to influence the level of health experienced by First Nations Australians.

Income

Income is directly linked to a variety of determinants that strongly influence health, such as housing, food choices, access to private health insurance and increased social participation. Income and health have a reciprocal relationship. Individuals with adequate income can enhance their health by spending more on health-related needs. Conversely, those in good health are more likely to secure employment and earn an income. In 2021, 35% of First Nations people had gross household incomes that were in the bottom 20% of national incomes.

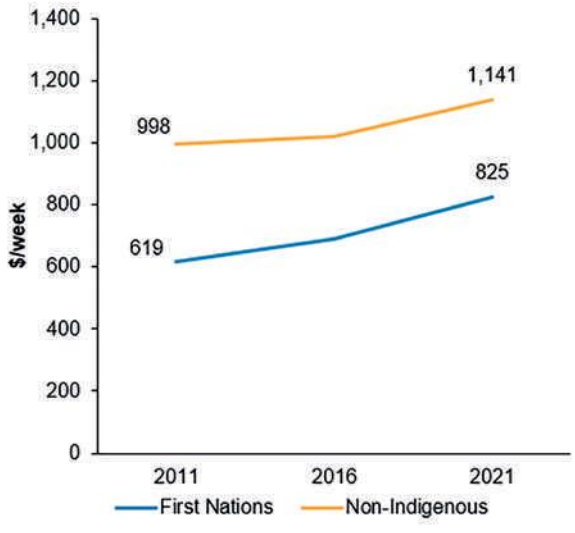


Figure 1.22 Median gross weekly income of adults by Indigenous status

Employment

Employment and health are closely linked. The benefits of employment extend to both individual and community health by enhancing financial security, improving social status, facilitating personal development, increasing social relationships, as well as enhancing self-esteem and emotional wellbeing. Indigenous Australians who are employed have lower rates of emotional distress and are better placed to break cycles of poverty and trauma caused by colonisation. The employment rate of First Nations people remains significantly lower than that of non-Indigenous people (56% compared with 78%). However, there has been an increase in the employment rate of First Nations people over the past decade and a decrease in the gap in unemployment rates between Indigenous and non-Indigenous Australians. The connection between education and employment is also evident in the fact that the number of Indigenous Australians aged 25–64 who are employed has increased with each level of educational attainment. Indigenous Australians face numerous barriers in relation to employment, including conflicts with family responsibilities, interaction with the justice system, disability, chronic disease and level of education.

Education

Education is closely connected to other determinants of health such as employment opportunities and income. Education can enhance health through

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greater health literacy and greater knowledge and understanding of health risk factors, as well as increased access to health services. The relationship between health and education is multidirectional; while increased education can improve health, a low level of health can hinder educational opportunities. For example, hearing and vision problems can impact on learning and can lead to learning difficulties and behavioural problems.

While Indigenous Australians show lower rates of school retention when compared with non-Indigenous Australians in all years, this is improving in all age groups. There have been increases in the number of Indigenous Australians achieving their year 12 certificate or higher. Significant improvements in literacy and numeracy standards are also being achieved. Aboriginal and Torres Strait Islander Peoples who attained a higher level of schooling rated their health as higher.

Housing

Stable, secure and appropriate housing is crucial for achieving good health and wellbeing. In 2021, 81% of First Nations people lived in appropriate housing compared with 94% of the non-Indigenous population. This rate varied from state to state and with remoteness, with 55% of First Nations people in remote areas experiencing overcrowding in housing. The gap in home ownership is lessening but is still significant (42% of Indigenous Australians compared with 68% of non-Indigenous Australians). However, homelessness among First Nations people was almost nine times higher than among non-Indigenous people – although it should be noted that some Aboriginal and Torres Strait Islander Peoples choose to live in public places and do not consider themselves homeless.

Transportation

Access to transport is important for access to education, employment opportunities and health services. It is thus a key enabler for health. Not having a licence to drive and issues with transport were identified as barriers for approximately 30% of Indigenous Australians in gaining employment. For 13% of Indigenous Australians, a lack of transport was identified as a barrier in accessing healthcare. A cyclic disadvantage exists with Indigenous Australians who experience barriers to gaining a driver licence, including lower literacy, less access to a vehicle for practising and financial difficulty.

Family structure

Aboriginal and Torres Strait Islander children were twice as likely to live in one-parent families. Being a child in a one-parent family has been linked to low socio-economic status (SES), low educational attainment and a lack of support.

Justice system

Forty-seven per cent of young people in youth justice supervision and 32% of all adults in prison were First Nations people. This is a huge overrepresentation when it is considered that First Nations people comprise only 3.8% of the population, and indicates the extent of the failure of systems to meet the needs of First Nations Peoples. Imprisonment has a compounding effect on social and economic disadvantage and can often have an intergenerational impact. Imprisonment also affects other determinants such as employment, income, housing and mental health.

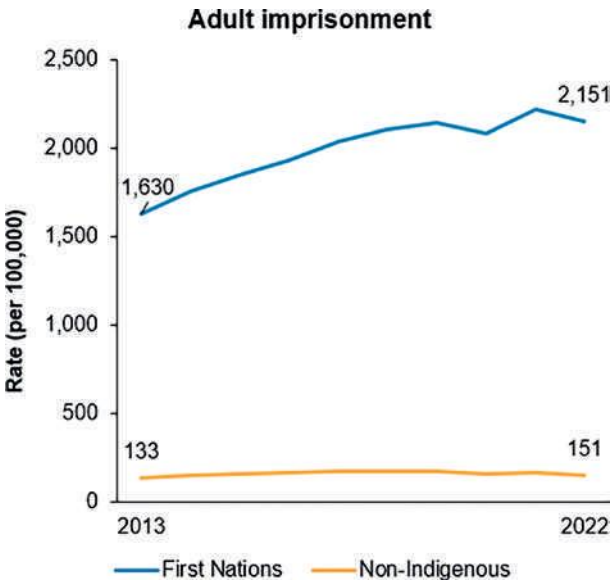
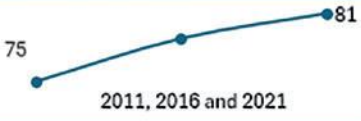
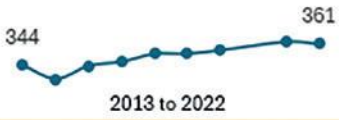
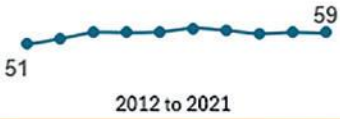
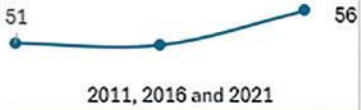
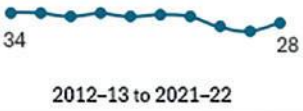
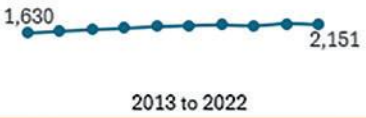
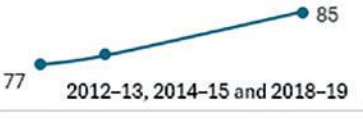


Figure 1.23 Rate of adult imprisonment by Indigenous status, 2013 to 2022

Geographical location

Access to health services, employment and education opportunities is closely related to where a person lives. Aboriginal and Torres Strait Islander Peoples living in remote areas tend to experience lower rates of income, lower rates of employment, lower school retention rates and lower achievement of year 12 certification or above. The challenges associated with living remotely must be considered when assessing strategies to address inequities. This is particularly

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Measure	Change over time	Progress: First Nations	Progress: Rate difference
Housing (measure 2.01)			
Increase in the proportion of First Nations people living in appropriately sized housing (%).		√	--
Literacy and numeracy (measure 2.04)			
Increase in the mean scale score of Year 3 students for reading.		√	--
Education outcomes for young people (measure 2.05)			
Increase in the Year 7/8 to Year 12 retention rate (%).		√	--
Employment (measure 2.07)			
Increase in the employment-to-population rate among those aged 25–64 (%).		√	√
Contact with the criminal justice system (measure 2.11)			
Decrease in the youth detention rate for ages 10–17 (crude per 10,000 population).		√	√
Increase in the adult imprisonment rate (age-standardised per 100,000 population).		×	×
Tobacco use (measure 2.15)			
Increase in the proportion of First Nations people aged 15–17 who had never smoked (%).		√	--

√ Improved × Worsened -- No change

Figure 1.24 Key changes in determinants of health for First Nations people over time

the case because connection to Country is such an important element of First Nations culture and is a protective factor in terms of health.

Sociological factors

Family, kinship, connection to and caring for Country, language, a sense of cultural identity and participation in cultural activities and access to traditional lands are important determinants of health and act as protective factors for Indigenous people. Currently there are 123 recorded languages being spoken, with 14 considered strong.

Interaction of determinants

It is difficult to measure precisely the relationship between these determinants, multiple risk factors and health status. However, it is widely acknowledged that the underlying determinants mentioned clearly increase the likelihood of exposure to a number of the following health risk factors:

- tobacco use
- alcohol consumption
- illicit drug use
- overweight and obesity
- poor nutrition
- physical inactivity
- exposure to violence
- poor housing conditions.

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Activity 1.9

Interaction of determinants

1 Draw a diagram to represent how the determinants interact to affect the health of Aboriginal and Torres Strait Islander people.
2 Explain your diagram to another student in your class or write a written response explaining the interactions.

Skills: communication, creative thinking

Causes underpinning inequalities

The inequity of government policies, institutional racism, the effects of colonisation and other past events have contributed to an ongoing experience of entrenched disadvantage for Indigenous Australians.

The impact of colonisation

The impact of colonisation on the communities and culture of First Nations Australians was immeasurable and devastating. Prior to the arrival of English settlers, First Nations people are believed to have lived in Australia for more than 65 000 years and to be the oldest continuous civilisation on earth. They lived in balance and harmony on the land with a culture rich in music, art and storytelling.

The immediate impact of colonisation was one of violence, upheaval and disease as Indigenous Australians were forced off their lands. Many were displaced and moved to missions or reserves on the outskirts of non-Indigenous settlements and were dispossessed of their lands. There were also numerous violent conflicts which led to the deaths of hundreds of thousands of Aboriginal and Torres Strait Islander Peoples as they were massacred because of their resistance. Traditional ways of life were disrupted as Indigenous people were no longer able to carry out their traditional methods of hunting and gathering. Settlers also brought with them diseases such as smallpox, syphilis and influenza. These had a devastating impact on the Indigenous population who had no resistance to the viruses. In the Sydney Basin area, over half of the Indigenous population died from smallpox within the first year of European settlement.

Indigenous Australians were considered to be less than people by many of the settlers, and their treatment by many reflected this view.



Figure 1.25 Sydney Cove, Port Jackson 1788. The impact of colonisation on the communities and culture of First Nations Australians was immeasurable and devastating.

> I have myself heard a man, educated, and a large proprietor of sheep and cattle, maintain that there was no more harm in shooting a native, than in shooting a wild dog. I have heard it maintained by others that it is the course of Providence, that blacks should disappear before the white, and the sooner the process was carried out the better, for all parties. I fear such opinions prevail to a great extent. Very recently in the presence of two clergymen, a man of education narrated, as a good thing, that he had been one of a party who had pursued the blacks, in consequence of cattle being rushed by them, and that he was sure that they shot upwards of a hundred. When expostulated with, he maintained that there was nothing wrong in it, that it was preposterous to suppose they had souls. In this opinion he was joined by another educated person present.
>
> Bishop Polding, 1845

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More disruption and devastation were to come, as can be seen in Case study 1.1.

Case study 1.1

The Stolen Generations and intergenerational trauma

Between 1910 and 1972, thousands of Indigenous children were forcibly removed from their homes and communities under government policies. They were placed in institutions, missions and foster homes and became known as the Stolen Generations. It is estimated that up to one in three First Nations children were affected by these policies and that around one in three First Nations adults are descendants of the Stolen Generations. Once taken from families, children were forced to assimilate into white culture, and were given new 'white' names. In some cases, children were not even given a name but were assigned a number and instructed not to speak their native languages or express their culture. Many experienced physical, psychological, sexual and emotional abuse. Children were not able to have contact with their families and were told that their parents did not want them or were dead. These devastating events were the cause of intergenerational trauma that is still ongoing today and has significantly impacted the level of health experienced by Aboriginal and Torres Strait Islander Peoples.

Follow the links below to watch videos on intergenerational trauma and the experiences of the Stolen Generations. Please note that the videos contain some distressing content.

Intergenerational trauma: https://cambridge.edu.au/redirect/11414.

Telling our stories - Florence Onus: https://cambridge.edu.au/redirect/11415.

Lorraine Peters (a Gamilaroi and Wailwun woman from central west NSW) was stolen and trained to be a servant: https://cambridge.edu.au/redirect/11416.

Telling our stories - Lorraine Peters: https://cambridge.edu.au/redirect/11417.

Heartbreak of the Stolen Generations: https://cambridge.edu.au/redirect/11418.

After viewing the videos, discuss the impact that the forcible removal of Indigenous children had on communities at the time and into the future.

Skills: analysis

Despite the devastating and ongoing impacts of colonisation and against overwhelming odds, First Nations Peoples have preserved their cultural knowledge, such as languages, songs and stories, and have tirelessly worked to revive lost, stolen and dormant traditions. The resilience needed to survive the damage of colonisation has been immeasurable. Much work remains to heal the wounds that remain and restore fragmented relationships.

Social and cultural factors

There are other less measurable social and cultural factors that also contribute in some way to the inequities experienced by Aboriginal and Torres Strait Islander Peoples. These include:

- a sense of 'loss of control of their own lives' among some Aboriginal and Torres Strait Islander Peoples, which contributes further to the level of inequity
- institutional and personal racism
- communal approaches to family and parenting
- a lack of Indigenous role models in some areas of society.

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Case study **1.2**

The Stolen Generations and intergenerational trauma

Experiences of Aboriginal and Torres Strait Islander people

Many Australians assume hospitals and healthcare services are neutral spaces focused on care for all people. However, for many Aboriginal and Torres Strait Islander people, these spaces can be unsafe, alienating or even life-threatening. Experiences of racism, neglect and systemic failure are not isolated incidents; they reflect a broader pattern of institutional harm rooted in colonisation.

1. Naomi Williams

Naomi Williams, a 27-year-old Wiradjuri woman, died of sepsis in 2016 after visiting Tumut Hospital more than 20 times in the seven months before her death. She was repeatedly dismissed and not given appropriate care, despite being pregnant and presenting with serious symptoms. A coronial inquest found that systemic racism played a role in her death.

2. Ms Dhu

Ms Dhu, a 22-year-old Yamatji woman, died in police custody in 2014 after being jailed for unpaid fines. She repeatedly told police and medical staff that she was in pain but was accused of 'faking it'. She died of septicaemia and pneumonia. The coroner's report acknowledged racism and mistreatment contributed to her death.

3. The NT Don Dale Youth Detention Centre

Reports and footage from 2016 showed the abuse of Aboriginal children in the Don Dale centre, including solitary confinement, physical assault and the use of tear gas. The Royal Commission found that the detention system was failing children and breaching their human rights. Most of the young people detained were Aboriginal.

1 Why do you think Aboriginal people may not always trust hospitals, police or government institutions?
2 What does justice in health mean? How is it different from health equity?
3 What would a culturally safe, trauma-informed health system look like for Aboriginal and Torres Strait Islander Peoples?
4 How might systemic racism be invisible to people who don't experience it?
5 Why is it important to name racism in health and not just refer to 'barriers' or 'inequities'?



Figure 1.26 The Don Dale Youth Detention Centre in Darwin.

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Actions to improve health status

We, as Aboriginal and Torres Strait Islander people, know what is best for our health and wellbeing. While our people and cultures are strong and resilient, we continue to see harmful policies and practices implemented by government. While this can be difficult to hear, true change exists within discomfort, and progress is made when all parties are open to listening and responding.

Ms Donna Murray, a descendant of the Wiradjuri and Wonnarua peoples of the Murrumbidgee River and Hunter Valley (NSW), Co-Chair, Implementation Plan Advisory Group and Health Plan Working Group, page 8

Activity 1.10

Quote

Discuss the above quote in relation to the actions required to improve the health status of Aboriginal and Torres Strait Islander people.

Skills: communication, analysis

Any action taken to improve the health status of First Nations people must reflect the holistic nature of Indigenous health and be culturally safe and responsive. Active engagement with First Nations people at all levels is pivotal to ensure that cultural values, backgrounds and traditions are respected and upheld and to allow for self-determination and empowerment alongside governments, organisations and communities.

Actions taken must address the determinants that are contributing to the health inequities experienced by Aboriginal and Torres Strait Islander Peoples which have been caused by colonisation and past traumas. One of the key actions that has been taken in an attempt to address inequities has been the Close the Gap campaign and the subsequent National Agreement on **Closing the Gap**.

Close the Gap / National Agreement on Closing the Gap

In 2008, the **Council of Australian Governments (COAG)** committed to closing the gap in Indigenous disadvantage, leading to the National Indigenous Reform Agreement (NIRA) and the Closing the Gap strategy. This strategy outlined targets to reduce inequalities in life outcomes between Aboriginal and Torres Strait Islander people and non-Indigenous Australians, with goals to be achieved through providing funding to new programs and services, strengthening reporting requirements, and government accountability measures to track progress.

Although some Aboriginal and Torres Strait Islander people were involved in developing the policy and programs, Indigenous representatives did not have full ownership, and it was seen as a predominantly government initiative. It was nevertheless welcomed by Aboriginal and Torres Strait Islander leaders. Over the following years there was little progression towards achieving the targets due to a lack of implementation, inadequate cooperation of governments, insufficient funding and a lack of community involvement.

After ongoing requests for greater involvement from Indigenous Australians in more formal roles in the Closing the Gap strategy and a refresh of targets, the **Coalition of Peaks** was established in 2018, and the Partnership Agreement on Closing the Gap and the National Agreement formed in 2019.

Closing the Gap Australian Government targets to address Indigenous disadvantage in key areas

Council of Australian Governments (COAG) Australian intergovernmental forum from 1992 to 2020, consisting of federal, state and territory governments, and the Australian Local Government Association. In 2020 it was replaced by a new structure.

Coalition of Peaks a representative body of First Nations community organisations that negotiates with federal and state governments on Closing the Gap strategies

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The National Agreement is characterised by a shift in the approach previously taken and acknowledges the need for Aboriginal and Torres Strait Islander Peoples to determine, drive and own the desired outcomes in partnership with government. It requires governments to 'build on the strong foundations Aboriginal and Torres Strait Islander people have, through their deep connection to family, community and culture'.

This Agreement also stems from the belief that when Aboriginal and Torres Strait Islander people have a genuine say in the design and delivery of services that affect them, better life outcomes are achieved. It recognises that structural change in the way governments work with Aboriginal and Torres Strait Islander people is needed to close the gap.

Preamble, *National Agreement on Closing the Gap*, July 2020





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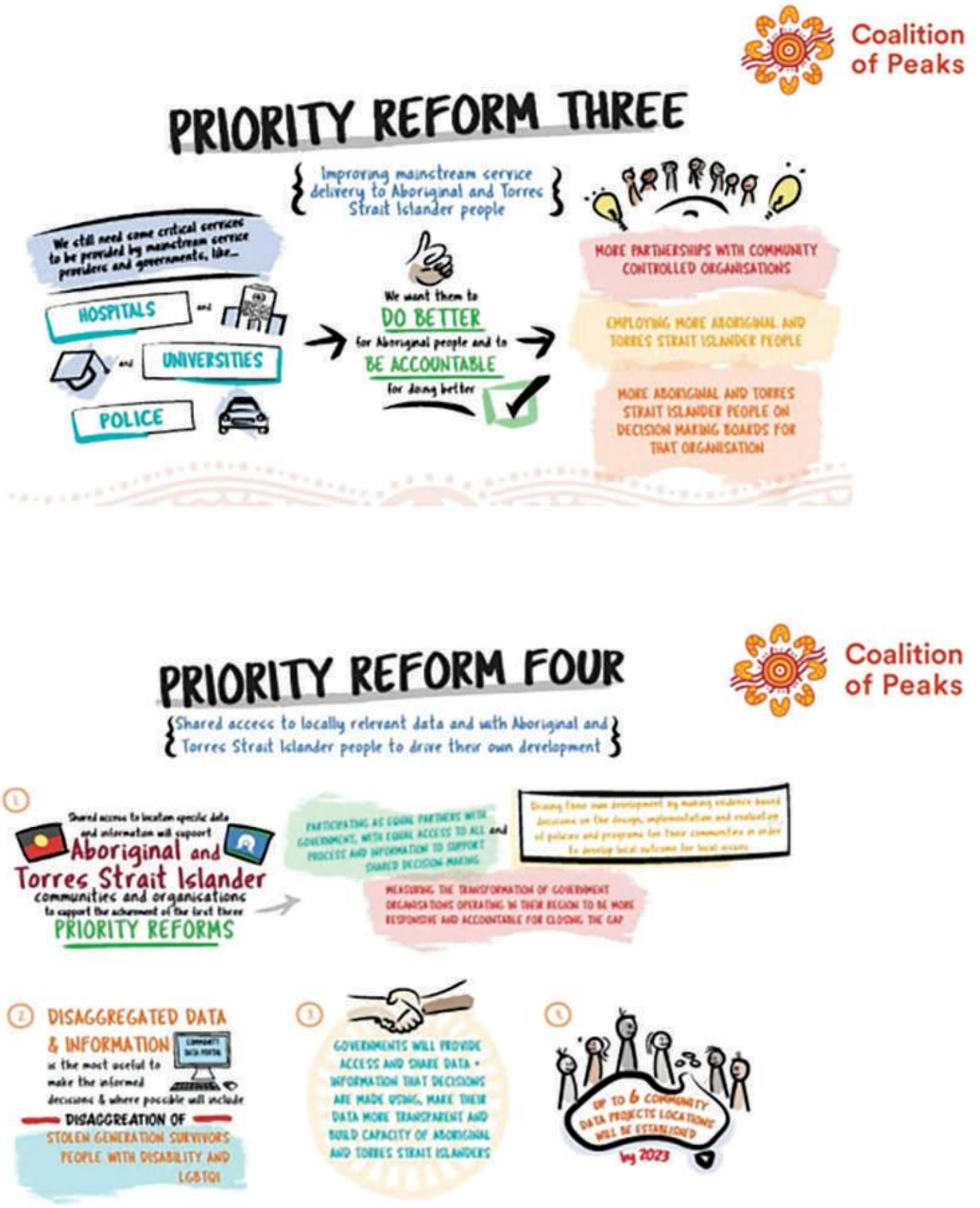


Figure 1.27 Priority areas for reform – the National Agreement

Activity 1.11

Closing the Gap

1 Look at the National Agreement on Closing the Gap targets. In what ways are the inequities experienced by Aboriginal and Torres Strait Islander Peoples being addressed?
2 Divide the targets up among the class. Conduct research to discover the progress being made towards achieving the target. Are they on track? Are the actions being taken effective in addressing the inequities? Compile the results and present as either an infographic, PowerPoint, short talk or video, or written document.
3 Look at the priority reform action areas. For each action area, summarise what is involved and its importance in achieving positive health outcomes for Aboriginal and Torres Strait Islander Peoples.

Skills: research, analysis, communication, collaboration

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SOCIO-ECONOMIC TARGETS IN THE NATIONAL AGREEMENT

The Coalition of Peaks together with all Australian governments and the Australian Local Government Association signed the National Agreement on Closing the Gap (National Agreement) in 2020. The National Agreement is built around what Aboriginal and Torres Strait Islander people said is important to improve our lives. It includes four Priority Reforms to change the way governments work, new government accountability measures and shared monitoring and implementation arrangements. In addition to the Priority Reforms targets, the National Agreement establishes targets under 17 socio-economic outcome areas to help bring focus to new areas and help monitor progress in improvements in the lives of Aboriginal and Torres Strait Islander people.

Target 1: Close the Gap in life expectancy within a generation, by 2031.

Target 2: By 2031, increase the proportion of Aboriginal and Torres Strait Islander babies with a healthy birthweight to 91 per cent.

Target 3: By 2025, increase the proportion of Aboriginal and Torres Strait Islander children enrolled in Year Before Fulltime Schooling (YBFS) early childhood education to 95 per cent.

Target 4: By 2031, increase the proportion of Aboriginal and Torres Strait Islander children assessed as developmentally on track in all five domains of the Australian Early Development Census (AEDC) to 55 per cent.

Target 5: By 2031, increase the proportion of Aboriginal and Torres Strait Islander people (age 20-24) attaining year 12 or equivalent qualification to 96 per cent.

Target 6: By 2031, increase the proportion of Aboriginal and Torres Strait Islander people aged 25-34 years who have completed a tertiary qualification (Certificate III and above) to 70 per cent.

Target 7: By 2031, increase the proportion of Aboriginal and Torres Strait Islander youth (15-24 years) who are in employment, education or training to 67 percent.

Target 8: By 2031, increase the proportion of Aboriginal and Torres Strait Islander people aged 25-64 who are employed to 62 per cent.

Target 9a: By 2031, increase the proportion of Aboriginal and Torres Strait Islander people living in appropriately sized (not overcrowded) housing to 88 per cent.

Target 9b: By 2031, all Aboriginal and Torres Strait Islander households:

i. within discrete Aboriginal or Torres Strait Islander communities receive essential services that meet or exceed the relevant jurisdictional standard

ii. in or near to a town receive essential services that meet or exceed the same standard as applies generally within the town (including if the household might be classified for other purposes as part of a discrete settlement such as a "town camp" or "town based reserve").

Target 10: By 2031, reduce the rate of Aboriginal and Torres Strait Islander adults held in incarceration by at least 15 per cent.

Target 11: By 2031, reduce the rate of Aboriginal and Torres Strait Islander young people (10-17 years) in detention by at least 30 per cent.

Target 12: By 2031, reduce the rate of over-representation of Aboriginal and Torres Strait Islander children in out-of-home care by 45 per cent.

Target 13: By 2031, the rate of all forms of family violence and abuse against Aboriginal and Torres Strait Islander women and children is reduced at least by 50%, as progress towards zero.

Target 14: Significant and sustained reduction in suicide of Aboriginal and Torres Strait Islander people towards zero.

Target 15a: By 2030, a 15 per cent increase in Australia's landmass subject to Aboriginal and Torres Strait Islander people's legal rights or interests.

Target 15b: By 2030, a 15 per cent increase in areas covered by Aboriginal and Torres Strait Islander people's legal rights or interests in the sea.

Target 16: By 2031, there is a sustained increase in number and strength of Aboriginal and Torres Strait Islander languages being spoken.

Target 17: By 2026, Aboriginal and Torres Strait Islander people have equal levels of digital inclusion.

The Parties may agree to vary or add additional targets during the life of the National Agreement. Any new or updated targets will be developed in partnership and agreed by the Parties to the Agreement.

Where a target is due to expire, the Parties agree to develop a new target in the same outcome area. The Parties will begin developing the new target at least six months prior to the projected target expiry. Additional actions to achieve the new target will be included in Parties' Implementation Plans.

Reporting on targets will show progress to close the gap, relative to non-Indigenous Australians. National trajectories for each numeric target will be published on the Closing the Gap website and subsequently on the Productivity Commission Dashboard. These will show the expected rate of progress and help inform whether parties are on track to meet the targets.

Figure 1.28 National socio-economic targets – National Agreement. Source: Coalition of Peaks website.

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Health system

In 2021, the federal government established the *National Aboriginal and Torres Strait Islander Health Plan 2021–2031*. This 10-year plan seeks to engage Aboriginal and Torres Strait Islander people with lived experience, in the process of developing health policies, plans and initiatives for First Nations Australians. It recognises that there is no single First Nations cultural identity, and therefore services must be tailored to suit individual people and communities.

> Culture is a foundation for Aboriginal and Torres Strait Islander health and wellbeing. It is a protective factor across the life course, and has a direct influence on broader social determinants and outcomes. Gains across these broader determinants, in turn, reinforce cultural connectedness, maintenance, resurgence, nation building and pride in cultural identity

National Aboriginal and Torres Strait Islander Health Plan 2021–2031, page 17

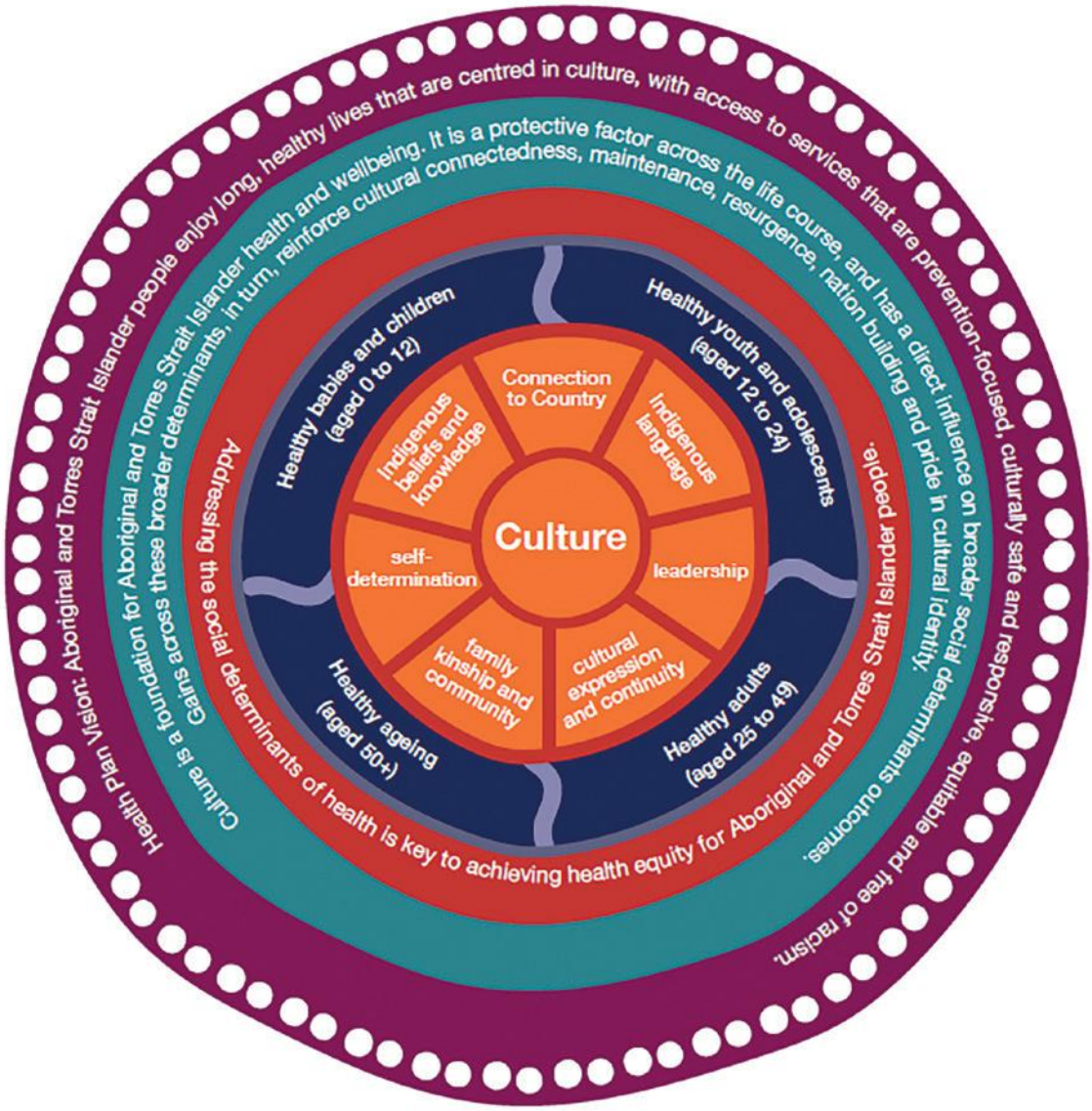


Figure 1.29 Circular framework of the Health Plan vision. *National Aboriginal and Torres Strait Islander Health Plan 2021–2031*

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Case study 1.3

Purple House and the purple truck

Purple House is a health service owned and run by members of the Pintupi people of the Western Desert of Central Australia. Based in Alice Springs, it focuses on people living with kidney disease who require regular dialysis treatment.

Scan the QR code to watch a video about Purple House, and read more about the services at the website, which can be accessed via this link https://cambridge.edu.au/redirect/11382.

Video 1.1 Mobile dialysis for remote communities (11:06)

1 What is the goal of Purple House?
2 Identify some of the challenges in offering dialysis in remote communities.
3 Discuss the importance of innovations like the purple truck in caring for the health needs of First Nations Australians.



Figure 1.30 The purple truck delivers dialysis services to remote locations to allow patients with end stage renal failure the chance to return home for family, culture or sorry business.

Purple House is an example of an Aboriginal Community Controlled Health Organisation (ACCHO). ACCHOs are services are governed by Aboriginal and Torres Strait Islander people, which respond to the specific needs of the community. They offer culturally safe, holistic care where people don't have to explain or justify themselves, and where racism is not part of the experience. Another example is the Central Australian Aboriginal Congress, which provides comprehensive, wraparound care that addresses not just medical needs but social and cultural wellbeing.

Quiz

Revise and summarise 1.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Identify three of the major inequities experienced by Aboriginal and Torres Strait Islander Peoples.
2 Using a specific example, describe how the determinants of health interact to affect the health of Aboriginal and Torres Strait Islander Peoples.
3 Describe the impact of colonisation on the health of Aboriginal and Torres Strait Islander Peoples.

Think critically and apply 1.2

Outline two actions that are being taken currently or could be undertaken to improve the health status of Aboriginal and Torres Strait Islander Peoples.

Skills: analysis

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1.3 Groups experiencing inequities in health: People living in rural and remote areas

Learning objective 1.3
ANALYSE groups experiencing inequities in health.

The syllabus requires you to analyse a second group experiencing inequalities in health, in addition to Aboriginal and Torres Strait Islander Peoples. The second group we will be looking at in this section is people living in rural and remote areas.

Approximately 26% of the Australian population lives in rural areas and a further 2% lives in areas classified as remote or very remote. Rural areas are areas outside of metropolitan areas that have lower populations and are further from major cities. Remote areas are significantly removed from major service centres.

People living in rural and remote areas generally experience a range of health inequities due to their geographical isolation. Many experience limited access to goods and services and fewer educational and employment opportunities.

While the majority of First Nations Australians live in urban and regional areas, as remoteness increases so does the proportion of First Nations people (1.9% in major cities compared to 32% in remote and very remote areas).

What does the data tell us?

Recent reports show the following:

- The burden of disease and injury increases with remoteness.
- People living outside of major cities have lower usage of chronic disease management services.
- Women and men living outside major cities are both more likely to have experienced partner violence and are 24 times more likely to be hospitalised due to domestic violence.
- The rate of smoking increases with remoteness.
- Mortality rates increase with remoteness.
- Median age of death decreases with remoteness.
- Death from accidents involving land transport was three times higher in remote areas and four times higher in very remote areas.
- The rate of potentially avoidable deaths increases with remoteness.
- People living in remote areas are hospitalised at twice the rate of those living in major cities.
- The burden of disease for coronary heart disease is 2.2 times higher in remote areas.
- The burden of disease due to self-inflicted injuries, suicide and type 2 diabetes is twice that of major cities.
- Remote areas have 3.2 times the disease burden of major cities.



Figure 1.31 Approximately twenty-six per cent of the Australian population lives in rural areas.

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Table 1.1 Leading cause of death by remoteness area, compared to the rest of Australia 2017–21

	Major cities	Inner regional	Outer regional	Remote	Very remote
1	Coronary heart disease	Coronary heart disease	Coronary heart disease	Coronary heart disease	Coronary heart disease
2	Dementia including Alzheimer's disease	Dementia including Alzheimer's disease	Dementia including Alzheimer's disease	Lung cancer	Diabetes
3	Cerebrovascular disease	Cerebrovascular disease	Lung cancer	Chronic obstructive pulmonary disease	Lung cancer
4	Lung cancer	Lung cancer	Chronic obstructive pulmonary disease	Dementia including Alzheimer's disease	Chronic obstructive pulmonary disease
5	Chronic obstructive pulmonary disease	Chronic obstructive pulmonary disease	Cerebrovascular disease	Cerebrovascular disease	Suicide
6	Colorectal cancer	Colorectal cancer	Colorectal cancer	Diabetes	Cerebrovascular disease
7	Diabetes	Diabetes	Diabetes	Suicide	Dementia including Alzheimer's disease
8	Accidental falls	Prostate cancer	Prostate cancer	Colorectal cancer	Land transport accidents
9	Heart failure	Heart failure	Suicide	Land transport accidents	Kidney failure
10	Prostate cancer	Cancer of unknown or ill-defined primary site	Cancer of unknown or ill-defined primary site	Prostate cancer	Other ill-defined causes

Rate ratio (compared with all of Australia)

<= 1.0

1.1–1.24

1.25–1.49

1.5–1.9

2.0–2.9

3.0–4.0

Notes

1 Rates are age-standardised to the 2001 Australian standard population.
2 Leading causes of death are listed in order of number of deaths in each remoteness area from 2017–2021.
3 Boxes are coloured based on rate ratio comparing each region to Australia overall.

Source: AIHW 2023; Table S4

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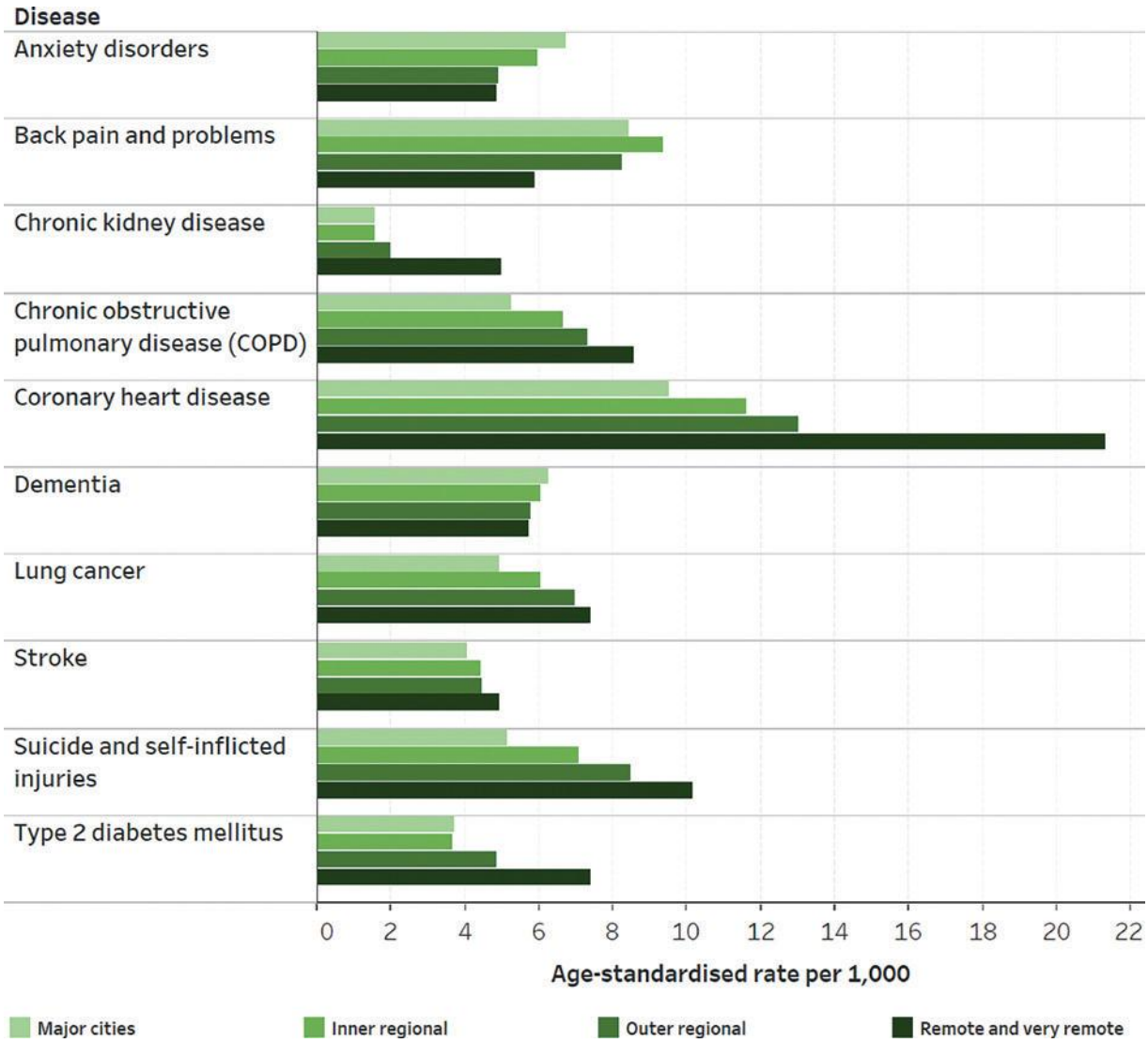


Figure 1.32 Health burden for major disease and injuries by remoteness area, 2018

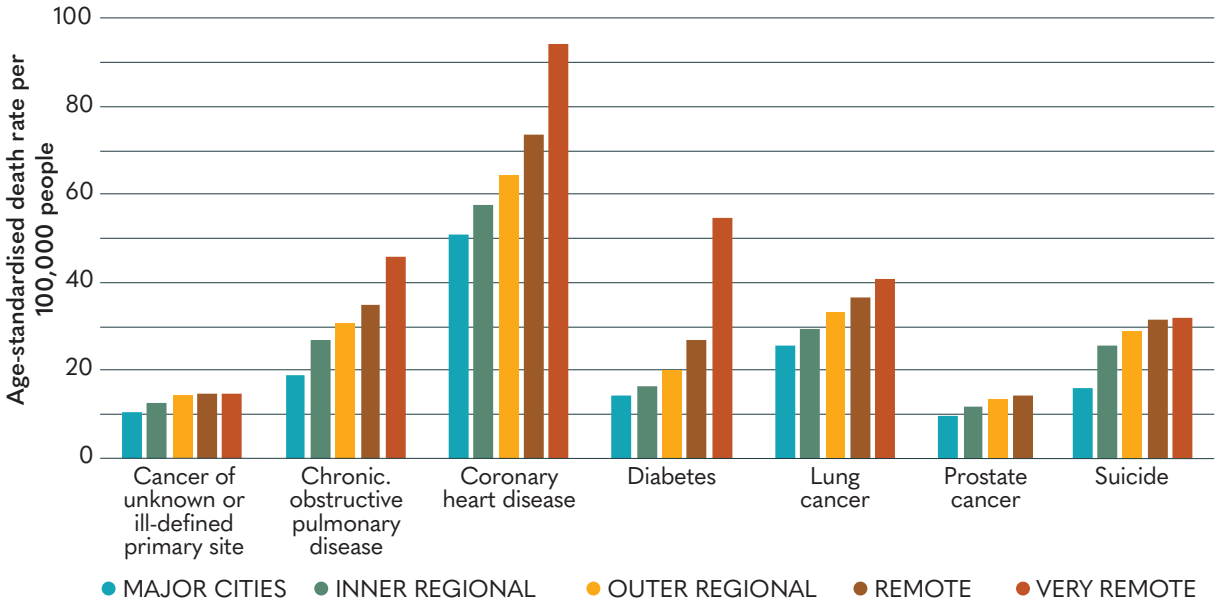


Figure 1.33 Death rate by cause and Australian Statistical Geography Standard (ASGS) remoteness for selected diseases, 2018–22

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Activity 1.12

Rural and remote health

1 Consider the major causes of death and the rates of death among those living in rural and remote areas and analyse their connection to remoteness. Refer in particular to Figure 1.32 and Table 1.1.
2 Consider Figure 1.33, which compares the major causes of death in various geographical areas. What lifestyle behaviours are connected to these conditions?

Skills: analysis

Case study 1.4

NEWS REPORT

'The tyranny of distance': rural health inequities persist

Dr Alisha Dorrigan
newsGP, 15 December 2023

Health disparities between those living in urban and rural areas have been laid bare in the National Rural Health Alliance's latest analysis.



Figure 1.34 People living in rural and remote areas are more likely to die from preventable illness.

continued

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Case study 1.4 *continued*

continued

For the more than seven million Australians who live in rural or remote areas across the country health disparities remain stark, according to a new analysis.

The latest data released in the National Rural Health Alliance's (NRHA) Rural Health in Australia Snapshot 2023 suggests that the further an individual lives from an urban centre, the lower their life expectancy and the higher the likelihood they will die from a preventable illness.

NRHA Chief executive Ms Susi Tegen says workforce shortages and 'the tyranny of distance' are both major contributors to health inequities that see shorter lifespans, a greater disease burden and fewer healthcare dollars spent on people living in rural and remote areas.

'There is clear evidence that per-person spending on healthcare is not equitable, and that this inequity is contributing to poorer health outcomes in rural areas,' Ms Tegen said.

'Fit-for-purpose funding is critical to ensure that the necessary policy and infrastructure is in place.'

According to the NRHA analysis, the all-cause death rate per 100 000 people in males is 569 in major cities, which increases to 925 in very remote areas. A similar trend is seen for females with 409 deaths per 100 000 in major cities compared to 644 in very remote areas.

These figures include deaths from preventable causes, with both men and women more than twice as likely to die from potentially avoidable causes in remote regions.

The data presented also details the health funding disparities that remain for those living outside of major cities, with NRHA estimating this as a $6.55 billion deficit in healthcare expenditure.

One reason for this is that people living remotely under-utilise Medicare, using services up to 50% less than their urban and inner regional counterparts, including GP services. Almost 45 000 people living in these areas have no access to primary healthcare within a one-hour drive from their home.

'The biggest deficits are in accessing primary health care which then leads to higher rates of costly and potentially preventable hospitalisations and increased hospital expenditure,' Ms Tegan said.

'This is a sad reflection on the rest of Australia, when not every citizen has the same access to a basic healthcare need.'

Rural and regional areas continue to have an inadequate supply of most healthcare professionals, owing to a maldistribution of the healthcare workforce, with the number of GPs servicing remote regions also declining in recent years.

Deputy Chair of the RACGP Rural Council Dr Rod Omond told newsGP that strengthening the primary care workforce and adequately funding training pathways are both essential when it comes to overcoming rural and remote health challenges.

'To encourage more GPs into the rural sector, and decrease some of the shortages that we're very aware are occurring, there needs to be increased emphasis on the training of GPs in the rural and remote sector,' he said.

continued

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Case study 1.4 *continued*

continued

'The most important thing is to have GPs in those areas with suitable training, to both have enough spread of GPs so that people can access them when they need to, but also to have the skills to be able to minimise trips to specialists and to other tests, which is a major factor in why it's difficult for rural people to access the care that they need.'

If there is adequate nursing support for GPs and local allied health services, Dr Omond says health outcomes in rural and remote area can be improved.

'What you really want to do is to get more of the services that urban people have immediately available into rural sectors. While you can't get all of them there – you can't have a big hospital in every town with all the facilities that they have – but increased numbers of GPs and some other services that GPs can then refer to locally will make a difference,' he said.

'So such measures as the rural generalist program, and that's not only the hospital type skills, but GP skills in specialised areas, tend to improve the access of rural people to medical care.'

RACGP Rural Council Provost and National Clinical Head of Rural Pathways Dr Karin Jodlowski-Tan told newsGP that while there is no simple solution when it comes to rural health, team-based training and support in these settings can overcome some of the challenges.

'It may be that there's a place with great workforce need but they don't have a supervisor, so we've been supporting practices to build that capacity by getting a team of remote supervisors working with an on-site support team which may be nurses, practice managers and other allied health that can support someone,' she said.

'For example, you've got a region or cluster of small towns where you've got a solo GP who may be getting towards retirement age and they can't have a registrar – there's no succession plan for those communities.

'We've been working with some of these [regions] as a group so that between all these GPs, they can actually support registrars in their region and within their practices by covering for each other.

'We've been looking at novel and innovative ways of enabling these capacities and succession plans to be built through GP training.'

1 What is meant by 'the tyranny of distance'?
2 Explain how per-person funding is not necessarily equitable?
3 What is meant by 'fit-for-purpose funding'? Why is this crucial for positive health outcomes of people living in rural and remote areas?
4 In groups, consider the major causes of mortality and morbidity in rural and remote areas. For one of these causes, propose how that issue could be addressed. For this task, assume that unlimited funding is available.

Skills analysis, collaboration, creative thinking

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Determinants and causes

The majority of the causes of inequities and determinants are linked directly to geographical location and the limited options that result.

Access to affordable and comprehensive health services can prevent illness from arising, slow the development of illness or chronic conditions, and provide timely emergency care. The long distances between population centres and a sparse population distribution can result in problems in providing adequate health services and difficulty in accessing them. This can be seen in the variation of access to bowel, breast and cervical cancer screening with remoteness; lower rates of screening are evident in remote and very remote areas.

In rural and remote communities, there are also fewer educational and employment opportunities available. This may contribute not only to a lower socio-economic status and income, but also to a feeling of loss of control. Studies have shown that stress related to lower levels of control over an individual's life is associated with substantially poorer health and higher death rates. Many people in some smaller and isolated communities have decreased access to real jobs and greater reliance on social security. They therefore have limited control over their lives, leading to higher levels of stress and the resultant health consequences.

Activity 1.13

Determinants

1 Consider the social determinants identified in the Rural Health in Australia Snapshot 2023 (Figure 1.33). What protective factors and risk factors are identified?
2 Consider the major causes of burden of disease, mortality and morbidity identified previously. Which of these would these determinants relate to?
3 Consider the health risk factors identified in the Rural Health in Australia Snapshot 2023. Also, consider the major causes of burden of disease, mortality and morbidity identified previously. Which of these health risk factors and causes would these determinants relate to?

Skills: analysis

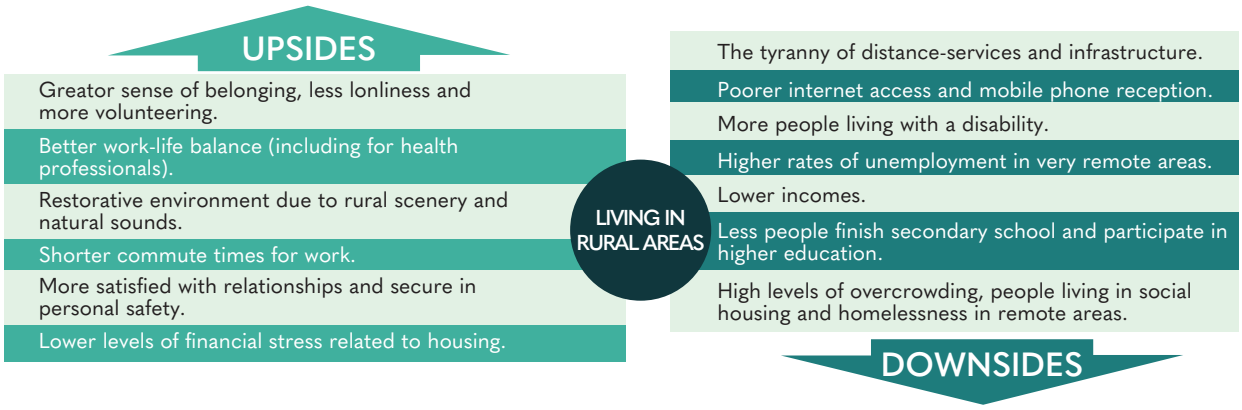


Figure 1.35 The upsides and downsides of living in rural areas
Source: National Rural Health Alliance

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HEALTH RISK FACTORS

Health risk factors are attributes, characteristics or exposures that increase the likelihood of a person developing a disease or health condition. These can be divided into behavioural and biomedical risk factors.[22]

BEHAVIOURAL RISK FACTORS

Factors that individuals can modify – such as alcohol consumption and smoking.[22]

DAILY SMOKING RATES increase with remoteness[23]



Major Cities | Inner Regional | Outer Regional | Remote & Very Remote

Rates of **DAILY SMOKING IN ABORIGINAL AUSTRALIANS**[24] increase with remoteness from

20.9%

in **Major Cities**

↓ to

46.7%

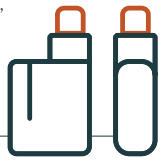
in **Very Remote** areas

RATES OF ALCOHOL CONSUMPTION that exceeds the Australian NHMRC Guidelines also increase with remoteness.[ii]



Major Cities | Inner Regional | Outer Regional & Remote

Unlike tobacco, which is most prevalent in *Remote* and *Very Remote* areas, a study found that rates of **VAPING** are higher among men in *Major Cities* (14%), followed by *Inner Regional* areas (9%), and **lowest (8%)** in *Outer Regional*, *Remote*, or *Very Remote* areas.[25]





Non-medical use of

PAINKILLERS, PAIN RELIEVERS AND OPIOIDS

is higher in *Remote* and *Very Remote* areas (2.7%) than in *Major Cities* and *Outer Regional* (both 2.2%).[23]

People living in rural areas are

24 TIMES MORE LIKELY

to be **hospitalised due to domestic violence** than those in *Major Cities*.[26]





Rural areas see **HIGHER EXPOSURE TO UV RADIATION**, making sun protection crucial. According to the National Health Survey 2022, **sun protection behaviours is more common** in rural areas, especially for hats and clothing, while urban areas rely more on sunscreen.[27]

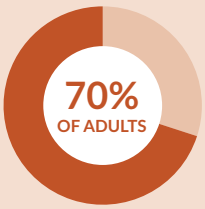
ii. For more information see 2020 National Health and Medical Research Council Australian Guidelines to reduce health risks from drinking alcohol.

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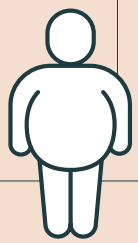
BIOMEDICAL RISK FACTORS

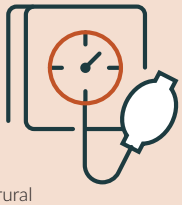
Bodily conditions that directly contribute to health risks, such as abdominal fat, obesity and high blood pressure.[22]

Almost



are **OVERWEIGHT OR OBESE** in *Remote* areas (compared with 64.4% in *Major Cities*).[28]





HIGH BLOOD PRESSURE

is more prevalent in rural areas, with **26.2%** of individuals in *Inner Regional* areas and **25.2%** in *Outer Regional* and *Remote* areas experiencing hypertension, compared to 22.4% in *Major Cities*.[29]

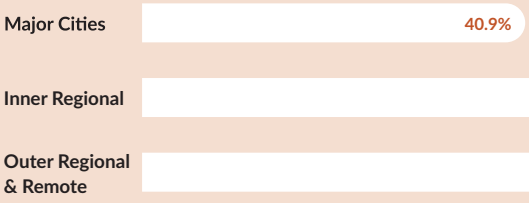
Statistics show that a greater proportion of rural Australians have

WAIST MEASUREMENTS

indicating an increased risk due to **excess abdominal fat**.[29]







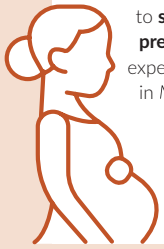
MOTHERS AND BABIES

The health of rural mothers and babies, over their lifetime, is also negatively impacted by more women **smoking during pregnancy**, more babies **being born prematurely**, and lower rates of **exclusive breastfeeding** (except in Indigenous infants).[30,iii]

Expectant mothers living in *Very Remote* areas are

5.5
TIMES MORE LIKELY

to **smoke during pregnancy** than expectant mothers in *Major Cities*.[30]



14.4%
OF BABIES BORN

in *Very Remote* areas are **pre-term**, compared with 8.1% of babies born in *Major Cities*.[30]



Exclusive breastfeeding rates for **6 months among**

FIRST NATIONS MOTHERS

varied across remoteness areas, from 41% of infants in *Very Remote* to 12% in *Major Cities*.[30]

iii. Throughout this document, data is age-standardised where accessible and appropriate and utilises the most recent source available prior to publication.

Figure 1.36 Rural Health in Australia Snapshot 2025 showing social determinants and health risk factors
Source: National Rural Health Alliance

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Actions to improve health status

Improving the health status of people living in rural and remote areas requires actions that target the main causes of disparity, including limited access to healthcare, workforce shortages, lower socio-economic status and geographical isolation. Advancements in technology have played a particularly important role in actions being taken to improve the health status of people living in rural and remote areas.

Activity 1.14

Actions being taken to improve health status

In groups select one of the following strategies or find your own strategy that addresses the health inequities of people living in rural and remote areas.

- Stronger rural health strategy: https://cambridge.edu.au/redirect/11383.
- Community First responder: https://cambridge.edu.au/redirect/11384.
- Outback futures: https://cambridge.edu.au/redirect/11385.
- Telehealth
- Artificial intelligence (AI) vision screening in remote communities: https://cambridge.edu.au/redirect/11386.
- Remote screening for cervical cancer: https://cambridge.edu.au/redirect/11387.

Create a summary page, infographic, PowerPoint, brochure or short clip to present to the class that summarises the action that is being taken to improve health status.

In your work, include the following sections:

a a brief overview including who funds and runs the action
b specific health inequities being targeted and how they are being targeted
c any statistics on the success of the program/strategy
d any suggestions for future directions.

Skills: research, communication, collaboration


Quiz

Revise and summarise 1.3

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Identify three of the major inequities experienced by people living in rural and remote areas.
2 Using a specific example, describe how the determinants of health interact to affect the health of people living in rural and remote areas.

Think critically and apply 1.3

1 Outline two actions that are being taken currently or could be undertaken to improve the health status of rural and remote Australians.
2 Perform the following activity in groups. For one of the groups experiencing health inequities, prepare a proposal to the federal government for increases in funding to target the health inequities experienced by the group. In your proposal, outline what determinants will be the main focus and what impact this will have on the health inequities. Also identify any major considerations or challenges.

Skills: collaboration, analysis, communication

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1.4 Health status of Australia compared with that of other OECD countries

Learning objective 1.4
COMPARE Australia's health status with other OECD countries.

In the previous sections of this chapter, we looked at disadvantaged groups within Australia. In this section we are going to be considering the overall health status of Australia.

The Organisation for Economic Co-operation and Development (OECD) is an international, intergovernmental organisation founded in 1961.

The OECD conducts independent analysis of a range of different policy and economic areas with the aim of establishing international standards and advising governments on how to 'build better policies for better lives'.

There are 38 member countries of the OECD, with Australia being an active member since 1971.

Other key member countries include New Zealand, Canada, the USA and Mexico.



Figure 1.37 OECD countries

Activity 1.15

Countries of the OECD

Consider the countries in the OECD.

1 Which country do you think would have the highest health status?
2 Why do you think that would be the case?
3 Which country do you think may have the lowest health status? What factors might contribute?
4 How do you think Australia compares with other countries in the OECD?
5 If you had to rank the countries based on health status, what measures would you use?

Skills: analysis

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OECD country rankings

The OECD draws on data from a broad range of areas to help establish solutions to economic, social and environmental issues. Health is one of the areas on which the OECD gathers and interprets data, and more recently the focus has shifted to wellbeing rather than levels of health.

Table 1.2 Comparison of five OECD countries across various health and other metrics

	Aus	Canada	NZ	USA	Mexico	OECD Average
Life expectancy	83 85 W 81 M	82 84 W 80 M	82 84W 80 M	79 81 W 76 M	75 78 W 72 M	81
Infant mortality	3.3	4.5	4.3	5.4	12.7	4.1
Life satisfaction	7.1	7	7.3	7	6	6.7
Disposable income (USD) *	37 433	34.421	39 024	51 147	16 269	30 490
Education – completes upper secondary	84%	92%	81%	92%	42%	79%
Literacy, maths and science ***	499	571	503	495	416	488
Employment	73%	70%	77%	67%	59%	66%
Very long work hours		3%	14%	10%	27%	10%
Perceived health status **	85	88.3	88.4	86.4		68.5
% population overweight or obese 15+	64	59.8	68.1	73.1	74.1	59.4
Tobacco – daily smokes 15+	8.5	8.7	8	8.8	8.6	15.7
Vaping – regular users 15+	5.7	4.7	10.3	4.5		3.4
Work-life balance	4.4	6.5	5.2	4.9	0.4	

*The average household net-adjusted disposable income per capita
** Proportion of population who perceive their health as good/very good, aged 15 years old and over, 2022
***Student score in reading literacy, maths and science in the OECD's Programme for International Student Assessment (PISA)

Activity 1.16

Country comparison

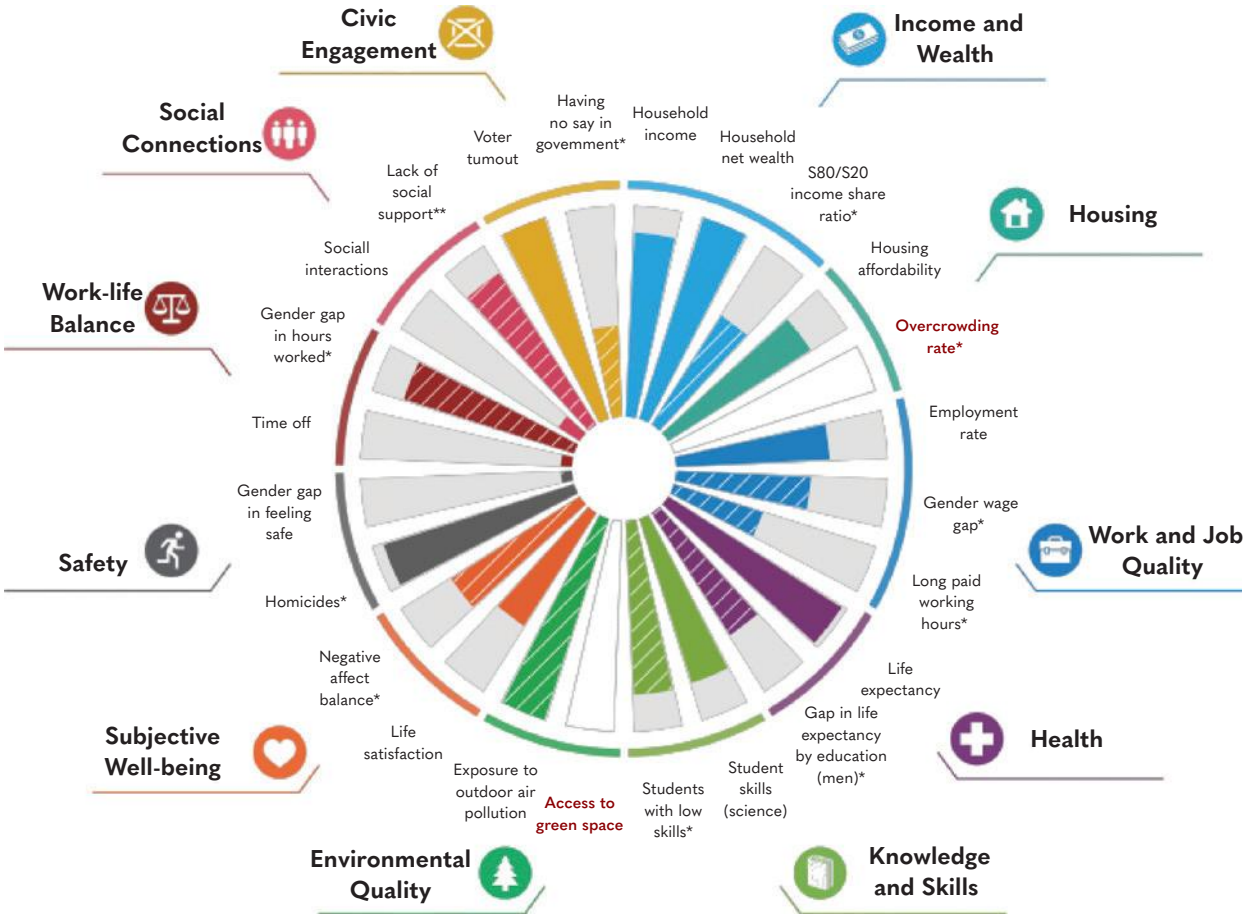
1 Looking at Table 1.2, which would you consider to be the country with the highest health status? Why?
2 Do you think other people would have a different opinion? Why?
3 Discuss the connection between education, employment and health.

Skills: analysis

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How's Life in AUSTRALIA?

Australia's current well-being, 2022 or latest available year



This chart shows Australia's relative strengths and weaknesses in well-being compared to other OECD countries. Longer bars always indicate better outcomes (i.e. higher well-being), whereas shorter bars always indicate worse outcomes (lower well-being) – including for negative indicators, marked with an *, which have been reverse-scored. Inequalities (gaps between top and bottom, differences between groups, people falling under a deprivation threshold) are shaded with stripes. Indicators in dark red refer to missing data for the indicator for the country, but are indicators otherwise available in the How's Life database.

Figure 1.38 Australia's relative strengths and weaknesses in wellbeing compared with other OECD countries

Activity 1.17

Australia's ranking

Why do you think Australia has the ranking it has? Divide the various indicators up between the class and research and propose reasons for their ranking. Discuss your results as a class.

Skills: collaboration, analysis

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Better Life Index

As part of the OECD's Better Life Initiative, the Better Life Index was established. Using 11 different topics and a variety of different measures that are essential to wellbeing, the Better Life Index provides a comparable picture of wellbeing.



Video 1.2 How to use the Better Life Index website. (02:15)

Video 1.2 The OECD Better Life Index provides a comparable picture of wellbeing. Scan the QR code to watch a video tutorial.

Activity 1.18

Better Life Index

1 Go to the Better Life Index at https://cambridge.edu.au/redirect/11388. Adjust the topics according to what is most important to you for wellbeing. How does Australia rate in those areas? Adjust the settings and consider the movement of various countries. Compare your rankings with those of another member of your class and discuss similarities and differences in how you ranked your topics.

2 Go to Australia's page at https://cambridge.edu.au/redirect/11389. Do you think this is an accurate reflection of the wellbeing of Australia? Pick two countries and compare their health statuses and contributing factors with those of Australia.

Skills: analysis, research



Figure 1.39 Australia does well in many of the Better Life Index topics, including health, environment and civic engagement

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Other country rankings compared with Australia

Australia tends to rank quite well in health outcomes compared with other OECD countries, maintaining above average scores in most areas, including life expectancy, general accessibility of healthcare and perceived health status, as can be seen in Table 1.2. Although Australia ranks well in most areas, there are definite areas for improvement, such as obesity rates and mental health outcomes.

Factors that lead to Australia ranking higher than some other countries

Some of the factors that contribute to Australia's ranking include:

- **Medicare:** Medicare is Australia's universal healthcare system, which ensures access to healthcare for all Australian citizens. This is unlike countries like USA and Mexico that do not have universal healthcare and therefore have higher individual costs and disparities in access to healthcare among citizens.
- **Public health:** Australia has successfully implemented many health promotion and public health campaigns and initiatives that contribute to positive health outcomes like lower smoking rates. These include immunisation programs, cancer screening programs, anti-smoking campaigns and road safety.
- **High-quality healthcare:** Australia's healthcare system is well established, with a strong focus on primary care. All Australians have access to this care through Medicare. This differs from countries such as Mexico and Turkey, which have less developed healthcare systems.
- **Standard of living:** Australia generally has a relatively high standard of living, with most Australians having access to clean water, nutritious foods, sanitation and education. While there are some disparities among socio-economic groups, the general experience of life is higher than that of countries such as Mexico that have higher levels of poverty and less developed infrastructure. Disposable income is also above the OECD average and more than double that of Mexico, Colombia and Turkey.
- **Education and employment:** All Australians have access to primary and secondary education, which is important for employment. Australians have high completion rates for upper secondary education and a high employment rate. These are both socio-economic contributors to good health outcomes.
- **Humanitarian factors:** Additional factors that may contribute to countries being ranked lower than Australia include circumstances like political instability and war. For example, Afghanistan has faced decades of conflict, international intervention, occupation, and now authoritarian rule under the Taliban, all of which have contributed to a humanitarian crisis.

Factors that lead to Australia ranking lower than some other countries

Countries that rank higher than Australia include:

- **Japan and Switzerland:** Countries like Japan and Switzerland often rank higher than Australia in life expectancy and other health metrics. Japan's high life expectancy is attributed to its diet, low obesity rates, and strong social cohesion. Switzerland benefits from a highly efficient healthcare system and high levels of wealth, contributing to excellent health outcomes.
- **Nordic countries (e.g. Norway, Sweden):** These countries often perform better in areas such as mental health and overall wellbeing due to strong social welfare systems, low inequality, and emphasis on preventive healthcare.



Figure 1.40 Japan's high life expectancy is partly attributed to diet.

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Features of other OECD countries that could be applied in Australia

New Zealand – Indigenous health

The government of New Zealand has a strong commitment to the health of Māori people. The government recognises the importance of the involvement of Māori in all levels of planning, decision making and the development and delivery of services. Its most recent strategy highlights the importance of collective action in working towards achieving health equity for Māori. This includes working with *iwi* (tribes), *hapū* (sub-tribes kinship groups), *whānau* (family groups) and Māori communities. These are all concepts that could be applied to the health of First Nations Peoples in Australia.

Italy – active and healthy ageing

In response to the World Health Organization's call to focus on healthy and active ageing, Italy has adopted an inclusive approach to active ageing and established active ageing as a fundamental human right. The National Plan for Active Ageing focuses on promoting the wellbeing and quality of life of older adults. The plan includes initiatives aimed at improving access to healthcare, social services, lifelong learning opportunities, and encouraging active participation in the workforce and community life. In addition, they have established regional laws relating to active ageing. The laws are supported by funding and cover a broad range of areas, which include the labour force, volunteering, sport and leisure activities, cultural activities, housing, safety and the environment.

This proactive and practical approach to managing an ageing population is one that is highly applicable to the Australian context, as Australia's population experiences similar demographic challenges. Its holistic and multifaceted approach is one that would benefit all health-promotion activities.

Canada – spending on public health

Public health includes programs, services and policies that aim to promote health and prevent illness, injury and disease. Public health can include things such as:

- vaccination programs
- health promotion campaigns
- road safety, education and awareness.

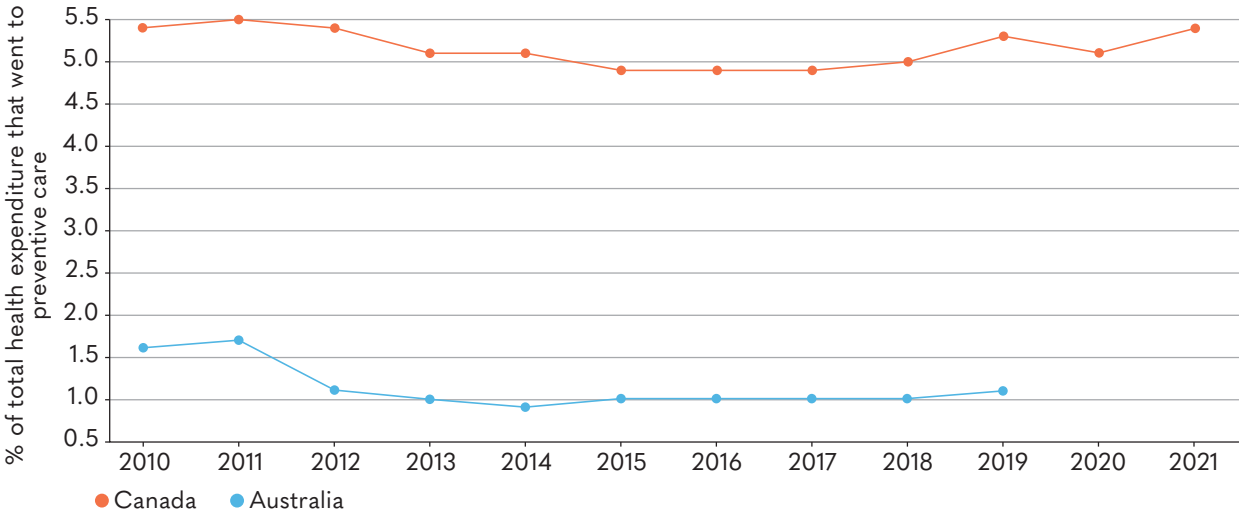


Figure 1.41 Spending on preventive healthcare from 2010–21 in Australia and Canada

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For the past 15 years, Canada has consistently been one of the biggest spenders on preventive health, with health expenditure more than double that of Australia and most other OECD countries. This investment in health continues to be made an area of priority and a key focus of local, regional and national health authorities.

A shift in funding and focus is of particular importance to the Australian context due to our growing and ageing population and the high rates of mortality and morbidity due to preventable causes.

An increased investment in public health and a shift away from curative care can significantly improve health outcomes in the future. It could lead to reduced avoidable mortality from preventable causes, greater healthy ageing and better quality of life. This sort of focus also proves to be the most cost-effective in the long term, resulting in reduced healthcare spending.

Estonia – digital health

Estonia stands out as a leader in digital healthcare, with its fully integrated e-Health solutions woven into the nation's medical infrastructure. The Estonian National Health Information System (HIS) launched in 2008 and was a forerunner in digital healthcare. The HIS system connects healthcare providers across the country, providing easy access to critical health information. Within a secure, centralised database, documents including summaries of medical visits, treatment records, discharge notes, referrals, diagnostic study reports and details of medical procedures are stored.

As well as collecting general health data, the Estonian Genome Centre has collected genomic data from over 200 000 individuals, which is a valuable tool for advancing personalised medicine. By integrating genomic data with the health information stored in HIS, healthcare professionals can offer tailored diagnoses and treatments based on individual genetic profiles. This synergy not only increases the effectiveness of medical interventions but also highlights the precision medicine capabilities enabled by Estonia's e-Health technologies. This unified and comprehensive approach to patient care is one that can be applied to the Australian context more deeply.

Revise and summarise 1.4


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What is the OECD?
2 What measures does the OECD use to determine the rankings of countries?
3 How does Australia rank in comparison to New Zealand, Canada, the USA and Mexico?
4 Why are the countries above ranked higher or lower than Australia? Give two reasons for each.

Think critically and apply 1.4

Conduct a class debate on one of the following topics. Alternatively, have students write a written response to one of the following questions:

1 Should Australia adopt health policies or practices from other OECD countries to improve its health outcomes?
2 Is comparing health status between countries always fair or meaningful? Why or why not?

Skills: communication, analysis

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1.5 Chronic conditions, diseases and injury in Australia

Learning objective 1.5
EXAMINE chronic conditions, diseases and injury in Australia.

The syllabus requires you to examine three chronic conditions, diseases and injuries in Australia. These are cardiovascular disease, cancer and one other. The third condition we will be looking at in this section is diabetes.

Depth Study

Cardiovascular disease

Cardiovascular disease (CVD) is a broad term used to describe all conditions and diseases of the heart and blood vessels. There are three main types of CVD in Australia.

- **Coronary heart disease** (also called ischaemic heart disease). This is the most common type of CVD. It takes two main forms:
  - Angina – a temporary loss of blood supply to the heart, which results in periodic chest pain. Angina is not life threatening and can generally be controlled with medication.
  - Heart attack – results from a sudden blockage to the heart's blood supply, which causes damage to the heart and its function.
- **Stroke**. A stroke occurs when there is a blockage in the vessels that supply blood to the brain or those vessels rupture and begin to bleed.
- **Peripheral vascular disease**. This occurs when the arteries that supply blood to the peripheries (e.g. the legs and arms) are obstructed. In severe cases, this can lead to gangrene and amputation.

atherosclerosis a condition where plaque forms on the inside of arteries

In the majority of CVDs, the main underlying cause is **atherosclerosis**. Atherosclerosis is the build-up of fatty and fibre-like deposits on the inside walls of the arteries. This build-up results in the wall of the artery becoming harder and less elastic (arteriosclerosis). As the plaque thickens the walls of the artery, the diameter of the blood vessel decreases, resulting in an increase in blood pressure. These build-ups of plaque take place progressively over a long period of time, and can occur in any artery in the body, but are most dangerous when they are located in the arteries that supply the heart, brain or legs. A blockage of the artery can occur if a piece of the plaque breaks off or a blood clot forms, resulting in a stroke, heart attack, gangrene or other condition.

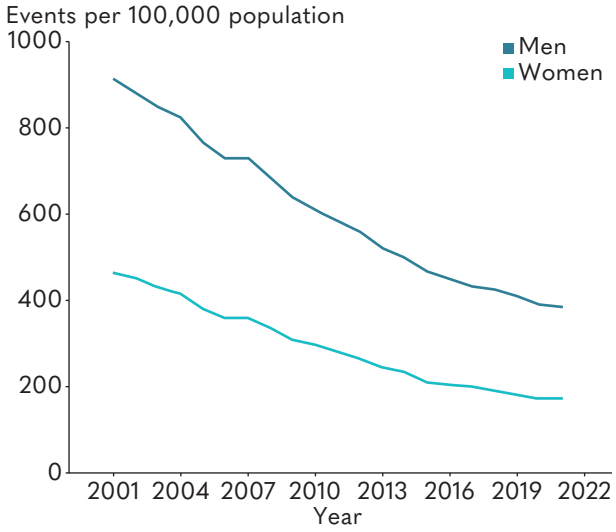
What does the data tell us?

Morbidity, prevalence and incidence

CVD affects a significant proportion of the population, with approximately 6.7% of adult Australians living with one or more conditions related to CVD in 2022–23. Every day in Australia there are around 112 stroke events and 157 acute coronary events such as heart attack or unstable angina. CVD predominantly affects older Australians with one in four people over the age of 75 affected. CVD is more common in men than in women, with 7.6% of men and 5.8% of women having one or more conditions.

Differences exist among population groups, with rates of heart stroke and vascular disease 2.1 times higher among Aboriginal and Torres Strait Islander Peoples than in the general population. While the prevalence of heart, stroke and vascular disease did not vary significantly between socio-economic groups or geographical location, lower SES areas and remote areas both experienced higher rates of hospitalisations and death rates when compared with high SES areas and metropolitan areas.

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Notes
1. Age-standardised to the 2001 Australian standard population.
2. Acute coronary events include heart attack (acute myocardial infarction) and unstable angina.

Figure 1.42 Acute coronary events among persons aged 25 years and over, by sex, 2001–21
Source: Australian Institute of Health and Welfare. Chart: AIHW. Sources: AIHW National Hospital Morbidity Database and AIHW National Mortality Database.

Activity 1.19

Acute coronary events

View Figure 1.42.

1 What are acute coronary events?
2 What difference is there in the rate of acute coronary events between men and women? Propose some reasons for the difference.

Skills: analysis

Mortality

CVD is a significant contributor to mortality in Australia. In 2022, CVD was the underlying cause of 24% of all deaths in the Australian population.

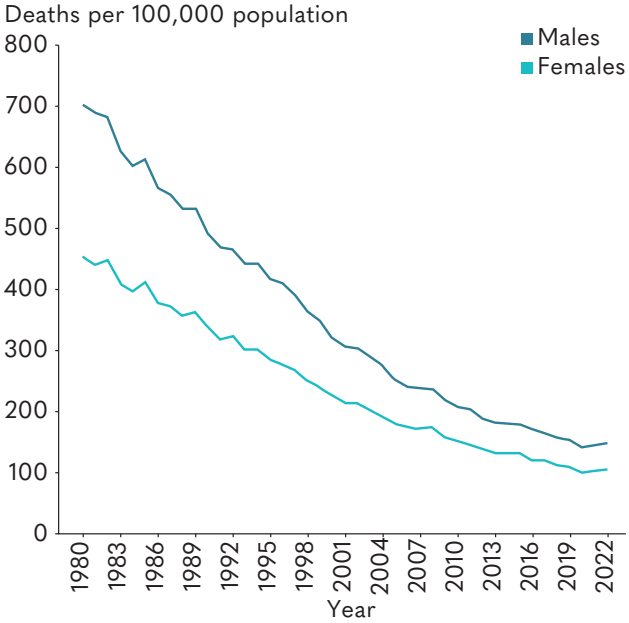


Figure 1.43 Cardiovascular disease death rates, by sex, 1980–2022. Chart: AIHW. Source: AIHW National Hospital Mortality Database

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Activity 1.20

Mortality from CVD

Figure 1.43 shows the continued decrease in death rates from CVD since the 1980s. This decrease has been due largely to improvements in public health and advancements in prevention and treatment.

1 Research one major development in treatment or one major health promotion campaign that may have directly contributed to the reduction in death rates.
2 Propose reasons for the slight increase in deaths in 2022.

Skills: research, analysis

Risk and protective factors for CVD

CVD is a largely preventable disease with many of the risk and protective factors being modifiable.

Risk factors

Risk factors include:

- **Smoking:** smoking causes damage to blood vessels as the smoke is absorbed into the bloodstream. It increases the formation of clots and plaques and decreases oxygen levels in the blood.
- **High blood pressure:** the risk of an acute coronary event is directly related to blood pressure.
- **Abnormal blood lipids:** abnormal blood lipids such as high cholesterol or triglycerides can increase the likelihood of atherosclerosis.
- **Diabetes:** diabetes increases blood sugar levels and over time can damage the blood vessels in the heart, increasing the risk of fatty deposits.
- **Overweight and obesity:** a high percentage of body fat increases the risk of high blood pressure, abnormal blood lipids and type 2 diabetes, which are all risk factors for CVD. High body mass also puts greater strain on the heart.
- **Age:** the likelihood of developing CVD increases with age.
- **Physical inactivity:** inactivity contributes to weight gain and high blood pressure.
- **Poor diet:** a diet high in salt, saturated fats and sugar can increase the risk of high cholesterol, abnormal blood lipids, high blood pressure, type 2 diabetes and overweight and obesity, which are all contributing factors to CVD.
- **Heredity:** a family history of CVD may mean an increased likelihood of developing CVD.

Protective factors

On the other hand, individuals can reduce their risk of developing CVD by maintaining a healthy, balanced diet, meeting the recommended physical activity guidelines and getting regular checks if they have a family history of CVD or any heart or vascular conditions.

Changing conditions

As seen in Figure 1.43, declines in death rates have remained fairly consistent since the 1960s.

In the period between 2000–01 and 2020–21, however, there was an increase in hospitalisations by 38% but a continued decrease in death rates by 16% in that same period of time. Similar rates of decline between males and females were evident, with males maintaining higher rates than females.

Activity 1.21

CVD

Go the AIHW website and visit the web report titled *Heart, stroke and vascular disease: Australian facts:* https://cambridge.edu.au/redirect/11390.

1 Explore the interactive graphs and record four interesting facts relating to prevalence and incidence rate trends within Australia.
2 Consider the death rates and prevalence rates of CVD among at least two different groups experiencing inequities in health.
3 Record two interesting facts for each group based on the data. Share your findings with the class.

Skills: analysis

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Depth Study

Cancer

Cancer is a group of diseases caused by the uncontrolled growth and multiplication of mutated body cells. Normally, cells grow in a regulated manner, but when a cell mutates, it can form masses called **tumours**. Tumours can be:

- **Benign**: localised, non-threatening and removable through surgery.
- **Malignant**: uncontrolled growth that invades surrounding tissues. If untreated, malignant cells can spread through the bloodstream to other body parts, a process called **metastasis**, resulting in secondary cancer.

Cancers are classified based on their origin, such as lung or breast cancer, regardless of whether they spread.

The exact causes of cancer are not fully understood, but certain agents, known as carcinogens, can trigger mutations. These include tobacco, ultraviolet radiation, chemicals, pollution and asbestos.

What does the data tell us?

Morbidity, prevalence and incidence

In Australia an average of 450 new cases of cancer were diagnosed every day in 2023, with the most common being:

Males:
1 prostate
2 melanoma of the skin
3 colorectal
4 lung

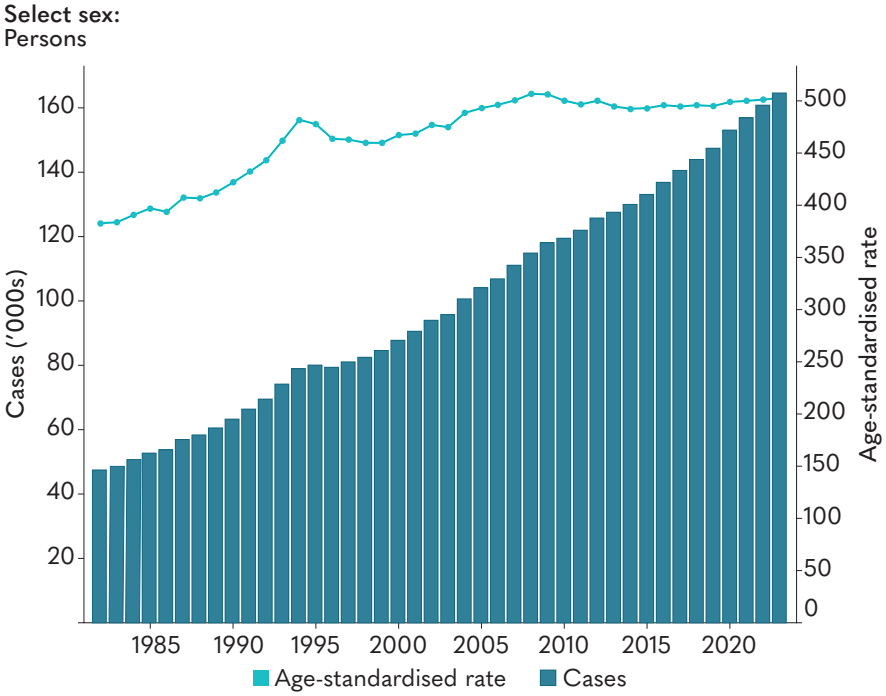
Females:
1 breast
2 melanoma of the skin
3 colorectal
4 lung

benign localised and not cancerous

malignant cancerous and has ability to spread to other parts of the body

metastasis the spread of cancer cells from the place where they first formed to another part of the body

As can be seen in Figure 1.44, incidence rates for cancer saw an increase during the period from 1982 to 2008 and then have remained fairly stable since then.



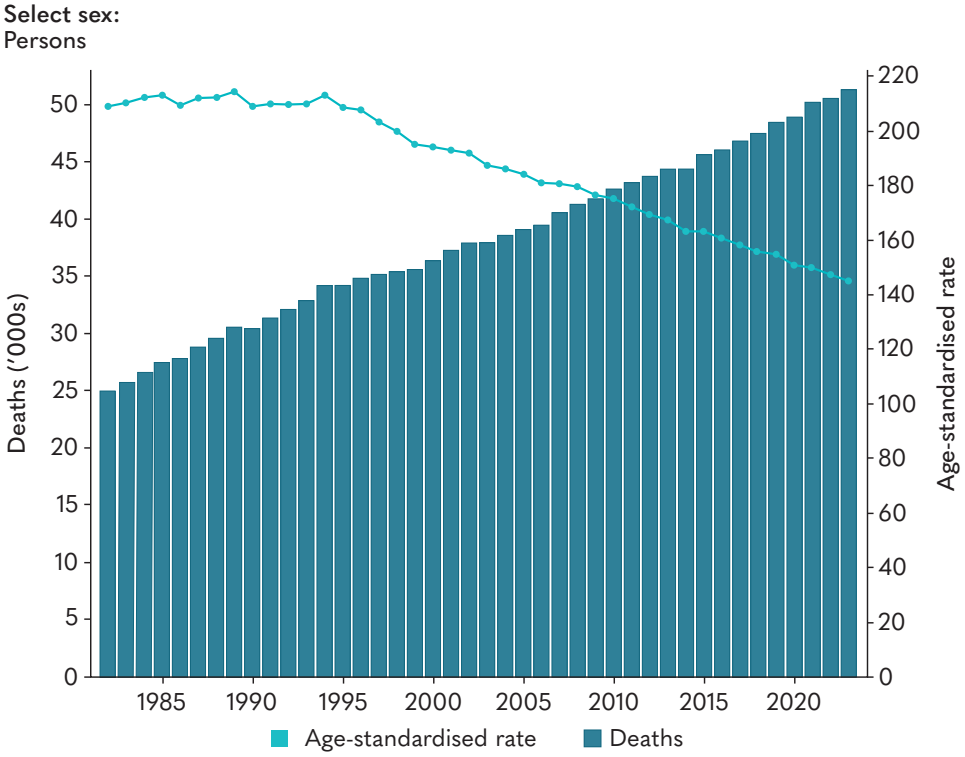
Notes:
1. Age-standardised rates are presented as cases per 100,000 of the selected sex (for example, if persons is selected, the rate will be cases per 100,000 persons) using the 2001 Australian Standard Population.
2. Cases and rates for 2020, 2021, 2022 and 2023 are based on projections.

Figure 1.44 Cancer cases and age-standardised incidence rates, by sex, 1982–2023
Source: Australian Institute of Health and Welfare. Source: Australian Cancer Database 2019.

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Mortality

In terms of mortality, cancer accounts for around three of every 10 deaths. This rate has increased since the 1970s but now remains relatively stable. Death rates from cancer vary significantly by age, with cancer contributing to around 45% of deaths in the 60–69 age group. This, in conjunction with Australia's growing and ageing population, has led to increases in cancer cases and deaths, with new cancer cases increasing by 88% between 2000 and 2023 and cancer-related deaths increasing by 41% for the same timeframe.



Notes:
1. Age-standardised rates are presented deaths per 100,000 of the selected sex (for example, if persons is selected, the rate will be deaths per 100,000 persons) using the 2001 Australian Standard Population.
2. Deaths and mortality rates for 2022 and 2023 are based on projections.

Figure 1.45 Cancer-related deaths and age-standardised mortality rates, by sex, 1982–2023
Source: Australian Institute of Health and Welfare. Source: National Mortality Database.

Activity 1.22

Cancer rates

Analyse Figures 1.43 and 1.44.

1 Discuss the trends in cancer rates and propose reasons for the increases in incidence rates of cancer since the 1980s.
2 Explore the Australian Institute of Health and Welfare's health topic summary on cancer and add any additional reasons that may have been missed: https://cambridge.edu.au/redirect/11391.
3 Discuss the correlation between improvements in screening programs and increased incidence rates of cancer.
4 Analyse the trends in cancer mortality rates. Propose reasons why even though there is an increase in the number of deaths, there is a decrease in the age-standardised death rate.

Skills: research, analysis

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Risk and protective factors for cancer

As with CVD, the risk factors for cancer can be divided into two categories: those that are modifiable and those that are non-modifiable. Risk factors vary depending on the type of cancer.

Skin cancer

The main cause of skin cancer is exposure to UV radiation. In most cases, this is from exposure to the sun; however, in some cases it may include exposure to radiation from sources such as solariums. There are a number of other factors that have been associated with an increased risk of skin cancer. They include:

- exposure to sun during childhood
- having a fair complexion, light-coloured, blond or red hair and/or fair skin that freckles or burns easily
- a family history of melanoma
- having several large or many small moles.

Protective factors for skin cancer include monitoring moles and freckles, and limiting exposure to the sun (especially during times of peak UV radiation) by wearing sunscreen, a hat, protective clothing and sunglasses.



Figure 1.46 Features of normal moles and cancerous moles. A protective factor for skin cancer is monitoring of moles and freckles.

Activity 1.23

Modifiable and non-modifiable risk factors

Class discussion: Which of the above risk factors relating to skin cancer are modifiable and which are non-modifiable? To what extent?

Skills: collaboration

Breast cancer

A number of factors are associated with an increased risk of breast cancer – that is, they are more common in women with breast cancer than those without. These factors are not necessarily 'causes' of breast cancer, but may be signs that someone has an increased likelihood of developing the disease.

The major risk factor for breast cancer is, of course, gender. Increasing age is also one of the strongest risk factors, with the risk increasing from one in 250 at the age of 30 to one in 30 for a woman over the age of 70. Women who have a close family relative – mother, sister or daughter – with breast cancer are twice as likely to develop breast cancer as compared with someone who does not have a close relative with breast cancer. As well as the non-modifiable factors just mentioned, some risk factors are related to lifestyle choices, and include being overweight or obese, consuming over three alcoholic drinks per day and a later maternal age (over 40 years).

Protective factors for breast cancer include practising regular self-examination and having regular mammograms when over the age of 50, as well as leading a healthy lifestyle, including being physically active, eating a balanced diet and not drinking excessive amounts of alcohol.

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Lung cancer

The most obvious risk factor for lung cancer is smoking. The younger the age at which a person begins to smoke and the longer a person has been smoking, the higher the chance of developing lung cancer. Other factors that may contribute to a higher risk include occupational exposure to carcinogens such as asbestos and lead, and exposure to pollution and second-hand smoke.

Protective behaviours against lung cancer include not smoking and quitting smoking. The risk of developing lung cancer drops by up to 50% once a decade elapses after a person quits smoking. Avoiding exposure to hazardous materials such as asbestos also decreases the chance of developing lung cancer.

Prostate cancer

Prostate cancer affects only men and is one of the cancers which is most closely linked to genetics.

Men who have a close relative with prostate cancer may be two times as likely to develop the disease, while those with two or more relatives may be nearly four times as likely. As men age, the risk of prostate cancer increases, with the chance of developing prostate cancer increasing significantly from the age of 50. Protective factors predominantly relate to awareness and include an acknowledgement of family history, which leads to increased and earlier screening.

Colorectal cancer / bowel cancer

Bowel cancer is one of the top five most diagnosed cancers in men and women. Risk of developing bowel cancer increases with age, with those over 50 at much greater risk. A history of inflammatory bowel disease such as Crohn's disease or polyps in the bowel can also increase risk. Other contributing factors can include a significant family history of bowel cancer, excess body fat and low physical activity levels, smoking, high alcohol consumption and type 2 diabetes.

Protective factors include maintaining a healthy body, regular physical activity, reduced consumption of processed meat, red meat and alcohol, regular screening, and a diet high in wholegrains, dietary fibre and dairy foods.



Figure 1.47 A doctor explains a colonoscopy screening for bowel cancer

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Changing conditions

Activity 1.24

Changing conditions

1 Divide students into small groups and assign each group a specific cancer type (e.g. breast, prostate, lung, melanoma).
2 Using Figures 1.43 and 1.44 and Table 1.3, the most recent release of the biennial *Australia's health* report on the AIHW website, and any other relevant information, students are to research the trends relating to their particular type of cancer. Provide data on:
   - trends in incidence and mortality rates by location (urban vs. rural) and demographics (age, gender, socio-economic status, etc.)
   - trends over the last decade (increasing or decreasing incidence and mortality rates)
   - survival rates and contributing factors (screening programs, access to care).

Create a summary of the information including:
- the key trends for the assigned cancer type
- comparison of how cancer rates vary by location and demographic group
- potential reasons for these differences (access to healthcare, lifestyle factors, public health campaigns)
- present the findings in a one-page summary, infographic or slide show.

Extension/student reflection
3 Research the effectiveness of national screening programs (e.g. BreastScreen Australia, National Bowel Cancer Screening Program).
4 Propose an initiative to reduce disparities in cancer outcomes for a specific demographic or region.

Skills: collaboration, research, analysis

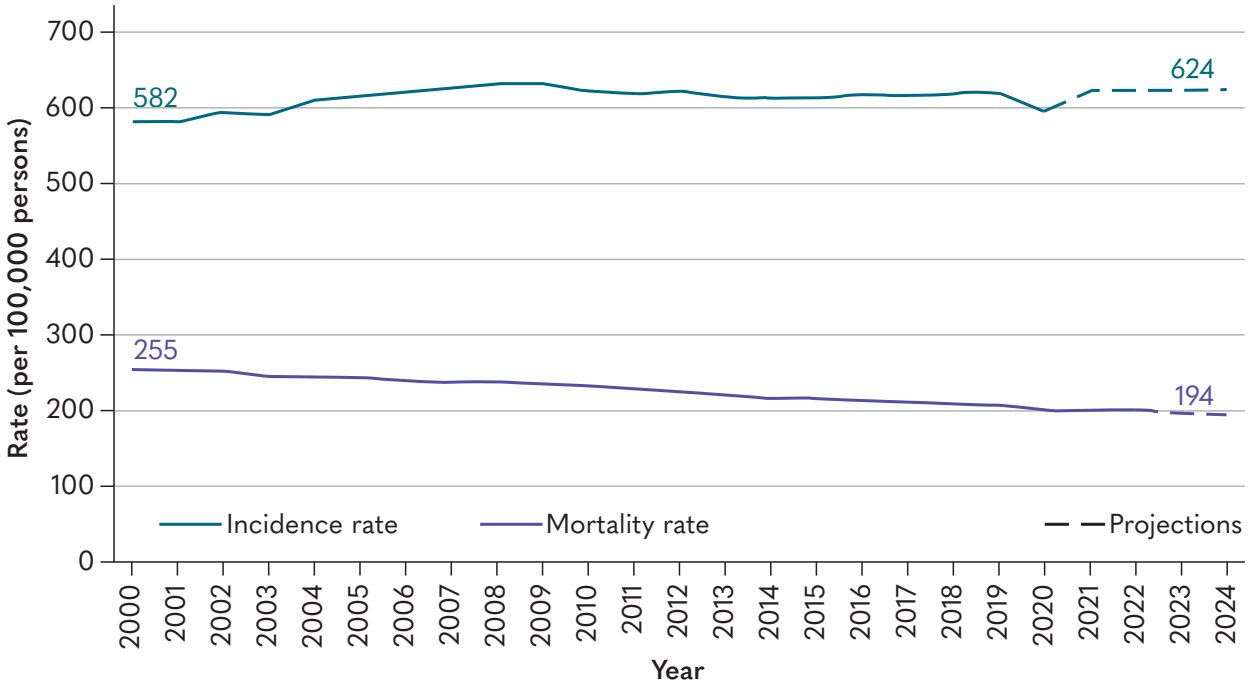


Figure 1.48 Age-standardised cancer incidence and mortality rates, 2000–24
Source: AIHW Australian Cancer Database 2020 and National Mortality Database

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Table 1.3 Change in cancer incidence rates (cases per 100 000 people), selected cancers, 2000–24

Cancer type / group	People aged 30 to 39			People aged 40 to 49		
	Rate in 2000	Rate in 2024	Change in rates	Rate in 2000	Rate in 2024	Change in rates
Breast cancer	22.1	23.0	0.9	76.6	85.6	9.0
Cervical cancer	5.5	8.0	2.5	5.6	8.5	2.9
Colorectal cancer	6.3	17.2	10.9	24.9	29.9	5.0
Kidney cancer	2.0	3.7	1.7	7.0	11.6	4.6
Liver cancer	0.3	0.5	0.2	2.1	2.4	0.3
Lung cancer	2.1	2.1	0.0	11.4	9.4	-2.0
Melanoma of the skin	31.4	23.6	-7.8	50.5	52.2	1.7
Pancreatic cancer	0.5	1.5	1.0	3.2	5.2	2.0
Prostate cancer	0.1	0.3	0.2	4.9	11.6	6.7
Testicular cancer	7.3	9.9	2.6	4.1	5.6	1.5
Thyroid cancer	7.0	16.8	9.8	9.6	20.8	11.2
Uterine cancer	1.2	2.9	1.7	5.3	8.3	3.0
All cancers combined	120.5	141.1	20.6	280.1	323.2	43.1

Source: AIHW Australian Cancer Database 2020

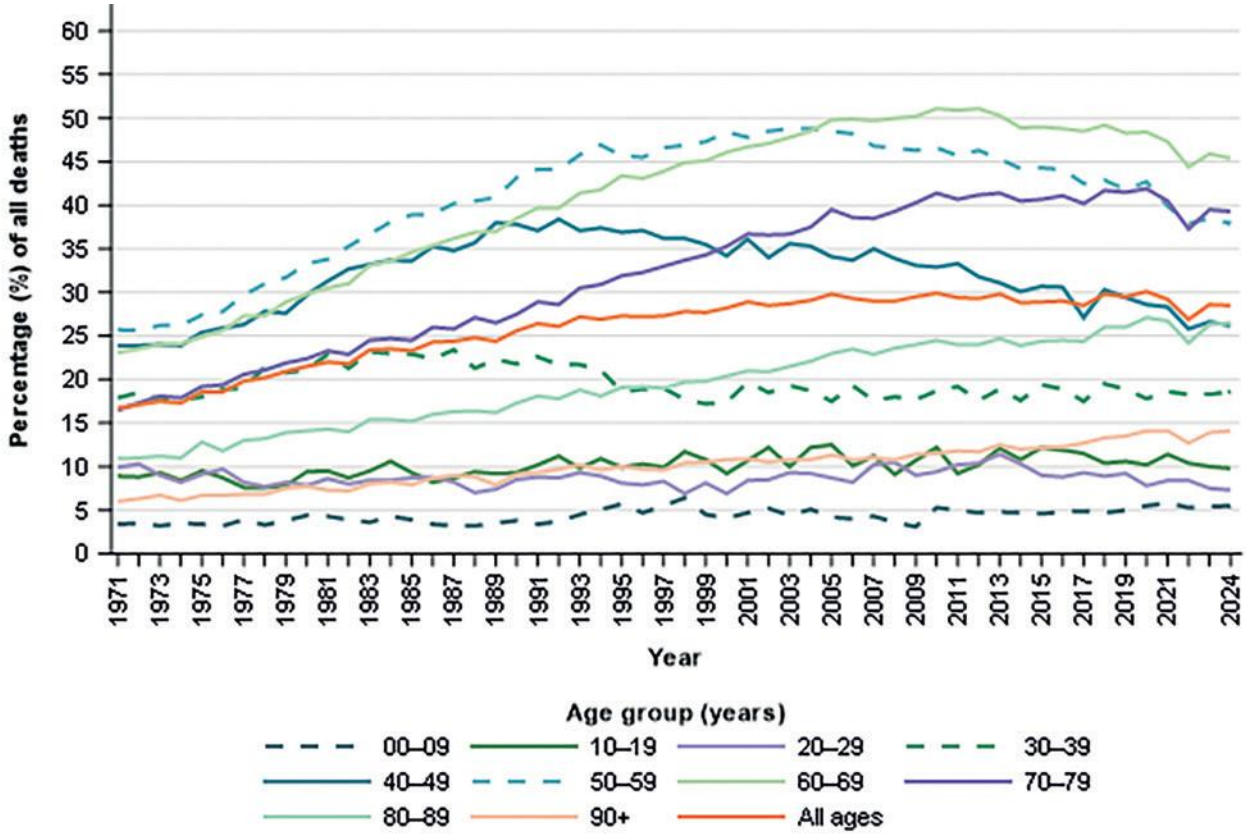


Figure 1.49 Percentage of deaths from cancer, by age group, 1971–2024
Source: AIHW, data from National Mortality Database

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Depth Study

Diabetes

In order to function, our body requires energy from food. To be able to use the energy from food, it must be processed by our body and converted into a form that our cells can use. In people who suffer from diabetes, there is a breakdown in this process.

When we eat, our stomach and small intestines break down the carbohydrates found in food and convert them into a type of sugar called glucose. This glucose is then absorbed into the bloodstream, ready to be either used for energy or stored in our body for later use.

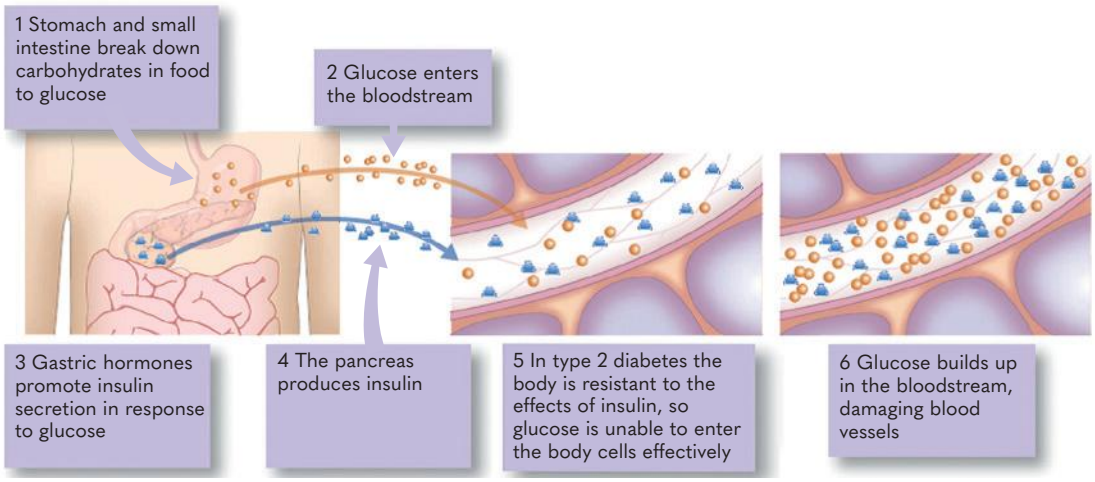


Figure 1.50 Pathology of diabetes

Insulin is a hormone made in the pancreas that is released in response to eating. Insulin enables the glucose to move from the bloodstream into the cells. If there is not enough insulin being produced in the pancreas, or the insulin being produced is ineffective, then the glucose cannot move into the cells to be used for energy, and instead remains circulating in the blood. This condition is called diabetes.

There are three different types of diabetes:

- **Type 1 diabetes (insulin-dependent diabetes mellitus):** In type 1 diabetes, the pancreas does not produce enough insulin or it does not produce any at all. This type of diabetes has a strong family link and cannot be prevented.
- **Type 2 diabetes (non-insulin diabetes):** Type 2 diabetes is the most common form of diabetes and affects 85–90% of all people with diabetes. In this type of diabetes, the body produces insulin but the amount produced is insufficient or ineffective. Type 2 diabetes is the result of a combination of lifestyle, genetic and environmental factors and in over 50% of cases can be prevented. While there is a strong genetic predisposition, the risk of developing diabetes is greatly increased by factors such as high blood pressure, overweight or obesity, poor diet and a lack of physical activity. There is no cure for type 2 diabetes, but in most cases, it can be managed with healthy eating and exercise in the early stages. As time progresses, it may become necessary to take tablets or have insulin injections to help control the condition. In many cases, people will not experience any symptoms but when they do have symptoms, these will be the same as for type 1 diabetes.
- **Gestational diabetes:** This is a form of diabetes that occurs during pregnancy. Pregnant women require two or three times more insulin than normal. If the body cannot produce enough insulin, then gestational diabetes develops. In many cases, it disappears after birth but increases the risk of the woman developing type 2 diabetes.

Diabetes can result in a range of short- and long-term complications, and these are the major causes of deaths and hospitalisations among people with the disease. Short-term complications are medical emergencies and include diabetic ketoacidosis (which can result from a severe lack of insulin in those with type 1 diabetes) and hypoglycaemia (low blood glucose, which is a complication of treatment). These conditions can be life threatening.

Long-term complications of diabetes develop over several years, and include disease of the large blood vessels (macrovascular disease), which may lead to conditions such as coronary heart disease, stroke and peripheral vascular disease; and disease of the small blood vessels (microvascular disease), which can cause chronic kidney disease, nerve damage and loss of vision.

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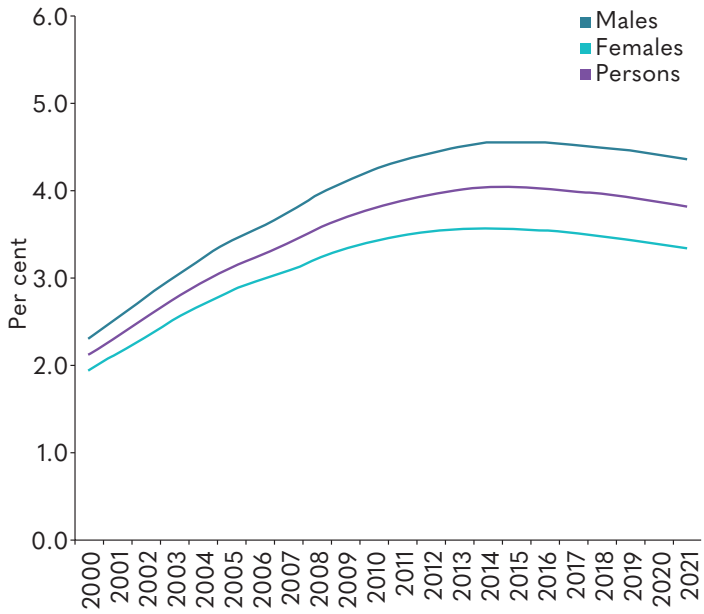
What does the data tell us?

Morbidity, prevalence and incidence

As can be seen in Figure 1.51, the prevalence of diabetes has increased significantly over the past few decades, increasing by almost a factor of three between 2000 and 2021. In 2021, one in 20 Australians were living with diabetes. This number, despite being high, may be an underestimation as it is based on confirmed medical diagnosis. Multiple Australian studies have revealed a significant number of Australians living with undiagnosed type 2 diabetes.

Prevalence rates for diabetes are higher among:

- males (1.3 times more than females)
- Aboriginal and Torres Strait Islander Peoples
- older age groups.



Notes:
1. Age-standardised to the 2001 Australian standard population.
2. Includes persons with missing or unassigned information on age and/or sex.

Figure 1.51 Prevalence of type 2 diabetes from the linked NDSS and APEG data, by sex, 2000–21
Source: Australian Institute of Health and Welfare

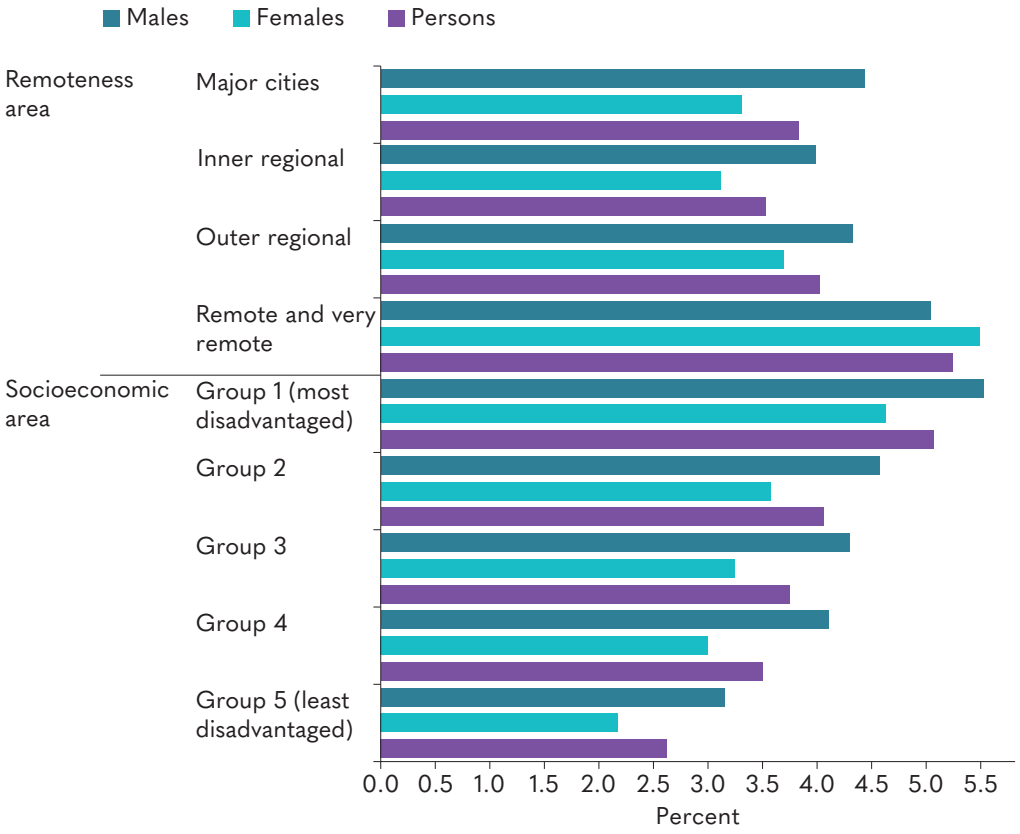
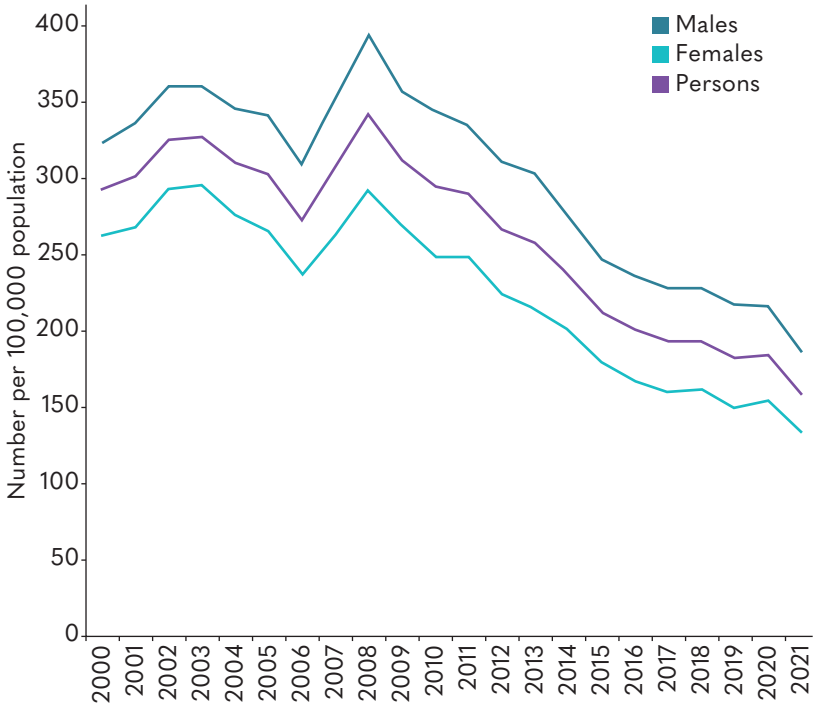


Figure 1.52 Prevalence of type 2 diabetes, by selected population group and sex, 2021
Source: Australian Institute of Health and Welfare

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As seen in Figure 1.53, incidence rates for diabetes have been decreasing over the past two decades, with approximately 175 individuals a day diagnosed in 2021. Incidence rates for diabetes in 2021 were higher among older Australians, with the highest rates in the 65–69 age group. Incidence rates were higher among males.

Due to the nature of the disease, diabetes is often accompanied by other conditions. This is called comorbidity or multimorbidity. Figure 1.54 shows the common conditions associated with diabetes.



Notes:
1. Age-standardised to the 2001 Australian standard population.
2. Includes persons with missing or unassigned information on age and/or sex.

Figure 1.53 Incidence of type 2 diabetes, by age and sex, 2000–21
Source: Australian Institute of Health and Welfare

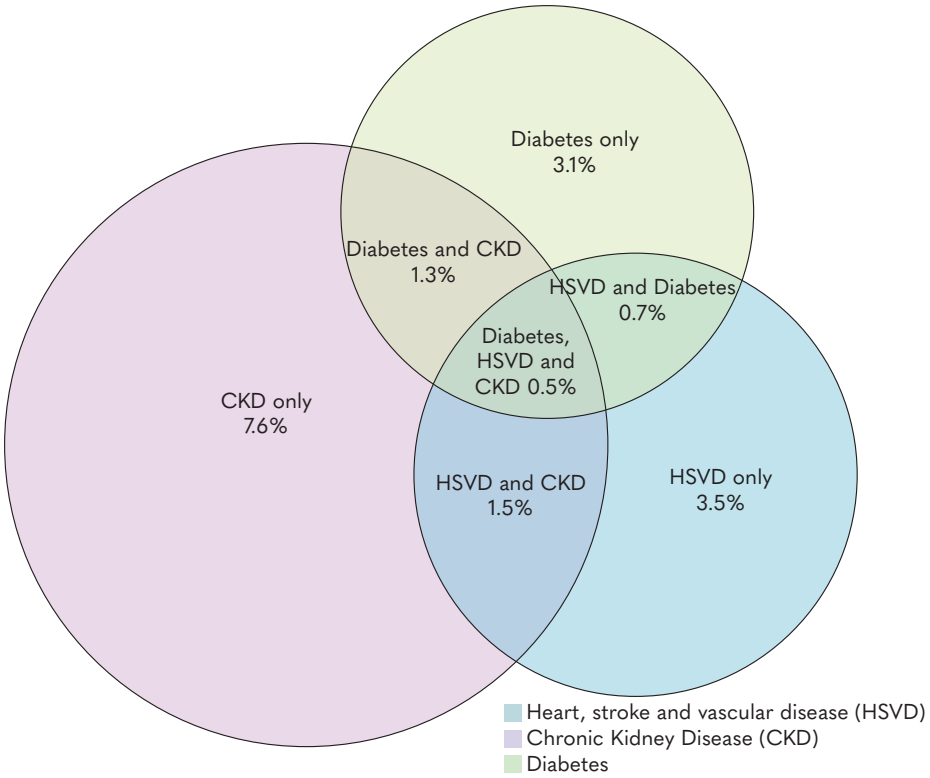


Figure 1.54 Prevalence of diabetes, chronic kidney disease (CKD) and heart, stroke and vascular disease (HSVD) and their comorbidity, persons aged 18 and over, 2011–12
Source: Australian Institute of Health and Welfare

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Mortality

Comorbidity is frequently associated with mortality, with diabetes often being recorded as an associated cause of death rather than the underlying cause of death. In 2021, diabetes was identified as the cause of 1.8% of deaths, as a contributing factor to 6.5% of deaths caused by CVD and as a contributing factor to 2.4% of deaths caused by CVD and CKD.

Diabetes associated with other causes of death

The most common underlying causes of death where diabetes is listed as the associated cause in 2021 include coronary heart disease (I20–I25), dementia (F01, F03, G30), cerebrovascular disease (I60–I69) and chronic obstructive pulmonary disease (J40–J44).

Australian Institute of Health and Welfare, 'Comorbidity of diabetes', 17 June 2024

Table 1.4 Common associated causes where diabetes is the underlying cause of death, 2021

Associated cause of death	Per cent
Coronary heart disease (I20–I25)	41.2
Kidney failure (N17–N19)	41.2
Hypertensive disease (I10–I15)	33.8
Other ill-defined causes (R00–R94, R96–R99, I46.9, I95.9, I99, J96.0, J96.9, P28.5)	29.8
Heart failure and complications and ill-defined heart disease (I50–I51)	21.4
Dementia including Alzheimer's disease (F01, F03, G30)	15.9
Cerebrovascular disease (I60–I69)	15.7
Cardiac arrhythmias (I47–I49)	12.9
Diseases of arteries, arterioles and capillaries excluding atherosclerosis, aortic aneurysm and dissection (I72–I79)	9.7
Selected metabolic disorders excluding dehydration (E70–E89 excl. E86, E87)	9.3

Source: AIHW, National Mortality Database

Activity 1.25

Comorbidity

Consider Figure 1.54 and Table 1.4.

1 What diseases are frequently associated with type 2 diabetes?
2 What is the connection between the two? What lifestyle factors may contribute to the development of these diseases?

Skill: analysis

Risk factors and protective factors for diabetes

Key risk factors in the development of type 2 diabetes are:

- being overweight or obese, due to the insulin resistance that can be caused by increased body weight
- being over 45 and overweight
- having had gestational diabetes or polycystic ovarian syndrome
- being over 45 and having high blood pressure
- having had a heart attack
- being over 35 and Aboriginal or Torres Strait Islander
- being over 35 and having a Pacific Islander, Indian or Chinese background.

Awareness of these risk factors can encourage people to take steps to modify their behaviours in order to reduce their risk.

Protective behaviours for type 2 diabetes include:

- regular physical activity
- eating a healthy, balanced diet
- maintaining a healthy body weight.

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Changing conditions

Activity 1.26

Modifiable and non-modifiable risk factors

1 Divide students into small groups and assign to each group one aspect of diabetes data:
   a **Group 1:** Prevalence trends over time
   b **Group 2:** Incidence trends among demographic groups
   c **Group 3:** Mortality rates and survival rates
   d **Group 4:** Geographic and socio-economic differences in diabetes outcomes.
2 In groups, students are to:
   a analyse the data with reference to their assigned point
   b identify key patterns, trends and any anomalies or inequities
   c hypothesise reasons behind the observed changes and disparities (e.g. changes in lifestyle, healthcare access, education, cultural factors, preventive health).
3 Prepare the key elements for presentation to the class using a visual format (charts, infographic, PowerPoint).
4 Students reflect on the findings as a class through discussion or as a homework or written task, considering such questions as:
   a What surprised you about the trends?
   b How do factors such as urbanisation, diet, activity levels or healthcare access influence diabetes outcomes?
   c What initiatives or interventions could help address diabetes?

Skills: collaboration, analysis, communication

Revise and summarise 1.5


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What is cardiovascular disease? What are the main types?
2 Identify the mortality, morbidity, prevalence and incidence rates for CVD in Australia.
3 Describe the risk and protective factors for CVD.
4 In which types of CVD are we seeing positive changes? Are any showing negative trends?
5 What are the most common types of cancer in Australia for men, women and the general population in terms of mortality, morbidity, prevalence and incidence?
6 Identify the risk factors for cancer and identify the type of cancer they may contribute to the development of.
7 Describe the protective factors for cancer.
8 Identify the current trends for the leading types of cancer.
9 Describe the different forms of diabetes.
10 What are the mortality, morbidity, prevalence and incidence rates for type 2 diabetes?
11 What factors contribute to the development of type 2 diabetes?
12 Are the rates of type 2 diabetes increasing or decreasing? Is this the same for all population groups? Explain.

Think critically and apply 1.5

Consider the mortality, morbidity, prevalence and incidence rates of either cancer, CVD or diabetes and the risk and protective factors. Propose two strategies to reduce the burden of these conditions in Australia.

Skills: creative thinking, analysis

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1.6 Ageing population and Australia's health

Learning objective 1.6
INVESTIGATE what impact an ageing population is having on the health of Australia.

What does the data tell us?

Australia has a population of approximately 27 million, with an annual growth rate of about 2.5%. Of this 27 million, one in six people are aged 65 or over. This ratio is expected to grow, with projections that by the year 2066, older people will make up 22% of the population.

This increase is being driven by two main factors, the first of which is a decline in birth rates. The birth rate in Australia has been declining since the 1960s, and has now fallen to below replacement rate. This means that without migration, our population will eventually start decreasing. The second factor is that life expectancy has increased.

So, with fewer babies being born but more people living longer, it is inevitable that the population will get progressively older and that this demographic shift will have a significant impact on all aspects of individual and community life.

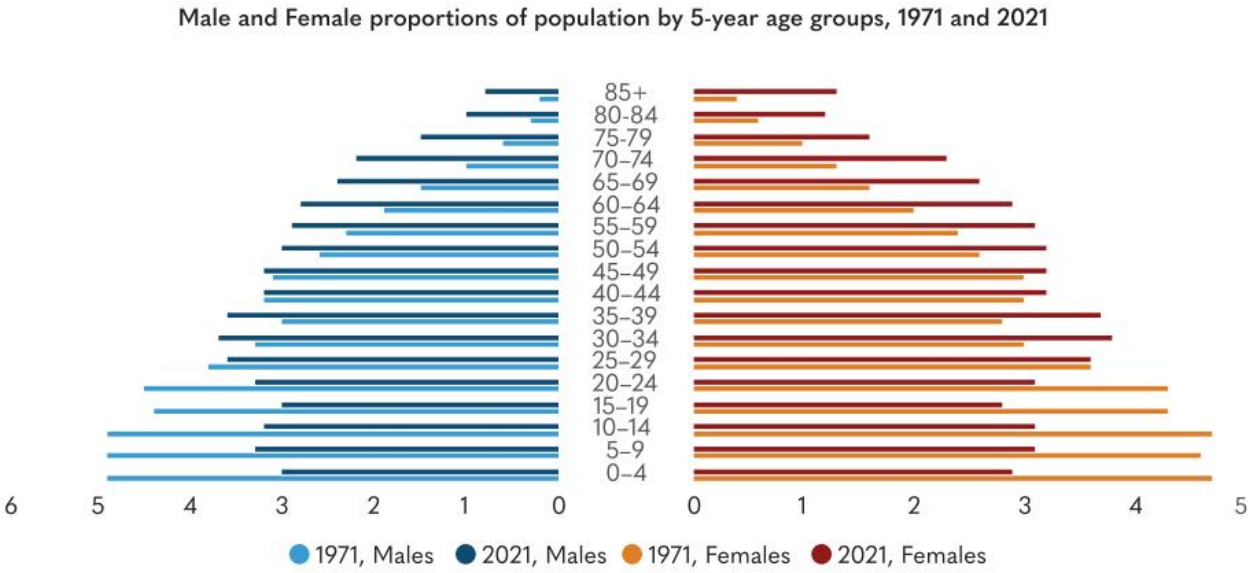


Figure 1.55 Male and female proportions of population by 5-year age groups, 1971 and 2021
Source: ABS

The World Health Organization reported that, globally:

- In 2020, the number of people aged 60 years and older outnumbered children aged younger than five.
- Between 2015 and 2050, the proportion of the world's population who are over 60 years old will nearly double from 12% to 22%.

World Health Organization, 'Ageing and health', 1 October 2024



Figure 1.56 Australia has an ageing population

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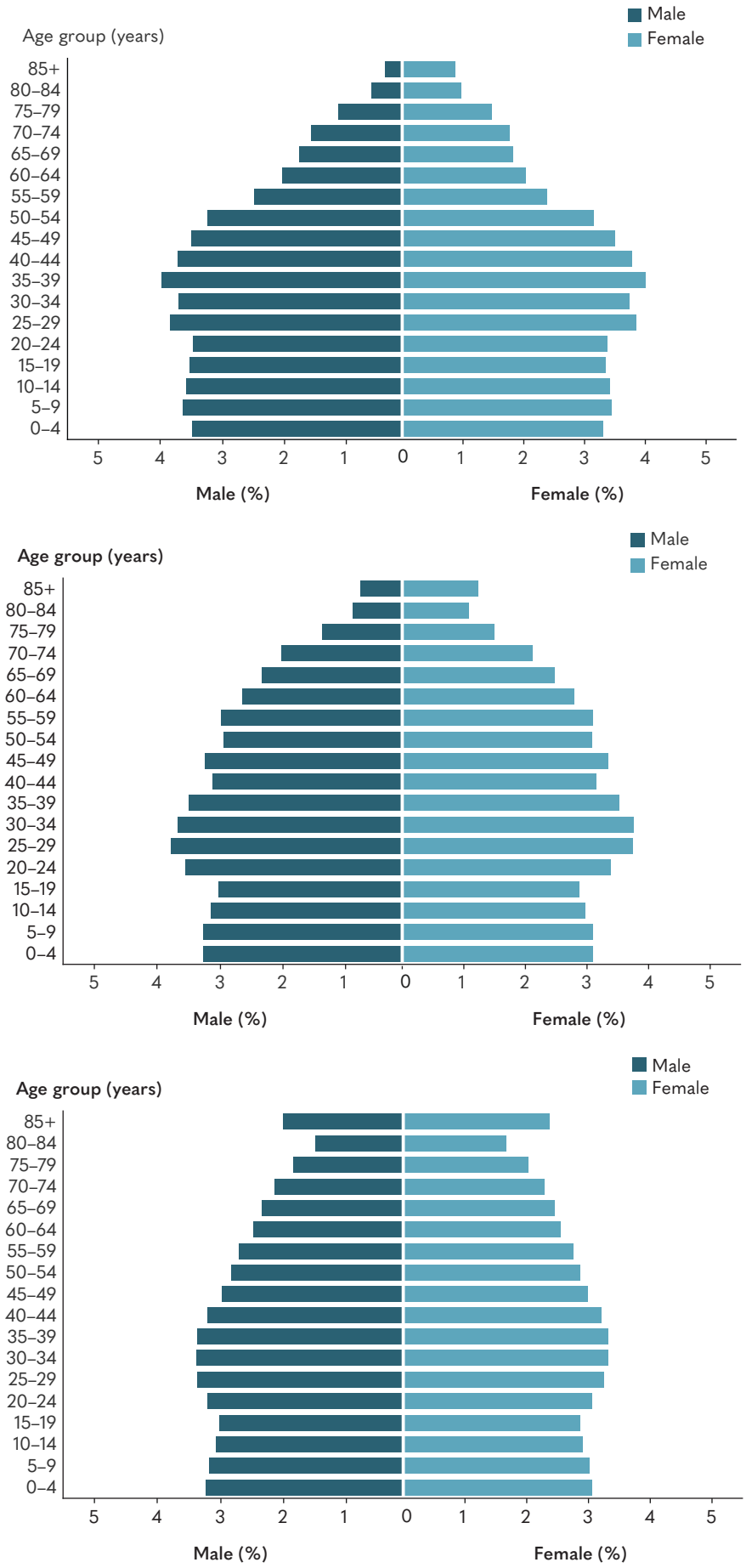


Figure 1.57 Population age groups by sex over time. Sources ABS 2018, 2019.

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Depth Study

Healthy ageing

Healthy ageing has become a key priority, not just for the Australian Government but for the entire world. With a global aged population that is expected to reach over 20% of the entire population by 2050, the implications for our society will largely be determined by whether older people are in good or poor health. The high rates of chronic disease and disability in the aged population can be significantly decreased or prevented through active and healthy ageing.

healthy ageing enhancing wellbeing in old age by developing and maintaining abilities

Healthy ageing is not just a concept that applies to the elderly; it begins in the younger years. Much of the poor health and chronic disease experienced in later years is attributable to earlier choices and behaviours, such as smoking, poor diet and low levels of exercise. Healthy behaviours need to start earlier and continue throughout life.

The benefits of healthy ageing are not just experienced by the individual but also the wider community. For an individual, healthy ageing means improved quality of life with fewer years lived in illness and with disability, decreased healthcare costs and more opportunities for social interaction. This will in turn have an effect on the wider community and means a decreased financial impact on the healthcare system through reduced burden of disease and fewer people requiring aged care facilities and palliative care. There is a reduced burden on families and friends, as less care and assistance is required. Furthermore, older people have a wealth of skills and experiences that can benefit society. Healthy ageing means that these skills and experiences can be utilised for longer. Involvement in volunteer work and community services, and the provision of care for children and other older people, are just some of the benefits of a healthy older population.



Figure 1.58 Healthy ageing has become a key priority

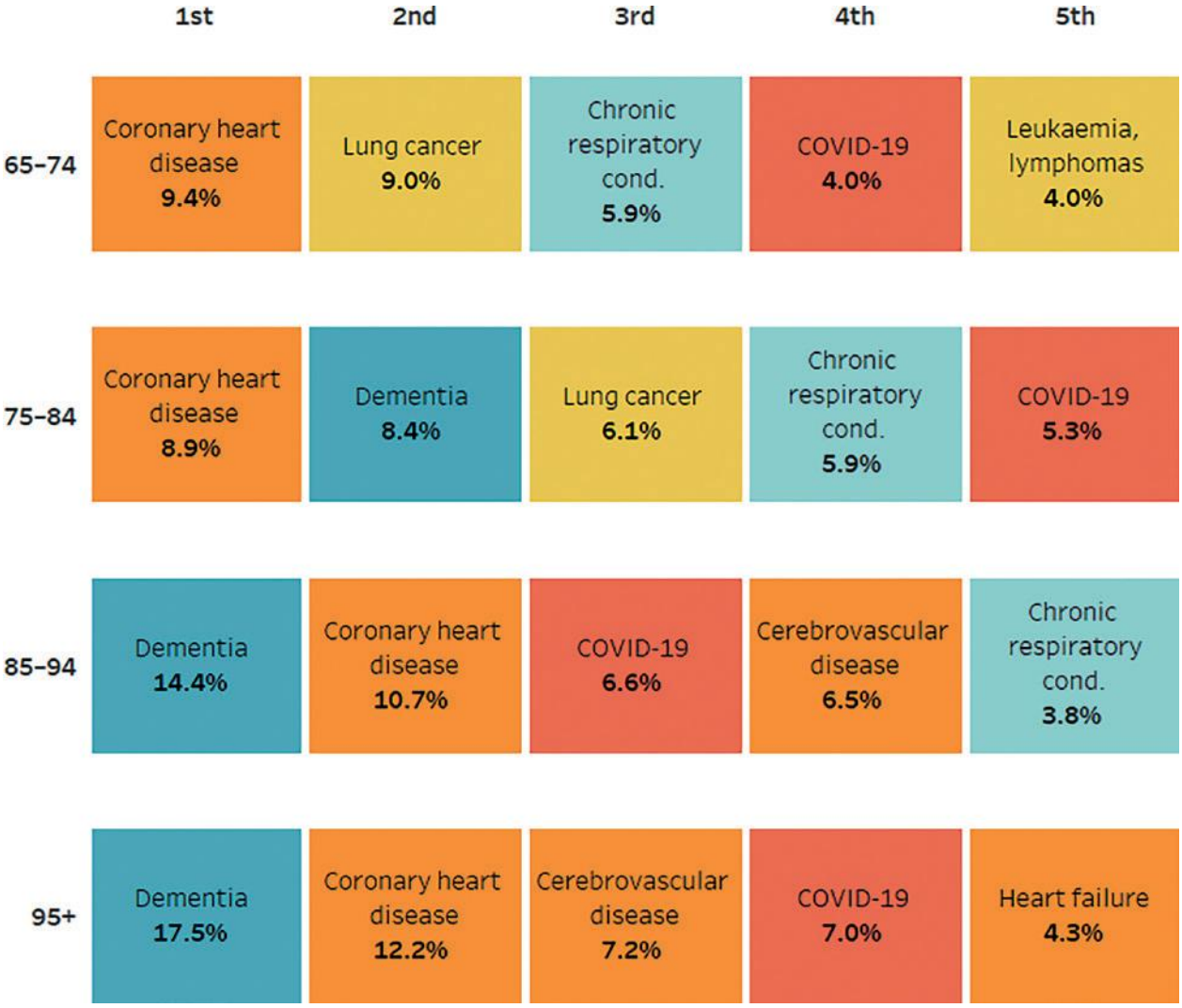
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Challenges and opportunities

An ageing population presents both opportunities and challenges for all aspects of society. Utilising opportunities and acknowledging and addressing challenges will lead to more positive outcomes for all involved.

Challenges

One of the challenges of an ageing population is the increased pressure that will be placed on the healthcare system as a result of higher numbers of people living with chronic disease and disability. Chronic disease accounts for approximately 83% of the burden of disease and is responsible for around 90% of all deaths.



Note: Year refers to year of registration of death. Causes of death data for recent years is preliminary and subject to a revisions process.

Figure 1.59 Five leading causes of death for people aged 65 and over by age group, 2022. Source: Australian Institute of Health and Welfare.

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Activity 1.27

Challenges of an ageing population

1 Look through the latest *Australia's health report*, available from the AIHW website, and identify the main causes of morbidity and mortality in the older age groups.
2 What proportion of older Australians were living with some form of disability?
3 Research the rates of dementia over the past 10 years. Consider the type of care that a person with dementia requires. What impact do you expect these trends to have on demand for carers?
4 Discuss the impact of multimorbidity on the challenges associated with providing care– for example, providing care to an older person with COVID-19 who also has chronic obstructive pulmonary disease (COPD).

Skills: research, analysis

As previously mentioned, the increase in the number of people living with chronic health conditions will place growing demands on health services and aged care. The need for healthcare increases with age, and those over 65 are the largest consumers of healthcare services.
A response has already been seen in the healthcare industry, with the number of aged care facilities growing by almost 50% since the early 2000s.

At the same time, growth in the number of people of workforce age is expected to plateau. This could cause problems, as the older population is reliant on workers and taxpayers for support. In 2002, for every person over the age of 65, there were more than five people of working age to provide support. By 2042, this number is expected to drop to only 2.5 workers for every elderly person.

In response to concerns about healthcare pressures and challenges, the government produced the National Strategy for an Ageing Australia, which focuses on addressing the key challenges of an ageing population on a national level and identifies four key areas to be addressed.

- **Increasing independence and self-provision**. This includes increasing employment for mature-aged workers and keeping workers as productive members of the workforce for longer, which will assist in decreasing workforce shortages and decrease the economic burden.
- **Positive attitudes, lifestyle changes and community-based support**. This involves fostering attitudes among the elderly as well as the community about the capabilities of the elderly, acknowledging their contributions to society and reducing stereotypes.
- **Promotion of and support for healthy ageing**. This is necessary to increase quality of life and the potential for contributions by the older generation as well as decreasing the burden of disease.
- **World-class care**. This means the provision of sustainable, accessible and high-quality care for older Australians.

Australia already has some systems in place to care for and support the elderly. Australia's retirement income system is considered a model of good practice by the World Bank and supports older Australians through a combination of public pensions, superannuation and voluntary savings. The taxpayer-funded age pension is means tested and is not linked to previous earnings. It is provided to almost 80% of the population who are old enough to receive it. Compulsory superannuation funds are also required from all employers, with employees able to make additional payments into their fund in preparation for retirement.

Opportunities

An ageing population presents some unique opportunities. Retired older Australians often contribute to their communities through volunteer work, mentoring, and caregiving, which can enhance social cohesion and support services. Through these sorts of involvement they can share their knowledge and experience with younger generations, promoting learning and mentorship across age groups.

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Strategies

Australia

In 2024, the Australian Government Department of Health and Aged Care released the *Aged Care Data and Digital Strategy*, which runs from 2024 to 2029.

You can download the full strategy via this link: https://cambridge.edu.au/redirect/11392.

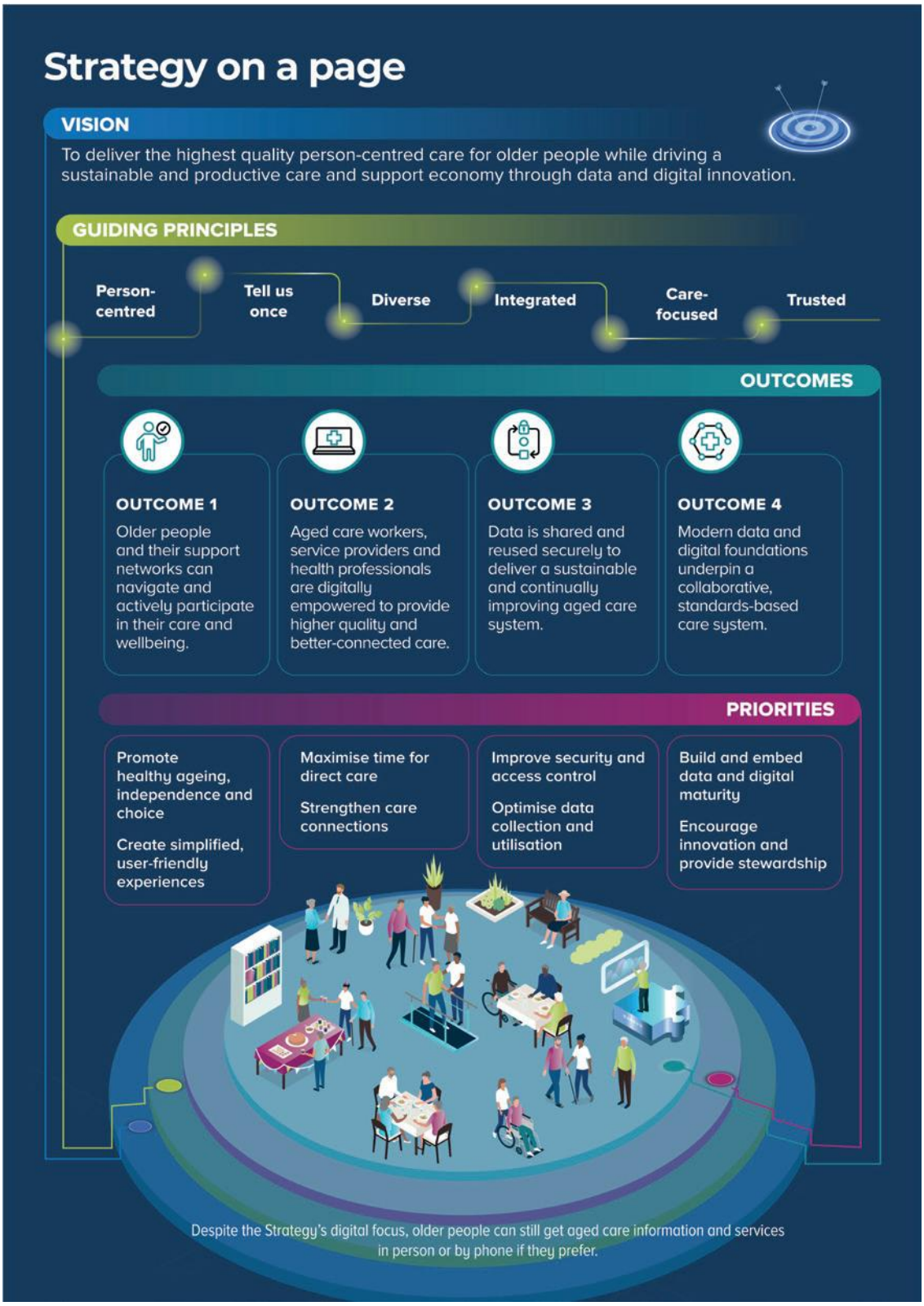


Figure 1.60 Graphic from Department of Health and Aged Care *Aged Care Data and Digital Strategy*

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The *Aged Care Data and Digital Strategy* identifies some key challenges for ensuring a lasting transformation of aged care digital systems:

- Australia's ageing population
- rising need for in-home services
- population growth slowing down
- ongoing shortage of skilled workers.

The department estimates that integrating digital technologies, enhancing the digital skills of aged care staff, and implementing new data-sharing policies could lead to a saving of up to one-third of administrative work time. It also estimates that digital improvements could help reduce the projected workforce gap in aged care.

United Nations

The importance of healthy ageing is reflected in United Nations *Decade of Healthy Ageing: Plan of Action 2021–2030,* which encompasses 10 years of dedicated, catalytic and consistent collaboration. Older people are at the core of this initiative, which aims to unite governments, civil society, international agencies, professionals, academia, the media and the private sector to enhance the lives of older individuals, their families, and their communities. This plan is the second action plan of the WHO Global Strategy on Ageing and Health, building on the United Nations Madrid International Plan of Action on Ageing. It aligns with the United Nations Agenda 2030 on Sustainable Development and the Sustainable Development Goals.

Activity 1.28

Challenges of an ageing population

1 Consider your local community. Research what facilities and services are available to:
   a promote healthy ageing
   b support older Australians.
2 What opportunities currently exist for older Australians to be involved in their local communities?
3 Propose three strategies that could be adopted in your local community to make it more age friendly, to directly promote healthy ageing and to engage the skills and experience of older adults.

Skills: research, analysis, creative thinking

Future needs

To meet the demands of a growing and ageing population, there are a number of future demands that Australia will have to meet, including demands for an increased workforce, increased facilities and a focus on healthy ageing.

technological integration investment in digital health systems, such as electronic health records and AI-driven diagnostic tools, to improve efficiency and patient outcomes

Aged care demands will increase as the proportion of the population living with chronic disease and illness increases. This in turn will lead to an increase in the number of healthcare professionals required, including geriatricians, nurses, allied health workers, and aged care staff to provide specialised care for older Australians. Increased demands for aged care will require a larger, better-trained aged care workforce to address the needs of residential and community-based aged care services. Encouraging older workers to remain in the workplace for longer could assist in managing workforce demands but may create the need for more flexible workplaces.

As well as a need for increased workers, increases in facilities will also become a requirement to accommodate the health and lifestyle needs of an ageing population. Healthcare infrastructure will become even more crucial, including **technological integration**, and ensuring hospitals and clinics are adequately equipped with facilities for managing chronic conditions, rehabilitation

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and palliative care. Development of telehealth and remote monitoring systems will improve access for older and less mobile patients as well as those living in rural and remote areas.

Expansion of residential aged care homes and community care programs that promote independent living can assist with the reduced burden on the health system. The burden can be further reduced by initiatives which support older people through community-based resources such as age-friendly public spaces, including recreational facilities, transport systems, and housing designed for accessibility and mobility.

Promoting healthy ageing is essential to reduce the burden on healthcare systems and enhance quality of life for older Australians. As mentioned earlier, this includes preventive health measures, improving social inclusion, engaging older Australians in the workforce or in volunteer roles and encouraging mental, physical and social involvement.

By addressing these needs, Australia can ensure that its ageing population remains healthier, more independent, and better supported while minimising the strain on its healthcare and economic systems.

Revise and summarise 1.6


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What does the data reveal about the current and projected size of Australia's ageing population?
2 Describe what the term 'healthy ageing' means in the context of Australia's health system.
3 Outline the key challenges posed by an ageing population for Australia's healthcare system.
4 Describe how an ageing population may impact workforce participation and economic growth.
5 What opportunities exist to enhance quality of life for older Australians?
6 Outline two current strategies in place to support healthy ageing in Australia.
7 How might Australia's healthcare system need to evolve to meet the demands of an ageing population?

Think critically and apply 1.6

1 Describe the role that government agencies play in planning for a growing and ageing population.
2 Outline how non-government organisations (NGOs) contribute to supporting healthy ageing.
3 What are some international examples of effective strategies for managing the health of an ageing population that Australia could adopt?

Skills: research, analysis, creative thinking

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Chapter summary

- Australia ranks highly globally in health due to factors like high employment, education, income and environmental quality.
- However, challenges like increasing obesity rates and significant health inequities persist among disadvantaged groups.
- Data is gathered from health service records, surveys, clinical registries, and surveillance systems and is an important part of understanding the health of a nation.
- Key organisations like the ABS and AIHW use this data for policy and healthcare decisions, focusing on determinants, major health issues and evaluation of system performance.
- Life expectancy has improved steadily over the past century due to advancements in technology, infrastructure and science.
- Many of Australia's major health issues are related to risky health behaviours.
- Indigenous Australians, rural and remote populations, socio-economically disadvantaged groups and people with disabilities face disproportionate health challenges.
- Causes include systemic barriers, colonisation impacts and limited access to healthcare and education.
- Cardiovascular diseases and cancers are leading contributors to morbidity and mortality, with trends in prevalence influenced by ageing, lifestyle and improved screening.
- Indigenous Australians and those in remote areas have higher rates of preventable deaths and hospitalisations for chronic diseases.
- Strategies like the Close the Gap campaign and National Agreements emphasise Indigenous-led solutions and culturally responsive care.
- For rural areas, telehealth, mobile health units and community-based programs aim to improve access and outcomes.
- Australia performs well in metrics like life expectancy and healthcare access but lags in obesity rates and mental health.
- Lessons from countries like New Zealand (Indigenous health) and Estonia (digital health integration) provide pathways for improvement.
- A growing and ageing population creates challenges both now and into the future, with healthy ageing being a key consideration for reducing the impact on healthcare and aged care services.

Multiple-choice questions

1 What is the primary use of health data in Australia?
- A to identify health inequities and plan interventions
- B to promote private healthcare services
- C to reduce government spending on health
- D to compare healthcare systems globally

2 Which cancer has the highest rate of incidence among Australian males?
- A lung cancer
- B prostate cancer
- C colorectal cancer
- D melanoma of the skin

3 What is a key challenge in addressing health inequities in Australia?
- A lack of health data sources
- B complex and varied reasons for disparities
- C limited involvement of non-government organisations
- D high literacy and numeracy standards

4 What does the National Agreement on Closing the Gap emphasise?
- A full government control over outcomes
- B Aboriginal and Torres Strait Islander Peoples driving strategies and policies
- C prioritising urban health services
- D reducing funding for cultural programs

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5 How is cultural connectedness significant to the health of Aboriginal and Torres Strait Islander Peoples?
- **A** it reduces the need for healthcare access
- **B** it is a protective factor influencing social determinants of health
- **C** it eliminates intergenerational trauma entirely
- **D** it provides direct financial assistance to families

6 What happens to mortality rates as remoteness increases?
- **A** mortality rates decrease
- **B** mortality rates increase
- **C** mortality rates remain stable
- **D** mortality rates fluctuate

7 What is a significant barrier to accessing healthcare in remote areas?
- **A** overcrowded healthcare facilities
- **B** lack of healthcare funding in cities
- **C** distance from healthcare services
- **D** limited need for healthcare

8 What is the primary underlying cause of most cardiovascular diseases (CVDs)?
- **A** high blood pressure
- **B** atherosclerosis
- **C** diabetes
- **D** obesity

9 How have cancer incidence rates changed in Australia since 2008?
- **A** increased steadily
- **B** decreased significantly
- **C** remained relatively stable
- **D** increased dramatically

10 What proportion of total deaths in Australia are caused by cancer?
- **A** 1 in 5
- **B** 3 in 10
- **C** 2 in 10
- **D** 4 in 10

11 Which of the following is a protective behaviour against type 2 diabetes?
- **A** avoiding all carbohydrates
- **B** regular physical activity
- **C** taking insulin daily without a prescription
- **D** reducing water intake

12 How is diabetes frequently recorded in relation to mortality?
- **A** as the primary cause of death
- **B** as an associated cause of death
- **C** as unrelated to other health conditions
- **D** as a contributing factor to mental health issues

13 What is one benefit of healthy ageing for the wider community?
- **A** higher healthcare costs
- **B** increased demand for aged care facilities
- **C** reduced burden on the healthcare system
- **D** fewer opportunities for older people to participate in volunteer work

14 How can the skills and experiences of older people benefit society?
- **A** by reducing the need for healthcare professionals
- **B** through involvement in volunteer work and caregiving
- **C** by decreasing the ageing population's overall lifespan
- **D** through limiting social interaction

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Exam practice

How to answer an exam question

Example question

Identify two risk factors and two protective factors for cardiovascular disease. (4 marks)

What is the question asking?

The key verb in this question is **identify**, which means you need to name the factors, but you do not need to spend time writing further explanation.

You need to supply both 'two risk factors' AND 'two protective factors'. Make sure your answer clearly states which is which.

As you need to supply four factors, and the question is worth four marks, you can assume that each factor you correctly identify will be worth one mark.

Marking criteria

Criteria	Marks
• Recognises and names two risk factors for CVD • Recognises and names two protective factors for CVD	4
• Recognises and names three factors for CVD, of which at least one is a risk factor and at least one is a protective factor	3
• Recognises and names two risk or protective factors for CVD	2
• Recognises and names one risk or protective factor for CVD	1

Sample response

Risk factors:
- Smoking
- Heredity

Protective factors:
- Healthy diet
- Physical activity



Video 1.3 Answering the exam question

Exam-style questions

1. Identify two key protective factors for cardiovascular disease. (2 marks)
2. Define healthy ageing and explain why it is important for Australia's health system. (3 marks)
3. For two determinants of health, describe how the interaction of these determinants can contribute to the health status of people living in rural and remote areas. (4 marks)
4. Identify two risk factors and two protective factors for cancer in Australia. (4 marks)
5. What does the data indicate about the prevalence and incidence rates of diabetes in Australia? (4 marks)
6. As well as challenges, an ageing population also presents opportunities. Describe the opportunities presented by an ageing population and the benefits to the broader Australian society. (6 marks)
7. Using specific examples, examine the importance of acknowledging the impact of determinants as contributing causes of health inequities experienced by groups experiencing inequalities in Australia. (7 marks)
8. Compare Australia's health status with that of other OECD countries. Evaluate the factors that contribute to Australia's ranking and discuss what can be learned from higher-ranking countries to improve health outcomes in Australia. (8 marks)

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Chapter 2
Australia's healthcare system

After completing this chapter, you will be able to demonstrate knowledge of:

- the effectiveness of Australia's system of healthcare
- responsibilities of government and non-government organisations
- person-centred healthcare as a collaboration of government and non-government organisations
- health expenditure and the impact it has on populations
- complementary healthcare approaches
- being a critical health consumer
- current and emerging changes and challenges.

Key terminology

Syllabus terminology:

digital health
disability
equity
health literacy
health promotion

Other important terms:

allied health
bulk bill
complementary healthcare approach
Medicare
National Disability Insurance Scheme (NDIS)
Pharmaceutical Benefits Scheme (PBS)
primary care
public health
sustainability



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Driving questions

1 What would be some of the signs or indicators of an effective health system?
2 Considering these indicators, and from what you know about the health of Australians, do you think Australia has an effective health system?
3 What are some of the current and future challenges faced by the healthcare system?

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Introduction

Medicare the publicly funded healthcare insurance scheme, available to all Australian citizens and permanent residents, which provides subsidised treatments for some medical practitioners, including GPs, and free treatment from public hospitals

Healthcare in Australia is among the best in the world, which is reflected in the increasing rates of life expectancy, decreasing rates of infant mortality and overall positive self-ratings of health for most Australians.

Healthcare facilities across the country provide a wide variety of services for the prevention, treatment and management of injuries and illness. Over the past 50 years, changing views about health have led to a shift in the nature of the health industry, with a move from largely curative healthcare services to healthcare services that reflect a more holistic view of health.

Despite the provision of universal healthcare through **Medicare**, significant inequities in access and outcomes remain for many Australians, including First Nations people.

Aboriginal and Torres Strait Islander communities continue to experience poorer health outcomes, lower life expectancy, higher rates of chronic disease, and face substantial barriers in accessing culturally safe and equitable healthcare.

These disparities reflect ongoing impacts of colonisation, systemic racism and socio-economic disadvantage, highlighting the urgent need for meaningful improvements in Australian health equity.

2.1 Effectiveness of Australia's healthcare system

Learning objective 2.1
ASSESS the effectiveness of Australia's healthcare system.

Activity 2.1

Healthcare services

Reflect on the last five times you visited or used a healthcare facility or service.

1 Who was responsible for running the service?
2 What financial exchanges were made – that is, how was the service provider or facility being paid for?
3 Were any of these services non-traditional, alternative or complementary healthcare services?
4 Referring to your own experience, what do you think makes a health service fit into this category?
5 Did you have the opportunity to provide any feedback on your experience?

Skills: analysis

Australia's healthcare system is a complex and varied mix of health professionals and service providers from both government and non-government sectors that all work together to meet the health and wellness needs of Australians. This includes primary healthcare services, specialist services, hospitals, health promotion and health protection, aged care services, medical research and the universal healthcare program – Medicare.

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In order for healthcare to be deemed 'effective' it must meet the desired outcomes for patients and the community as well as support the needs of the clinicians. We can explore the effectiveness of healthcare by examining the role of the healthcare system and its many facets.

Role

The healthcare system in Australia encompasses a wide range of healthcare services, including institutionalised services such as hospitals and nursing homes, and non-institutionalised services such as **public health** programs and the vast range of health professionals working in the community.

public health government and other programs aimed at the prevention of disease, the prolonging of life and the promotion of health

Table 2.1 Health service categories

Public health services	Primary care and community healthcare services	Hospitals	Specialised health services	Goods
Health promotion and education Cancer screening Immunisation	General practice Dental Private sector allied health Community health Complementary/ alternative health Ambulance and Royal Flying Doctor Service	Admitted patient care Emergency department care Outpatient care	Specialist medical practitioners Specialised mental health practitioners Reproductive health Alcohol and other drug treatment Hearing Palliative care Australian Defence	Pharmaceuticals

Source: Australia's Health 2010, p. 333

Activity 2.2

Alphabet challenge

In groups, provide examples of both institutional and non-institutional health facilities and services for every letter of the alphabet.

Skills: collaboration

Hospitals

There are 1354 hospitals operating in Australia: 697 public hospitals and 657 private hospitals. On an average day, 24 700 people are treated in emergency departments, 2100 people are admitted for elective surgeries and 33 200 hospitalisations take place. Outpatient services are provided to 113 000 people. In public hospitals, all these services are delivered by 186 000 nurses and 56 700 doctors.

Public hospitals

Public hospitals are operated and funded by state governments and the Commonwealth Government, and provide highly specialised services. Patients can access public hospitals through emergency departments, where they may present themselves on their own initiative, through ambulance services or after referral from a general practitioner (GP). Public hospital emergency and outpatient services are free under Medicare arrangements, as is inpatient treatment for public patients. Public hospitals treat a higher proportion of elderly and young children.

Private hospitals

Private hospitals are owned and managed by individuals or community groups. They also have emergency departments that patients can access in the same way as public hospitals, provided they have private health insurance. Private hospitals tend to perform more elective procedures (not emergencies), such as some orthopaedic procedures and procedures on the nose, ear, throat and musculoskeletal system.

primary care medical treatment provided by local doctors or other health workers, rather than special treatment in a hospital

allied health a collective term used to describe a number of health professionals, including physiotherapists, dieticians/ nutritionists, podiatrists, chiropractors and exercise physiologists, as well as others

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Figure 2.1 Hospitals are an important element in the delivery of primary healthcare.

Table 2.2 Characteristics of admitted patient care, public and private hospitals, 2021–22

	Public hospitals	Private hospitals	All hospitals
Hospitalisations	6.8 million	4.8 million	11.6 million
Medical	4.8 million	1.6 million	6.4 million
General intervention (surgical)	999 000	1.6 million	2.6 million
Specific intervention (other)	443 000	933 000	1.4 million
Childbirth	232 000	69 000	301 000
Mental health care	134 000	218 000	352 000
Sub-acute and non-acute care	211 000	332 000	543 000
Overnight versus same day	55% same-day stays	73% same-day stays	63% same-day stays
Number of days of patient care	21.7 million (average increase of 1.9% per year since 2017–18)	10.0 million (average increase of 0.2% per year since 2017–18)	31.8 million (average annual increase of 1.3% since 2017–18)
Average length of stay (for overnight stays)	5.9 days	5.2 days	5.7 days

Source: Australian Institute of Health and Welfare

Aged care facilities and nursing homes

Nursing homes provide long-term care for those who are no longer able to look after themselves independently. The elderly, chronically ill, people with disabilities and dementia patients make up the majority of patients in nursing homes. The role of nursing homes in caring for the elderly within Australia is of increasing importance given the nature of our growing and ageing population.

Primary care and community health services

General practitioner

For many health issues, the patient's first contact with the healthcare system is presenting to their GP. General practice plays an integral role in the provision of primary healthcare in Australia. GPs diagnose, treat and manage health complaints, provide preventive advice and care, prescribe medicines, and refer patients to other health professionals, hospitals and aged care. In 2023–24, 84% of Australians accessed at least one GP service through Medicare.

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Mental health services

There has been an increase over the past 15 years in the number of people accessing the Medicare-subsidised mental health-related services and an increase of about 45% over the past 10 years of people presenting to emergency departments for mental health-related issues.

Mental health treatment, care and support is provided by:

- live-in mental health care services
- private practitioners
- primary care services, like GPs
- allied health services such as art and music therapy, psychology and counselling
- community mental health services such as support groups
- non-government organisations such as Beyond Blue.

Other health professionals/services

Medical specialists and allied health professionals provide specialist services in public and private hospitals, as well as in the community through private practice. Many patients are referred to these health professionals by their GP, but you do not need to be referred by a GP to use these services. Allied health is a collective term used to describe a number of health professionals who are generally university qualified and deliver health services in their area of expertise, from prevention to diagnosis and treatment. Allied health services cover a broad range of areas including audiology, physiotherapy, dietetics, podiatry, chiropractic, speech pathology and include Aboriginal and Torres Strait Islander health practitioners. Some of these services are subsidised by Medicare, private health insurance and the Department of Veterans' Affairs. In 2020–21, 39% of the population consulted with an allied healthcare service subsidised by Medicare.

Community healthcare services include those provided through local health services or governments. They include services such as community nurses, women's health services, immunisation program implementation, rehabilitation programs and preventive health education.

Digital health services

During the COVID-19 pandemic there was a significant shift towards digital health technologies, increasing access to health services and products. This also led to improved communication between patients and service providers and between the providers themselves.

My Health Record

The introduction of My Health Record has been pivotal in streamlining communication in healthcare. My Health Record is an online health record that provides a summary of your medical information, including any allergies, medications, boosters, pathology results and general medical conditions. It is available to healthcare providers at any time, including during emergencies. It allows for more effective communication, improved access, decreased wait times and the provision of better care.

Through the my health app and the myGov website, individuals are able to manage vaccinations and immunisations, find health services, view medicine information and view hospital discharge summaries.



Figure 2.2 My Health Record is an online summary of your medical information, available to healthcare providers at any time.

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Telehealth

Another initiative that has been expanded over the past four years has been telehealth, which provides healthcare services through the use of communications and computing technology. For example, a person in a rural or remote area can consult with their GP through video conferencing. Such initiatives allow for greater access to health services for people in rural and remote areas, those for whom travel and mobility can be difficult or those who might be isolated. They also aim to reduce unnecessary visits to the doctor, decreasing Medicare costs and pressure on GPs.

Another government initiative that has been effective in increasing access and awareness of health services is Healthdirect Australia – an online and telephone advice service staffed by health professionals (see https://cambridge.edu.au/redirect/11393).

This service answers questions about health with the use of specialist software that provides advice and information as well as recommendations if further help is required.

Electronic prescriptions

Electronic prescriptions can now be provided instead of paper prescriptions by a healthcare provider, offering a safer and more convenient way to manage prescription medication. These prescriptions can also be sent remotely following a telehealth consultation, increasing accessibility for all.

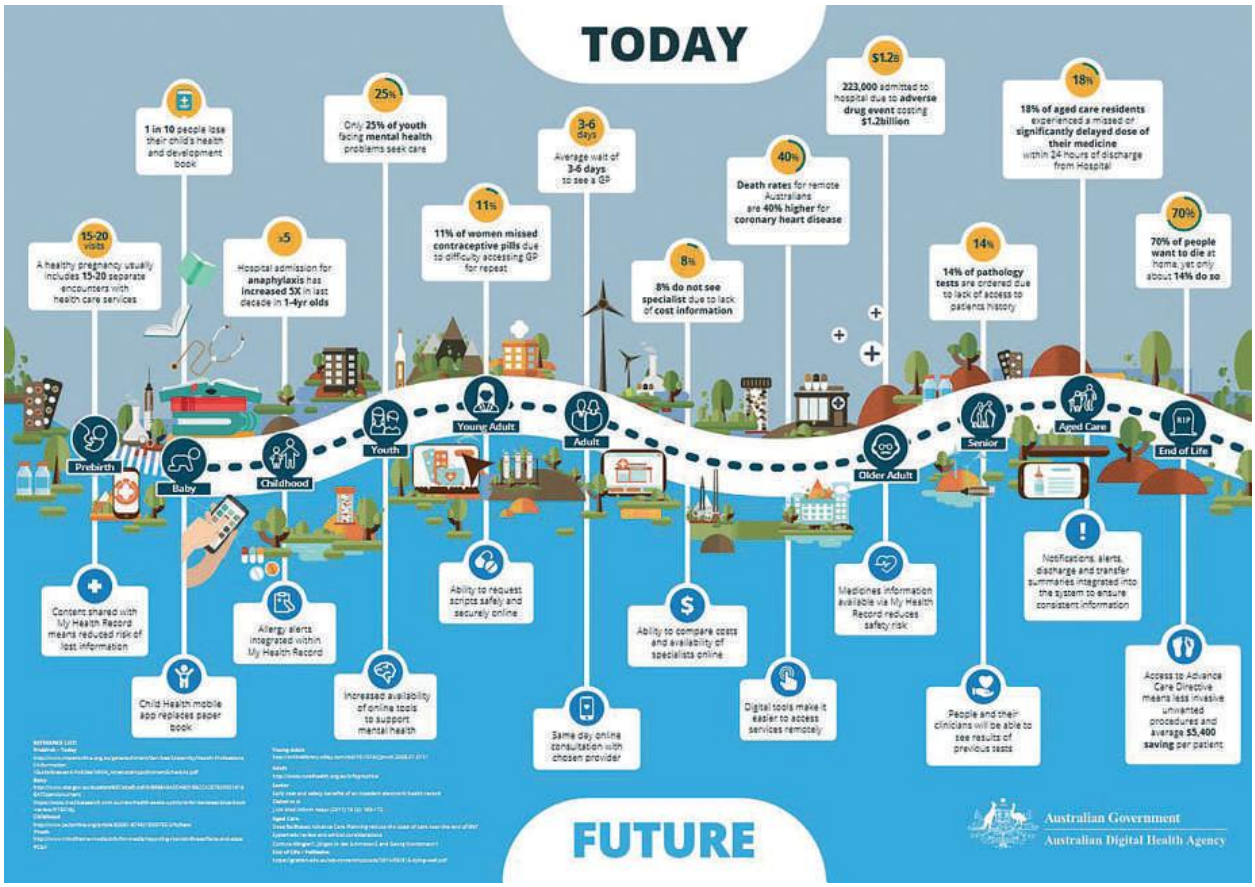


Figure 2.3 Australia's National Digital Health Strategy. A high resolution version of this graphic can be accessed via the Interactive Textbook.

Activity 2.3

Digital health

1 Consider Figure 2.3. What is the role of digital health services in improving the health of Australians?
2 What could be some barriers to the effectiveness of digital health services?
3 Brainstorm any negative elements associated with digital health services.
4 For each of the negative elements you have identified, discuss ways they could be addressed.

Skills: analysis

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Public health

Public health services focus on prevention and health-promotion strategies rather than treatment and are aimed at populations, not individuals. These preventive and promotional strategies focus on addressing the behaviours and factors that cause ill health, and promoting those behaviours associated with good health. Public health campaigns use a variety of methods, such as health education and advertising campaigns, lifestyle advice including telephone-based services, immunisation programs and infection control in order to promote healthy lifestyle choices and behaviours.

Specific examples include cancer screening initiatives for breast, bowel and cervical cancers. BreastScreen Australia provides free breast screening services to eligible women and gender diverse people, the National Cervical Screening Program offers pap smear tests that are covered by Medicare and National Bowel Cancer Screening uses faecal occult blood tests for those who have been invited to participate in the screening.

The National Immunisation Program provides childhood vaccinations for numerous illnesses and diseases, including diphtheria, tetanus, whooping cough, polio, measles, mumps, rubella, influenza, meningococcal, chickenpox and HPV (cervical cancer vaccine). These programs are delivered through schools, hospitals, medical centres and GPs.



Figure 2.4 The National Immunisation Program delivers childhood vaccinations through schools, hospitals, medical centres and GPs.

Activity 2.4

Elements of the healthcare system

Create a mind map of the various elements of the healthcare system and their roles.

Skills: analysis

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Equity of access

Activity 2.5

Equity

1 As a class, brainstorm factors that may reduce equity of access to healthcare in Australia.
2 Are the factors that you identified easy or hard to address? Why or why not?

Skills: collaboration

Depth Study

Equity is a key measure of the performance of a healthcare system. Australia works to achieve equitable access to health facilities and services for all Australians through several major avenues. Medicare is Australia's national healthcare system, enabling access to health services by providing subsidised treatments for some medical practitioners, including GPs, and free treatment from public hospitals. The **Pharmaceutical Benefits Scheme (PBS)** is another national scheme that subsidises certain prescription medications, making them more affordable for all.

Pharmaceutical Benefits Scheme (PBS) a government scheme that subsidises the cost of certain medicines

bulk bill where a GP charges the fee for a consultation directly to Medicare, enabling free access by the patient

While Medicare and the PBS are available to all Australians, there are still many factors that can act as barriers to people accessing the treatments and facilities they need. Cost can be a barrier, due to out-of-pocket expenses incurred from medications and services. Although there are rebates and subsidies for many services and medications, often the complete cost is not covered. Fewer GPs now **bulk bill**, and there has been an increase in out-of-pocket expenses for prescription medications. In 2023–24, 8.8% of Australians delayed seeing or did not see a GP due to cost. This rate shows an increase from 7% in 2022–23.

The increasing demand for health services and the decreasing availability of healthcare workers also mean that in some cases, long waiting periods for non-emergency treatments and services are experienced. More people in 2023–24 felt that they had waited longer than is acceptable for a GP appointment than in previous years (28% compared to 23% in 2021–22). Twenty-nine per cent of people delayed a consultation with a GP due to long waiting times, lack of service availability and busy services.

Australia's health performance framework showed that between 2022 and 2023:

- 33% of people attending public hospital emergency rooms were not treated within national benchmarks for waiting times
- there were decreases in the number of people admitted within clinically recommended times for elective surgery
- there were increases in waiting times until commencement of clinical care and increases in waiting times for elective surgery
- there were decreases in the availability of hospital beds.

Australians who have private health insurance may have greater access to certain healthcare services and procedures. For example, private patients may experience shorter waiting times for elective procedures. To address this with the aim of maintaining equity in healthcare services for all Australians, categories have been developed to assess the urgency of patients' conditions.



Figure 2.5 In 2023–24, 8.8% of Australians delayed seeing or did not see a GP due to cost.

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Groups experiencing more inequity

It is apparent that some groups experience more inequity in healthcare than others. People living in rural and remote areas generally face more barriers to accessing healthcare due to their geographical location, limited health service availability (due to low population density) and the higher costs associated with the delivery of health services in rural and remote areas. People living in rural and remote areas experienced higher numbers of potentially preventable hospitalisations and lower levels of access to screening programs. On the positive side, people in rural and remote areas are displaying increases in the general use of primary healthcare services.

Low socio-economic groups also experience reduced accessibility to healthcare due to limited choices and longer waiting times.

Aboriginal and Torres Strait Islander people continue to face systemic barriers to healthcare due to ongoing colonisation and institutional racism. Although geographical isolation is often cited as a barrier to healthcare, it's important to recognise that these geographic patterns result directly from historical displacement and exclusion from Country. Major barriers include culturally unsafe care, mistrust caused by histories of medical racism, long waiting times, transport challenges and financial constraints. Despite these systemic failures, Aboriginal Community Controlled Health Services continue to demonstrate strength and leadership, driving positive trends by providing healthcare grounded in culture, respect and self-determination.

In an attempt to monitor and improve the accessibility and cultural safety of the Australian health systems for Indigenous Australians, the *Cultural safety in health care for Indigenous Australians: Monitoring framework* was developed by the Australian Institute of Health and Welfare (AIHW). The framework assesses available data to determine the progress being made towards achieving culturally respectful healthcare services, a positive patient experience for First Nations peoples and improving access to healthcare services.

Table 2.3 Key trends over time in health system performance for Indigenous Australians

Health system performance measure	Trend
Antenatal care – proportion of Indigenous women accessing antenatal care in their first trimester of pregnancy	✔
Immunisation– proportion of Indigenous children fully immunised at age five	✔
Early detection and early treatment – rate of Indigenous health checks (per 1 000 population)	✔
Chronic disease management – rate of claims for GP management plans for chronic disease (per 1 000 population)	✔
Access to hospital procedures – proportion of hospitalisations for Indigenous Australians where a procedure was recorded	✔
Selected potentially preventable hospital admissions – rate of potentially preventable hospitalisations among Indigenous Australians (per 1 000 population)	✘
Discharge against medical advice – rate at which Indigenous hospital patients leave hospital without completing treatment (per 1 000 population)	✘
Access to services compared with need – proportion of Indigenous Australians who needed to go to a health provider in the previous 12 months but did not go to a health provider.	≈

Notes:

1 ✔ = improved; ✘ = not improved; ≈ = little or no change.
2 Trend based on analysis of change over time for the relevant time period. These periods vary by measure. See Indigenous Health Performance Framework for detail. Trends may differ from those presented in Chapter 3 'Changes in Aboriginal and Torres Strait Islander people's use of health services in the early part of the COVID-19 pandemic' in *Australia's health 2022: data insights* because of differing time periods and type of data presented.

Source: Australian Institute of Health and Welfare

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Future opportunities for the healthcare system

In rural and remote locations

The evolution of digital healthcare has allowed for many new opportunities in healthcare in rural and remote locations. One outcome of the COVID-19 pandemic was the acceleration of digital health technologies, enabling individuals to access healthcare while isolating or reducing contact.

Digital technology has become a key focus of the Commonwealth Government and the development of the National Digital Health Strategy 2023–2028 sets the path and vision for person-centred, inclusive and equitable digital health.

This provides great opportunity for improving the connections between of people living in rural and remote areas and healthcare providers.

Further opportunities come with innovations in cancer screening. The self-collection of samples for bowel and cervical cancer screening enables greater access to such important preventive measures.

Case study 2.1

Telehealth and digital health

INNOVATION SPOTLIGHT

Rural Doctors Network – increasing access to multidisciplinary healthcare through digitally enhanced outreach services

People living in rural and remote communities experience poorer health outcomes and have reduced access to health services compared with urban populations. In response, New South Wales Rural Doctors Network (RDN) works to create and sustain access to quality multidisciplinary healthcare for all Australians, no matter where they live, using digital health technology to augment and scale its services.

The Outreach Program, funded by the Australian Government Department of Health and Aged Care, is part of RDN's Health Access initiative that increases rural and Aboriginal communities' access to locally designed and managed multidisciplinary health services. The program overcomes access barriers relating to distance, delay, affordability and cultural safety to deliver more than 1000 services to rural and Aboriginal communities in New South Wales and the Australian Capital Territory. These services are delivered by medical specialists, allied health practitioners, nurses and Aboriginal health practitioners both face-to-face and virtually, as well as using hybrid delivery methods. The outreach models are sustainable and respond to locally identified health priorities.

Digitally augmented outreach services – fully virtual clinics and alternating face-to-face/virtual care – often involve local health practitioners, who provide in-person patient support in clinical rooms, and medical specialists providing virtual consultations. These models support the patient–clinician therapeutic relationship and increase access through timely follow-up care. RDN trialled a general practitioner telehealth model at rural aged care facilities that reduced unnecessary and costly hospital transfers for many frail patients. This has now been scaled through changes to Medicare GP telehealth items.

Digital health also supports rural service resilience and workforce skills. Most outreach services were sustained during COVID-19 when rural and Aboriginal communities worked to reduce community transmission. More than 50% of rural health practitioners reported using virtual models to maintain community access between July 2020 and June 2021 when more than 200 000 occasions of service were accessed by patients, of whom 62% identified as Aboriginal and/or Torres Strait Islander people. Multidisciplinary outreach clinics also facilitate skills and knowledge transfer between health professionals, with 15% of services routinely reporting upskilling activity.

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Case study 2.1 *continued*

Patients have reported high rates of satisfaction when accessing services through the Outreach Program and the provision of virtual care alongside in-person care correlates with higher health practitioner satisfaction. RDN continues to explore ways to use digital health technology to support rural community access to healthcare and invest in rural workforce capability.

Australian Digital Health Agency, *National Digital Health Strategy 2023–2028*, p. 26

1 Outline the elements of the RDN and how it is assisting people living in rural and remote areas with access to healthcare.
2 What future opportunities exist for improving care in these areas?
3 Outline the positive impact that telehealth may have on the health of rural and remote communities.
4 Imagine that funding was not an issue. Propose a strategy that could either increase access to health services for rural and remote areas or encourage doctors and services to move to these areas.

Skills: analysis, creative thinking, problem solving



Figure 2.6 Advancements in communication technology allow for greater access to a broader range of health services for rural and remote communities.

For Aboriginal and Torres Strait Islander people

There has been an increase in the representation of First Nations people in the health workforce, in birthing, among nurse practitioners and in health worker services provided on behalf of medical practitioners. Between 2018–19 and 2022 there was an increase of 21% in primary health services delivered by nurses and First Nations health workers. This increase reflects not just improved representation, but the continued assertion of First Nations Peoples' rights to lead, shape and deliver healthcare in ways that are culturally grounded and community-controlled.

Strengthening the presence and leadership of First Nations people in the health system is a necessary response to the ongoing failures of mainstream services and a vital pathway towards restoring trust, improving access and supporting better health outcomes for communities.

Community-controlled health sector

The Aboriginal and Torres Strait Islander community-controlled health sector plays a crucial role in delivering primary healthcare to Indigenous communities. Aboriginal Community Controlled Health Services (ACCHS) are managed by local community members through elected boards, enabling them to effectively address the comprehensive health and wellbeing needs of their community. These services operate independently from government control. They are a vital part of Australia's healthcare system, providing culturally safe, comprehensive and community-led healthcare specifically tailored to the needs of Aboriginal and Torres Strait Islander communities.

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Figure 2.7 Aboriginal Community Controlled Health Services are an important element in meeting the health needs of First Nations peoples.

ACCHS vary in size and scope, ranging from smaller facilities staffed by Aboriginal and Torres Strait Islander health workers, practitioners, and/or nurses offering basic primary healthcare, to larger centres with specialists providing a wide range of health services. ACCHS prioritise holistic and culturally appropriate care that is responsive to the needs of the community it serves.

Research indicates that ACCHS play a significant role in improving the health and wellbeing of Aboriginal and Torres Strait Islander Peoples by delivering care that is led by community, and shaped by cultural knowledges, values and experiences.

ACCHS are supported by the National Aboriginal Community Controlled Health Organisation (ACCHO), which provides national leadership and advocacy in self-determined, community-developed health solutions.

These organisations continue to provide strong, community-led pathways to health justice in response to the ongoing failure of mainstream health services to meet the needs of Aboriginal and Torres Strait Islander Peoples in culturally safe and respectful ways.

Further opportunities for collaboration and engagement exist within the National Digital Health Strategy and My Health Record with the aim of improving access to affordable and reliable digital services and connectivity of ACCHOs. These changes will enable greater communication and collaboration and allow for better treatment in a more holistic and culturally safe way.

For example, as part of the My Health Record, Indigenous Australians can record any traditional or bush medicines that they are using or have been using, to create a more complete picture of healthcare which allows for more effective treatment.



Figure 2.8 Bush medicine has been practised for tens of thousands of years and involves the use of native Australian botanicals, such as *Melaleuca quinquenervia* (broad-leaved paperbark) for physical and spiritual healing.

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Activity 2.6

Digital health and bush medicine

Follow the links below to watch videos on digital health and bush medicine.
Digital records support preservation: https://cambridge.edu.au/redirect/11419.
How digital health helps to empower people in the Kimberley: https://cambridge.edu.au/redirect/11420.
Can digital health help people stay on Country?: https://cambridge.edu.au/redirect/11421.

1 How do the videos emphasise the role of collaboration between community members and healthcare professionals?
2 What challenges or barriers are mentioned that communities may face when implementing digital health technologies?
3 How do digital health technologies advocate for a holistic and culturally sensitive approach to healthcare?
4 What are some of the key strategies or recommendations proposed in the videos for improving community health outcomes?

Skills: analysis

For individuals with disability

Australia's healthcare system continues to face challenges in the delivery of care to people with disability. The **National Disability Insurance Scheme (NDIS)** continues to provide support and assistance to Australians with a disability. Moving forward, the NDIS has developed a new computer program that it is currently rolling out, which will make the NDIS more accessible and user friendly for all. Digital Health also provides the opportunities for greater support. Outcome 3 of the National Digital Health Strategy is 'Inclusive'. The goal is to provide more flexible options and great support for Australians with disability.

National Disability Insurance Scheme (NDIS) an Australian Government scheme that provides support and funding to those with a permanent and significant disability

Revise and summarise 2.1


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Outline the range and types of health facilities and services in Australia.
2 Outline the various responsibilities of health facilities and services in Australia.
3 Identify the two government systems that aim to achieve equitable access to health facilities and services for all Australians.
4 Describe two factors that can act as barriers to people accessing the treatments and facilities they need.
5 Outline one of the future opportunities for the healthcare system for:
   a people living in rural and remote areas
   b Aboriginal and Torres Strait Islander peoples
   c individuals with disability.

Think critically and apply 2.1

1 You have just been appointed the Minister for Health for Australia. Part of your role is to work to address inequities in the healthcare system. For one area of inequity within healthcare in Australia:
   a Identify and provide a summary of the inequity.
   b Establish a proposal for a way that the inequity could be addressed.
   c Identify the resources that would be required for the proposal to be implemented effectively.
2 Justify the allocation of funding to this proposal.
3 Outline the benefits to the Australian community should the proposal be effective.

Skills: analysis, communication, research, creative thinking

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2.2 Responsibility for the health system

Learning objective 2.2
EXPLAIN how responsibility for Australia's health system is shared by government and non-government organisations.

The Australian Government and state and territory governments collectively fund, operate, manage and regulate the health system. Additionally, both for-profit and not-for-profit sectors contribute by operating public and private hospitals, pharmacies, medical practices, and offering private health insurance products.

The delivery of health services takes place in a range of different settings by a variety of health professionals all working in an array of capacities. Health services are supported by an array of organisations. Health departments and other agencies oversee policy development and service planning. Research and statistical entities gather and disseminate information on health system performance, prevalent health conditions and related issues. Universities and health services contribute to the training of healthcare professionals. Consumer and advocacy groups engage in public discussions concerning policies and regulations. Voluntary and community organisations provide direct support to individuals and engage in activities like fundraising for research and conducting health advocacy programs to raise awareness.

This shared responsibility for the health system promotes the delivery of health services that are accessible, holistic and address the specific needs of communities.

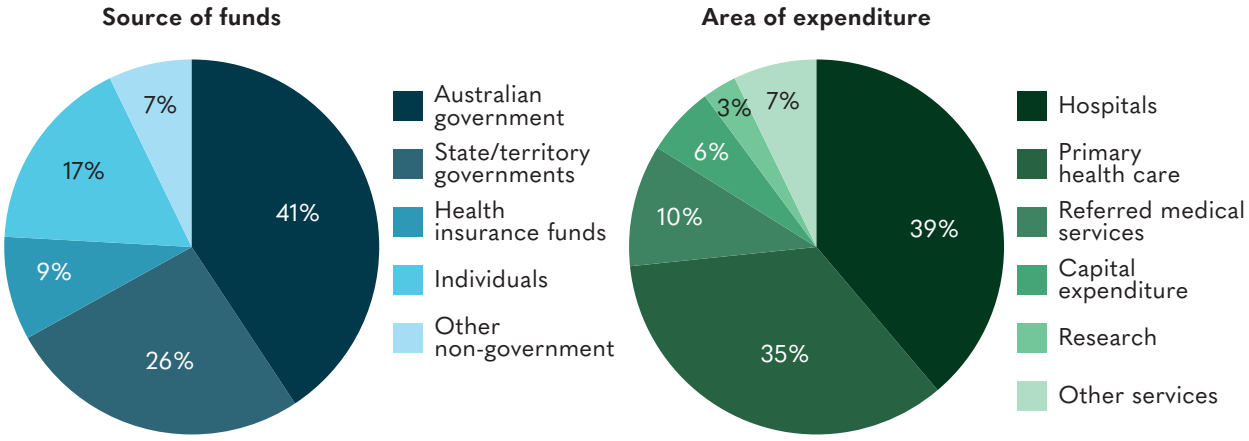


Figure 2.9 Who funds health services and where does the money go?

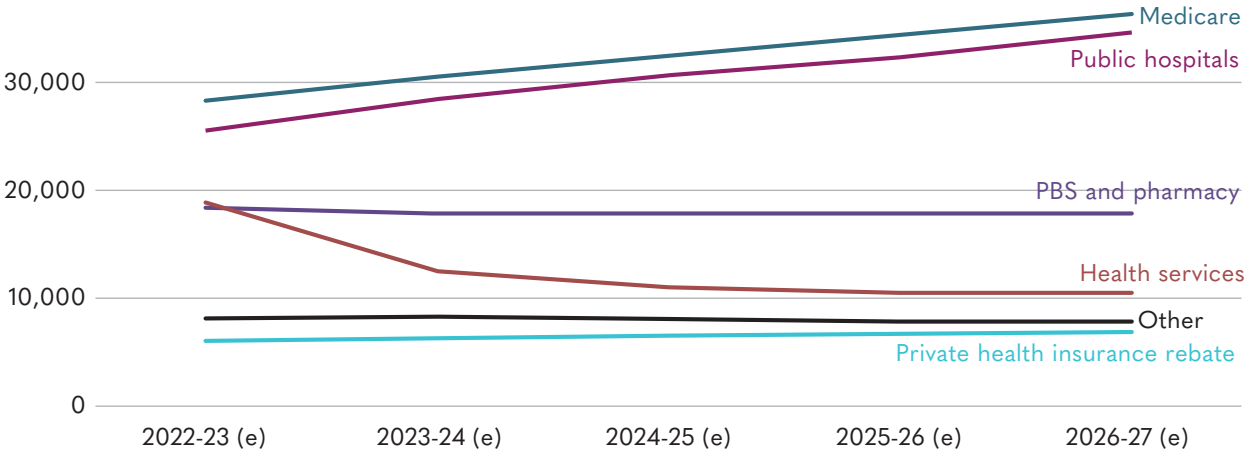


Figure 2.10 Health function expenses, 2022–23 to 2026–27 ($million)

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Commonwealth Government

The Commonwealth Government focuses on generating and allocating funding to the healthcare system and the development of national healthcare policy. Funding is provided to the state and territory governments by the Commonwealth Government, which also influences policy development and implementation in the states.

The Commonwealth Government is also responsible for health programs for specific groups such as Indigenous communities and war veterans, as well as providing funding for research, pharmaceuticals and public health initiatives.

State, territory and local governments

State and territory governments are responsible for delivering healthcare services to the community, including:

- hospitals
- health promotion
- rehabilitation programs
- licensing, inspection, regulation and monitoring of premises, equipment and personnel
- mental health programs
- dental programs
- home and community care
- children and adolescent health programs.

The main responsibility of local government is to monitor areas such as sanitation and hygiene, standards and compliance in the hospitality industry and Meals on Wheels. State governments may also oversee some of the health programs that are implemented by local governments, such as immunisation programs.

Non-government sector

A wide range of services is provided by the private health sector, including private hospitals, dental services and other health professionals in private practice. Although they are independent organisations, they must still comply with Australian standards for healthcare and are approved by the Australian Department of Health and Aged Care.

Private

Private Healthcare Organisations are typically owned by individuals, shareholders or corporations. They operate on a for-profit basis, aiming to generate returns for their owners or shareholders. Funding comes from private sources, primarily through private health insurance, patient fees and out-of-pocket payments. An example is Ramsay Health Care, which provides a range of different healthcare services, including day surgeries and specialist clinics.

Not-for-profit

Not-for-profit healthcare organisations are often owned by charitable groups, religious organisations or community groups. They aim to reinvest surplus funds into their operations rather than distributing profits. A key role of these organisations is also raising awareness about particular health issues, leading research into treatment, prevention and cure, fundraising activities and promotion of social justice. Funding may come from donations, grants, private health insurance and patient fees. They may also receive some government support, particularly if they provide public health services. Key examples in Australia include the Cancer Council, Beyond Blue and the National Heart Foundation.

Activity 2.7

Non-government organisations

Research a non-government organisation such as the Cancer Council or Beyond Blue.

1 What issue do they advocate for? What are their main methods of advocacy?
2 Where does their funding come from?
3 Is there any interaction between the organisation and the government? If so, in what way?

Skills: research, analysis

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Figure 2.11 Princess Alexandra Hospital in Brisbane. State and territory governments are responsible for hospitals.

Quiz

Revise and summarise **2.2**

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What are the responsibilities of each of the levels of government for healthcare within Australia?
2 In what ways are non-government sectors involved in healthcare in Australia?
3 How do government and non-government organisations work together to run the healthcare system in Australia?

Think critically and apply **2.2**

Create a Venn diagram that illustrates how the government and non-government organisations share responsibility for the health system.

Skills: analysis

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2.3 Person-centred healthcare

Learning objective 2.3
OUTLINE how government and non-government organisations collaborate to provide person-centred healthcare.

Person-centred healthcare is based on respect and understanding and not just the treatment of a condition. It is a way of encouraging greater involvement of consumers in the delivery and planning of care and is internationally recognised as a dimension of delivering high-quality healthcare.

Person-centred care involves working with patients, families, carers and support people to work out what is important to them and to share in decision making and care planning.

Person-centred care reflects the holistic nature of health and can lead to improvements not only in patient satisfaction but also in safety, quality and cost-effectiveness of healthcare. It is a key focus of the Australian Commission on Safety and Quality in Health Care.

Healthcare in Australia continues to move in a direction that is more focused on person-centred care, with many health services already embedding this approach in their practices.

To enable the effective provision of this care, governments and non-government organisations need to work together to understand and address the needs of the communities they serve.

Local health districts

Local health districts (LHD) replaced Local Health Networks in 2015 and are responsible for managing public hospitals and health services in defined areas of a state. They are also responsible for promoting, protecting and maintaining the health of communities.

By focusing on a specific area of a state, the LHD can also focus more effectively on the needs of the community.



Figure 2.12 Person-centred care involves communication and consideration of an individual's circumstances and needs.

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Depth Study

Case study **2.2**

South Western Sydney Local Health District (SWSLHD)

On of the largest LHDs in NSW is the South Western Local Health District, which covers an area of over 6000 km^2 from Bowral to Bankstown. The Traditional Owners of this land are the Cabrogal People of the Darug Nation as well as parts of Dharawal and Gundungurra Country.

The SWSLHD is guided by a Consumer and Community Participation Unit which assists in maintaining delivery of healthcare in a respectful manner.

With more than 30% of consumers speaking a language other than English, the needs of the community are diverse. Services overseen and/or managed by the LHD include six hospitals and 14 major community health centres that provide prevention, early intervention and community-based treatment, palliative care and rehabilitation services. The LHD also partners with charity organisations such as the Benevolent Society (not-for-profit independent charity providing a range of support services including disability support) and Karitane (a not-for-profit organisation that provides advice and support services to parents). It provides support to community groups, and promotes fundraising and awareness through events such as Dry July and 24 Hours for Cancer.

PDF

Partnering with consumers case study

Go to the Interactive Textbook and read the downloadable document *Partnering with Consumers Case Study: South Western Sydney Local Health District* before answering the questions below.

1 Explain the importance of the four standard criteria in delivering person-centred healthcare.
2 Outline some of the practical ways that consumers have been partnered with.
3 What are some of the positive outcomes evident from partnering with consumers and with the community?
4 What evidence is there of collaboration between government and non-government organisations?

Skills: analysis

Quiz

Revise and summarise **2.3**

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What is person-centred healthcare?
2 Why is person-centred healthcare beneficial?
3 Describe the role of Local Health Districts and explain why their role is beneficial.

Think critically and apply **2.3**

1 Research your local community health centres and services and identify any ways that they are providing person-centred healthcare.
2 Propose three ways that the focus on person-centred healthcare could be improved from both a government and non-government perspective.

Skills: research, creative thinking

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2.4 Impact of health expenditure on the population

Learning objective 2.4
DISCUSS health expenditure and the impact it has on populations, both now and in the future.

Health expenditure includes money spent on health services and goods by all levels of government, non-government organisations, private health organisations and individuals.

It includes spending on public and private hospitals, allied and referred medical services, primary healthcare (for example, dental, community health, medication), research, administration and transport, aids and appliances.

Depth Study

Healthcare versus prevention

In 2022–23 Australia spent $252.5 billion on health, which is an average of $9597 per person. The majority of this spending was on hospitals ($107.1 billion) and primary healthcare ($83.3 billion). Overall health spending accounted for 9.9% of the gross domestic profit (GDP) in Australia. Health to GDP is a commonly used measure to describe and compare the size of health systems. It measures a country's spending on health as a percentage of its spending on all goods and services. During this period, the government was responsible for funding approximately 70.8% of the expenditure.

The majority of healthcare expenditure is on treating illnesses and managing health conditions through hospitals and primary health services. In contrast, expenditure on prevention aims to reduce the occurrence of diseases and health issues through measures like vaccination programs, public health campaigns, and screenings. Investing in prevention can reduce the need for expensive treatments and improve population health in the long term. However, while prevention has proven cost-effective and beneficial, it often receives a smaller portion of healthcare budgets compared to direct medical treatment, leading to a debate over the optimal allocation of healthcare resources.



Figure 2.13 Prevention programs, such as vaccination, often receive a smaller portion of healthcare budgets than direct medical treatment.

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Activity 2.8

What was the money spent on?

Table 2.4 Total health expenditure, constant prices, by area of expenditure and source of funds, 2022–23 ($ million).

Area of expenditure	Government					Non-government				
	Australian Government				State and local	HIF	Individuals	Other	Total	Total health expenditure
	Department of Veterans Affairs	Health and other	Premium rebates	Total						
Hospitals	**1 020**	**34 850**	**3 553**	**39 424**	**49 665**	**10 600**	**3 465**	**3 934**	**18 000**	**107 089**
Public hospital services	373	31 119	295	31 787	49 409	879	1 093	2 446	4 417	85 613
Private hospitals	648	3 731	3 259	7 637	256	9 721	2 373	1 489	13 583	21 476
Primary health care	**795**	**34 878**	**1 174**	**36 847**	**13 495**	**3 502**	**26 611**	**2 867**	**32 980**	**83 322**
Unreferred medical services	119	11 010	. .	11 129	. .	. .	1 402	1 311	2 713	13 842
Dental services	90	446	825	1 360	995	2 460	7 644	52	10 156	12 511
Other health practitioners	248	2 351	328	2 928	15	979	833	768	2 579	5 522
Community health and other	5	2 158	0	2 163	9 654	1	204	454	659	12 476
Public health	. .	4 452	. .	4 452	2 832	. .	30	174	203	7 488
Benefit-paid pharmaceuticals	333	13 345	. .	13 677	. .	. .	1 538	. .	1 538	15 215
All other medications	. .	1 116	21	1 137	. .	62	14 961	109	15 131	16 268
Referred medical services	**646**	**13 344**	**622**	**14 612**	**. .**	**1 856**	**4 851**	**. .**	**6 708**	**21 319**

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Area of expenditure	Government						Non-government				
	Australian Government				State and local	Total	HIF	Individuals	Other	Total	Total health expenditure
	Department of Veterans Affairs	Health and other	Premium rebates	Total							
Other services	**438**	**2 987**	**1 137**	**4 562**	**6 390**	**10 952**	**3 391**	**3 930**	**317**	**7 638**	**18 590**
Patient transport services	120	157	115	393	4 564	4 956	344	553	149	1 046	6 002
Aids and appliances	148	764	279	1 191	. .	1 191	831	3 367	164	4 362	5 553
Administration	169	2 066	743	2 978	1 826	4 804	2 216	10	4	2 230	7 034
Research	**5**	**5 772**	**. .**	**5 777**	**1 062**	**6 839**	**. .**	**3**	**528**	**530**	**7 369**
Total recurrent expenditure	**2 905**	**91 830**	**6 487**	**101 221**	**70 612**	**171 833**	**19 350**	**38 860**	**7 646**	**65 856**	**237 689**
Capital expenditure	. .	232	. .	232	6 641	6 873	. .	. .	7 953	7 953	14 826
Medical expenses tax rebate	. .	—	. .	—	. .	—	. .	—	. .	—	—
Total health expenditure	**2 905**	**92 062**	**6 487**	**101 453**	**77 253**	**178 706**	**19 350**	**38 860**	**15 599**	**73 808**	**252 515**

. . not applicable
— rounded to zero

Notes:
'Health and other' figures include Australian Government Department of Health and Aged Care's own programs, grants to states and territories (including National Health Reform grants, National Partnership of COVID-19 Response grants, PBS section 100 programs in public hospitals and other National Partnership Payments), funding by other Australian Government agencies (including Department of Defence, capital consumption and others).
'HIF' figures include health spending by health insurance providers.
'Other' figures include health spending funded by other non-government sources (such as injury compensation insurance providers, non-government sector capital spending, non-patient revenue of private hospitals, and other private spending on health and medical research).
Source: Australian Institute of Health and Welfare

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Activity 2.8 *continued*

Examine Table 2.4, which shows the total health expenditure by government and non- government agencies.

1 What are the top three areas of expenditure for governments and individuals?
2 How much is spent on preventive health (public health)? Compare this to the top three areas of expenditure.
3 Outline a potential impact of increasing expenditure on preventive health on overall healthcare expenditure in the long term.

Skills: analysis

Chronic conditions represent the primary cause of illness and mortality in Australia, responsible for 87% of deaths. Approximately 38% of this chronic disease burden could be avoided by addressing modifiable risk factors such as obesity, physical inactivity, and substance use (including alcohol, tobacco and other drugs). For Aboriginal and Torres Strait Islander Peoples, this burden increases to 49%, largely driven by systemic inequities resulting from colonisation, dispossession, and limited access to culturally safe healthcare and resources.

Australia has a strong history of preventive health measures, with successful programs in immunisation, tobacco control, UV exposure reduction, HIV containment, road safety and screening programs. However, despite these successes, the overall investment in preventive health remains relatively low with only 2% of total health expenditure allocated to public health and prevention. This level of funding is significantly lower than that of other similar OECD countries such as Canada and the UK, which allocate over 6% and 5% respectively. Among OECD nations reporting on prevention spending in 2018, Australia ranked 20th in per-capita prevention spending and 27th in the percentage of total health spending allocated to prevention. The National Preventive Health Strategy seeks to address this. This strategy outlines a 10-year plan aimed at enhancing the health and wellness of Australians across all life stages. The goal of the strategy is to reform Australia's health system, which currently focuses predominantly on treating illness and disease, and redirect attention towards prevention—from illness to wellness, and from healthcare to overall health improvement.

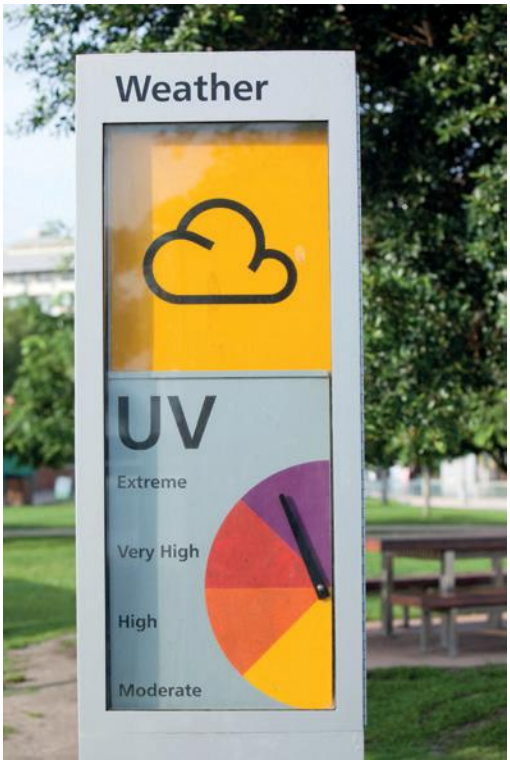


Figure 2.14 Australia has had successful programs in a range of preventative measures, including UV exposure reduction.

The benefits of a stronger focus on prevention extend past mere reductions in the expenditure on healthcare, and include social benefits such as a more productive workforce, increased community engagement, improved quality of life and healthcare for future generations. This plan comes at a time when chronic conditions are becoming increasingly prevalent.

Striking a balance between meeting the immediate medical needs of individuals and investing in long-term health initiatives is a complex challenge, often influenced by political considerations.

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Figure 2.15 National Preventive Health Strategy report card for Australia

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Activity 2.9

Healthcare vs. prevention

Debate: healthcare spending versus prevention of illness or disease.

1 Within your class, divide into three groups: two groups will be political parties, and the rest will be the population, who will vote to decide on the best approach.
2 Imagine you are coming up to an election. The big issue? How to spend money on health.
   - Party A believes most of the funding should go to preventing illness (like health education, vaccinations, and healthy lifestyle programs).
   - Party B thinks the focus should be on improving hospitals and treatments for people who are already sick.

   The voters will listen, ask questions, and decide who made the stronger case.
3 Decide how many people will speak for each party.
   - Each party prepares their arguments. Everyone is encouraged to do some research to back up their points.
   - Voters should make a list of what they'll use to judge the debate (such as how clear the arguments are, how realistic the plans sound, and how each plan affects people now and in the future). They can also come up with questions to ask the parties.
4 Conduct the debate.
   - Each party presents their case.
   - Voters ask questions, give feedback, and vote for the party they think had the best plan.

Skills: collaboration, analysis, communication

Sustainability, equity and access

sustainability the ability to continue at a particular level for a period of time

Health expenditure plays a critical role in shaping the current and future health outcomes of populations, influencing **sustainability**, access and equity.

Sustainability

The multiple challenges of ageing populations, increasing rates of chronic disease, higher costs of new technology, greater awareness of the global impact of carbon emissions, and the expectations of consumers creates many pressures for sustainable healthcare within Australia. As part of a global move towards sustainability, Australia's policies show an increasing emphasis on sustainability at state and territory levels. However, there is notable diversity in approaches among different jurisdictions and, currently, there is a lack of sustainable healthcare programs at the federal level.

Most states and territories have established sustainable healthcare policies and programs, such as the NSW Government's Net Zero Plan, which like many other states is still in initial stages of implementation. These initiatives often require further refinement to be effectively integrated into individual health systems within each jurisdiction.

An example of how this has been done effectively is the *Mid North Coast Local Health District – Sustainable Healthcare Framework towards 2030*, which has taken the Net Zero plan and applied it specifically to their health district. Its goals are related to reducing waste, carbon emissions, and environmental impact, alongside strengthening Aboriginal stewardship for the environment and caring for Country. The framework recognises and values the role that both government and corporations play in addressing climate change and protecting our environment for future generations. It has already seen progress towards some of its goals.

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Case study **2.3**

Mid North Coast Local Health District – Sustainable Healthcare Framework Towards 2030

The Mid North Coast Local Health District (MNCLHD) is an area of NSW extending from Woolgoolga (north of Coffs Harbour) down to Camden Haven (south of Port Macquarie). It is responsible for healthcare services to over 226 000 people, across an area of approximately 11 335 square kilometres.

The MNCLHD aims to operate as a low-carbon, low-waste, and climate-resilient health system that can deliver high-quality, person-centred care.

From a Sustainability Implementation Plan, that ran from 2016 to 2023, the MNCLHD has now established a Sustainable Healthcare Framework Towards 2030.

The framework has six main focus areas: building a sustainable organisation, enhancing people and places, improving clinical care, managing waste and promoting resource recovery, responsible procurement, and developing sustainable infrastructure. These areas are all grounded in an Environmental, Social, and Governance (ESG) framework and were shaped through collaboration with District staff.

A PDF of the framework can be downloaded from https://cambridge.edu.au/redirect/11422. Use this - in particular, the page on 'Our Achievements', and the 'Sustainable Healthcare Plan on a Page' - to answer the questions below.

1 How is sustainability, access and equity represented in the framework?
2 Explain how the above achievements promote sustainability.
3 What impact will practices that promote sustainability have on healthcare spending now and in the future?
4 In groups, imagine you are representatives from the Mid North Coast Local Health District. Prepare a brief presentation to other local health districts, highlighting the importance of sustainability and explaining why your model is effective.

Skills: analysis, communication, collaboration



Figure 2.16 Kempsey is one of the towns in the Mid North Coast Local Health District

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Equity and access

Encouraging greater usage of primary health services reduces the burden on hospitals and emergency care and allows for greater access to preventive measures and early intervention.

The 2023–24 Federal Budget saw a focus on equity and access to healthcare. It included a tripling of the incentive benefit to GPs who bulk bill their patients, thus increasing the availability of this service. This means more patients will be able to access primary healthcare without any out-of-pocket expenses. It is a key factor in encouraging greater usage of primary health services among priority population groups, such as Aboriginal and Torres Strait Islander peoples, and people who live in rural and remote areas. The government said that this would offer a direct benefit to 11.6 million Australians.

The 2024–25 Budget built on this commitment to equity, with a $137.3 million package of measures to support the access of First Nations people to health and aged care services, and cheaper medicines, and a $213.6 million package to improve healthcare access in regional and remote communities.

Activity 2.10

Equity and access for particular groups

Working in pairs or small groups, choose one of the following populations that face inequity in accessing healthcare:

- people in rural and remote areas
- Aboriginal and Torres Strait Islander Peoples
- people living with disability.

For your selected group, discuss, identify, and research the following:

1 The common barriers these groups face when trying to use healthcare and related services, including accessibility and cultural safety.
2 The main areas where equity is not evident.
3 What actions are being taken to improve healthcare access for your chosen group. How is government funding being used to support these efforts in a way that respects and responds to their specific needs and circumstances?

Skills: collaboration, research, analysis

Medicare, private health insurance and related Commonwealth-funded programs

Medicare

Medicare is Australia's universal health insurance system, and one of the key components of accessible healthcare in Australia. It was established in 1984, and is funded by the Commonwealth Government. Medicare is funded through taxes paid by Australian citizens. The Medicare Levy is paid by all Australian taxpayers, at 2% of their taxable income. Further, people on a higher income who don't have private health cover, are also subject to the Medicare Levy Surcharge

Medicare gives all Australians access to free hospital services as public patients in a public hospital. It also pays rebates for other medical services, such as visits to a GP, diagnostic tests, X-rays, pathology services and specialist consultations. As noted earlier in this chapter, healthcare providers may choose to bulk bill: that is, accept the Medicare benefit as full payment for a service. If the practitioner does this, then the individual has no out-of-pocket expenses. If the practitioner does not offer bulk billing, the patient will pay upfront for the service, and then get a rebate from Medicare. Medicare rebates for a service are typically processed automatically and quickly.

In addition, Medicare supports the Pharmaceutical Benefits Scheme (PBS), which subsidises the cost of prescription medications, making these vital drugs more affordable for Australians. The system also includes the Medicare Safety Net, which provides extra financial relief for individuals and families facing high medical costs.

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Private health insurance

Private health insurance offers membership to cover medical and allied services that are not covered by Medicare. For example, most dental services, optical services and allied services like physiotherapy and chiropractic services are not covered by Medicare. There are many different private health insurance companies in Australia.

Private health insurance companies normally offer:

- hospital cover, which helps pay for treatment in a private hospital with choice of doctor, and
- extras cover, which includes a range of health and wellbeing services, such as fertility treatments, massage therapy, optical and dental care, alternative therapies, nutrition consultations, and others.

Members choose the amount of cover they would like, from the options offered by the company, and pay a regular fee (called a premium). They can then claim money back for treatments they may have. Australians with private health insurance generally experience greater access to medical services and healthcare.

The Australian Government provides incentives to Australians within higher wage brackets to take out private health insurance by providing a **means-tested** rebate for those who have insurance and enforcing the Medicare Levy Surcharge on those who do not have private health insurance.

Over time, private health insurance became increasingly complex and many people found it difficult to understand what the various policies covered. In 2018, the Australian Government implemented a series of reforms to the management of private health insurance, to take place in three waves over four years.

The reforms included:

- classifying private hospital cover into four tiers
- allowing insurers to offer:
  - discounts for people aged 18–29
  - lower premiums with higher excesses
  - travel and accommodation support for people requiring hospital treatment a long way from their homes
  - no waiting period for those updating cover to include mental health treatment
- allowing dependents to stay on family policies up to the age of 31 (previously 24)
- extended mental health and rehabilitation at home or in community-based settings
- greater powers for the Private Health Insurance Ombudsman.

means test a way to check how much money a person earns or owns, in order to qualify for government help or support







Figure 2.17 There are many different coverage options when it comes to private health insurance. Three of the largest are Medibank, Bupa and NIB.

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Figure 2.18 Australian Government factsheet about the first wave of private health insurance reforms

Activity 2.11

Private health insurance

Refer to the government information about the first wave of private health insurance reforms, in Figure 2.18 and Video 2.5.

1 In what ways did the reforms increase access and address equity, particularly for people in rural and remote areas, young people and people with a disability?
2 List the benefits available to people with private health insurance.
3 Explain the major differences between the tiers of hospital cover.

Skills: analysis

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National Disability Insurance Scheme (NDIS)

The NDIS provides support to people with disabilities in a variety of different ways. Financed by the Australian Government, it works with individuals to create goals and then develop a plan to support the achievement of those goals. The NDIS works to establish and maintain connections between communities and people with disability, and provides funding to eligible people with a disability, dependent on their needs. Funding can assist with things such as:

- transportation to community and social events and daily activities
- modifications to housing
- modifications to vehicles
- assistance with household tasks
- help within the workforce
- daily life tasks
- mobility equipment
- therapeutic services.

The NDIS is delivered by the National Disability Insurance Agency (NDIA), a government agency that manages applications and determines that is eligible. Several other community-based organisations also partner with the NDIS to ensure access and equity of services.

These include:

- local area coordinator partners, which are community-based organisations that work with all people with a disability in their area.
- remote community connectors, that assist in the delivery of NDIS to remote and very remote communities, First Nations people and those from a culturally and linguistically diverse background
- early childhood partners, that assist by providing early childhood educators and allied health professionals to support children with developmental delays.









Figure 2.19 NDIS funding can assist with things such as transportation, modifications to housing, assistance with household tasks and theraputic services

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My Aged Care

My Aged Care was established by the Australian Government in 2013 to provide easier access to the aged care system. It is the gateway for accessing aged care services funded by the government, and can be accessed either online, by phone, or in person.

My Aged Care assists by providing:

- information about various services to support older people
- assessments to determine what care or services an individual is eligible for
- connections to service providers
- information on any costs associated with care or services.

The aim of My Aged Care is to empower older people to maintain independence and quality of life in a way that best suits them.



Figure 2.20 My Aged Care aims to assist older people in maintaining independence.

Quiz

Revise and summarise 2.4

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What does expenditure on healthcare include?
2 What does expenditure on preventive health include?
3 Identify the benefits of each.
4 Describe the importance of a sustainable healthcare system for future generations. Use specific examples in your answer.
5 Explain how access to healthcare can be improved through expenditure.
6 Discuss the importance of equity in healthcare for current and future generations.

Think critically and apply 2.4

1 Create a mind map or diagram that demonstrates the role of Medicare, private health insurance and other Commonwealth-funded programs.
2 If you were the Minister for Health and Aged Care in Australia, what would you prioritise in a health budget, and why? Discuss as a class.
3 Explain how governments should balance health expenditure with other societal needs?
4 Propose one policy change to ensure that health expenditure benefits future generations.

Skills: analysis

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2.5 Complementary healthcare

Learning objective 2.5
EXPLAIN complementary healthcare approaches.

Complementary healthcare approaches have shown an increase in usage in Australia over the past decade and refer to a broad range of treatments and healing practices that traditionally haven't been viewed as part of conventional evidence-based Western medicine. Many forms of these treatments and practices have existed for hundreds of years in the cultures in which they originated and in more recent years have increasingly been used to support conventional medicines and therapies.

The increase in use of complementary healthcare approaches has been driven by increased globalisation, multicultural influences, social trends, accessibility of information, and increased recognition of these therapies and services by private health funds.

Range of products and services available

Complementary healthcare approaches are claimed to target a range of body systems in a number of ways. Common forms include the following practices:

- **Acupuncture** is based on ancient Chinese beliefs, and involves inserting very fine needles into the skin at certain points where the body's natural energy flows. Acupuncture is claimed to be effective for a range of conditions, including migraines and headaches and joint and back pain.
- **Aromatherapy** uses essential oils, and claims to be a holistic treatment with benefits for both physical and emotional health. The essential oils can be used in massage, in baths or inhaled in vapour form.
- **Ayurvedic medicine** began in India 3000–5000 years ago and is a holistic system of healing. Using a range of natural remedies, including yoga, massage and herbal medicine, it seeks to promote healing within the body, preserve health and prevent disease.
- **Bowen therapy** is a form of physical treatment to the muscular and connective tissue in the body and claims to realign the body and stimulate energy flow. Bowen therapy is claimed to be effective in treating a range of musculoskeletal conditions, stress, arthritis and even sinus symptoms.
- **Chiropractic** is a physical treatment technique focusing on the nervous and musculoskeletal system and its association with the spine. It involves the adjustment and manipulation of joints in the spine to affect the nervous system, which is believed to provide health benefits to many parts of the body.
- **Herbalism** is based on the belief that humans have the ability to heal themselves. It involves the use of whole plants and herbs to form natural medicines that are used to support and replenish the body's healing mechanisms.
- **Homeopathy** is a treatment claimed to promote individual healing. It is based on the principle that substances that cause symptoms in healthy people will cure similar symptoms in sick people. These substances are heavily diluted in water before being used to treat the individual. Scientific studies have repeatedly shown homeopathic remedies to be ineffective.
- **Naturopathy** is a holistic approach that claims to treat the whole person by harnessing the body's own processes and its ability to heal and regulate itself. It is a non-invasive form of treatment, and encourages minimal use of drugs and surgery.

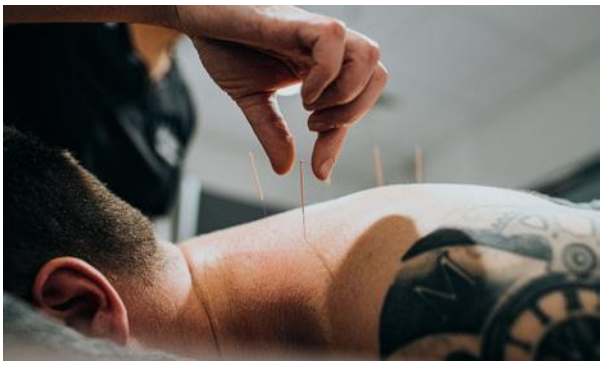


Figure 2.21 Acupuncture involves the insertion of very fine needles into the body to treat pain, headaches and other ailments.

complementary healthcare approach a broad range of treatments and healing practices, used together with (and not instead of) evidence-based conventional Western medicine

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- **Osteopathy** is based on the principle that overall health is related to the functioning of the skeleton, muscles and connective tissue and their ability to operate together efficiently.
- **Health apps** are growing in number and popularity, with many linked to wearable devices. Health apps and websites can assist in monitoring an individual's biomedical data such as heart rate and blood pressure, monitoring behaviour and mood, and monitoring sleep patterns. They also may assist with managing medications, keep track of changes in health, or promote healthy behaviours such as reducing harmful activities and improving mental health.

Activity 2.12

Wearable technology

Conduct and write a review of one type of wearable technology. Consider its benefits and applications and any limitations. Use the following questions to assist:

1 What functions does it have?
2 What sets it apart from the others on the market?
3 What health benefits do you perceive to be possible from the use of the technology?
4 Who is the target market and why do you think that?
5 How accessible is it?
6 Do you deem it to be financially worthwhile?
7 Are there any lower cost comparable options?
8 Give the technology a rating out of five stars.

Skills: analysis, research

Complementary healthcare for prevention

The need for a greater focus on prevention is becoming increasingly important, with half of all Australians having at least one chronic disease. The encouragement of health and active ageing and the support of lifestyle modifications, good nutrition and overall balance is emphasised by most complementary medicine practitioners. Complementary medicines and healthcare are recognised by the World Health Organization as important in providing care to population groups. Appropriately monitored and integrated complementary healthcare approaches can assist in the prevention of numerous health conditions and chronic illnesses.

Activity 2.13

Complementary healthcare approaches and chronic disease

1 For one of the complementary healthcare approaches listed above, research how it can reduce the risk of chronic disease. In your research, make sure that you are considering the reliability of the information you are gathering.
2 Present your findings as either a PowerPoint, infographic, short podcast or article.

Skills: research, communication

Complementary healthcare for treating health issues

The place of complementary healthcare in treating health issues should be considered carefully. Due to the limited nature of research surrounding many complementary healthcare approaches and the variety in the delivery of services, care needs to be taken when using them in replacement of conventional medicines and treatments. The WHO recommends that while the use of complementary medicines is valuable and to be embraced, this should be done 'appropriately, effectively and safely, based on the latest scientific evidence'.

Complementary healthcare as a supplement to other medical treatments

Complementary healthcare approaches can provide many benefits when used alongside conventional medical treatments for various health conditions.

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These benefits include access to a broader range of treatment options, palliative care to manage the side effects of conventional treatments, improvement in mental and emotional wellbeing, and increased patient satisfaction. For example, a patient undergoing treatment for cancer may use complementary therapies such as acupuncture, aromatherapy or reflexology to assist with pain management or fatigue. However, consultation with medical professionals in these cases is necessary to ensure that the complementary therapy does not interfere with the treatment or increase negative side effects.

Integrating traditional products and practices with modern medicine supports overall health and the safe and effective treatment of health conditions. However, it's important to note that complementary healthcare should not replace or cause a delay in seeking conventional healthcare for serious or time-critical medical conditions such as a heart attack or an aggressive cancer.

Activity 2.14

Migraines and chronic headaches

1 Research and describe the characteristics and symptoms of a migraine.
2 Identify the conventional treatments used to manage a migraine.
3 Investigate how complementary therapies such as acupuncture can be used for treatment, prevention and/or supplementary treatment of migraines.
4 Analyse the benefits of these therapies, compared to more conventional approaches such as medications?

Skills: research, analysis

Revise and summarise 2.5


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What are complementary healthcare approaches?
2 Describe three different complementary healthcare approaches and what benefits they may provide the user.
3 Using a specific example, outline how complementary healthcare approaches can be used as a preventive measure.
4 Using a specific example, outline how complementary healthcare approaches can be used to treat a health issue.
5 Using a specific example, outline how complementary healthcare approaches can be used to supplement other medical treatments.

Think critically and apply 2.5

Health apps and websites are becoming increasingly popular in supporting the health of Australians.

1 As a class, discuss the following questions.
   a What health apps or websites have you used or heard of?
   b Why do people turn to apps or websites for health information?
   c What risks might arise from using unreliable or inaccurate health platforms?
2 As a class, create a checklist that someone could use to evaluate a website or app (you may like to read ahead to section 2.6 if needed).
3 In groups, select and evaluate a health app or website and prepare a summary of your findings to present to the class.
4 Extension: What role should governments or organisations play in regulating health apps and websites?

Skills: research, analysis, communication, collaboration

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2.6 How to be a critical health consumer

Learning objective 2.6
EXPLAIN why it is important to be a critical consumer of health information, products and services.

Being a critical health consumer means actively engaging with health information, products and services. It involves the ability to research, evaluate and make informed decisions about matters relating to health. Being a critical health consumer is directly linked to health literacy and is a key determinant of health status.

Who to believe

With so much information available, it can be difficult to determine which sources are genuinely credible. This has become even more important given the access to information via the internet and the increase in influencers on social media platforms promoting products and services for monetary gain.

Healthcare professionals such as doctors, pharmacists and allied health professionals are sources of information that can generally be trusted, as they have qualifications and expertise in their given fields. Checking for up-to-date licensing with their professional association can also alleviate concerns of trustworthiness. Having a set of questions that you would like answered before a visit can also help you to find out everything that you want to know.

If you are considering information online, it is very important to identify the source of information. Is it a trusted organisation or a peer- reviewed journal? If so, it is much more likely to be reliable than an individual's personal opinion or information that is presented in marketing for a product.

Conflicts of interest can also reduce the trustworthiness of information. For example, is the source of information selling a product or service? If the information is the result of attempting to market a product or service, there is a possibility of bias.



Figure 2.22 Being a critical consumer is important when navigating the sheer volume of information available on the internet.

Making informed decisions

When making healthcare decisions, it is important to gather and analyse the available information so you can understand your options, weigh the benefits and risks, and consider the potential outcomes of your decisions. The following steps can be followed to assist in the process:

1. Gather information: use reliable sources of information. This may include those identified as trustworthy in the previous section.
2. Establish options: from the information, identify all available options and clarify what each entails.
3. Consider risks and benefits: consider any complications or side effects and the possible benefits for each of the options.
4. Consider personal values and priorities: are there any ethical considerations? Does the product, service or practitioner fit with your goals and values?
5. Cost and accessibility: is there any coverage through Medicare or private health insurance? Is the cost comparable to other options around? Is the cost a one-off expense or will there be any recurring costs?
6. Seek advice: consult with those who have knowledge and expertise in these areas. Read reviews and discuss options.

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7 Make the decision and implement.
8 Review and evaluate: consider the pros and cons of the product or service. Did it achieve the result you wanted? Did it deliver on everything that you expected? Would you consider it value for money? Was there anything unexpected?

Assessing accuracy and credibility

Accessing reliable information can be quite challenging due to the sheer volume of information available. As mentioned earlier, the most trustworthy sources include those which have the backing of credentials, training and expertise in the area and are affiliated with a **peak body** or are government sources. These include GPs, allied health professionals and hospitals.

The credibility of online information can be more difficult to determine due to the sheer volume and ease with which information can be posted. Reliable online information is available both through trusted government-endorsed websites and through peak bodies such as Beyond Blue or the Cancer Council.

In order to determine whether the information is reliable, there are a few questions you can ask and things to consider.

- Check the source – is it a medical professional or reputable organisation? This is preferable to a company which is selling a product or an individual stating a personal opinion or promoting a product for which they gain compensation.
- Check the evidence – is there scientific research to support any claims that are made? Are the studies reliable and backed by strong evidence?
- Check the date – does the product or service align with current health guidelines? Is the information up to date? Are there any recent reviews?
- Check the reality – be sceptical of claims that seem too good to be true. This is particularly important when using social media as a source of information.
- Check the regulations – has it been approved by regulatory bodies? Are they affiliated with the appropriate body for the service or practice?

peak body the leading organization that represents and advocates for a specific industry, profession, or group

Activity 2.15

Digital health and health literacy of adolescents

Figure 2.23 identifies some of the influencing factors on adolescents' experiences in developing health literacy.

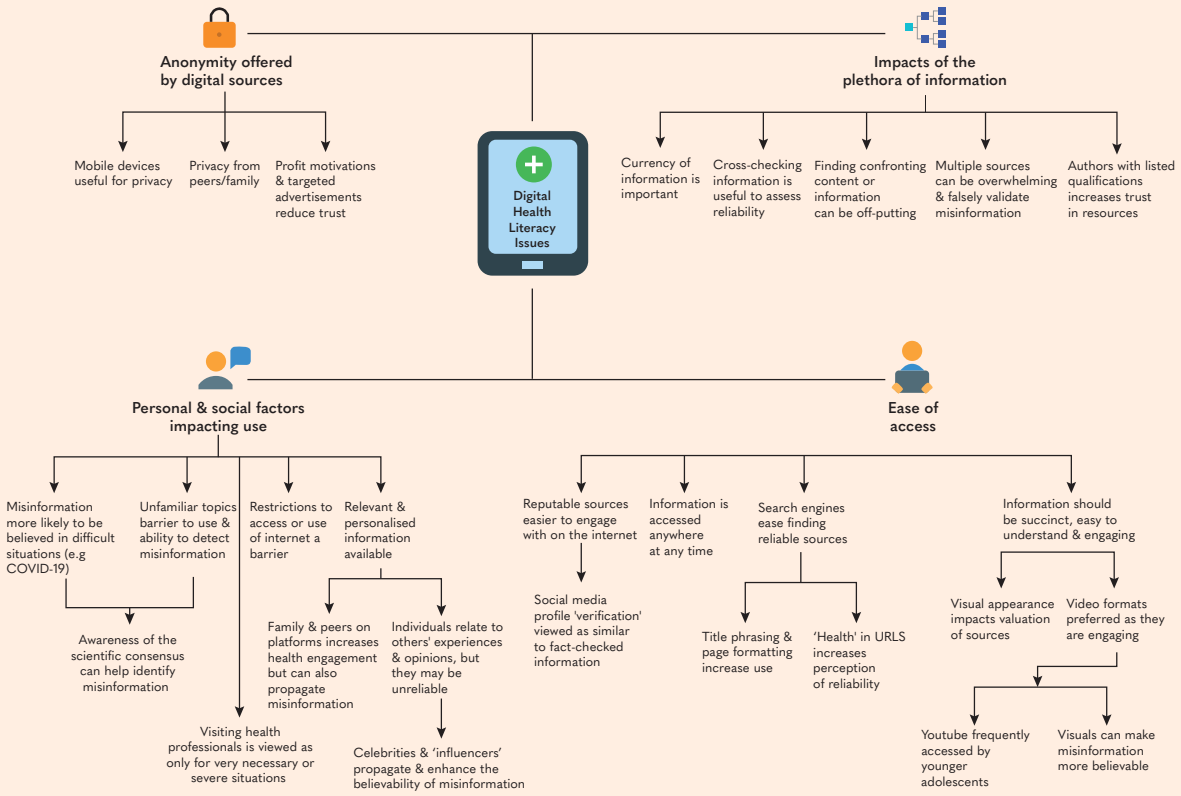


Figure 2.23 Digital health literacy issues: themes and subthemes representing adolescents' experiences and challenges with digital health literacy. A larger version of this graphic can be accessed via the Interactive Textbook.

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Activity 2.15 *continued*

Discuss as a class:
1 Why is health literacy a particularly important skill for adolescents?
2 What might be some of the common types of health information sought by adolescents?
3 In groups, develop a resource that promotes and teaches digital health literacy aimed specifically at adolescents. This could be done in the form of a series of Instagram posts, a YouTube clip or an infographic.

Being a critical health consumer is important for several reasons.

- Ability to make informed decisions: includes the ability to evaluate all available information to distinguish reliable from unreliable information, and to determine the credibility of the sources.
- Avoiding negative health outcomes: critical health consumers are more able to identify potentially harmful products and treatments, avoid ineffective treatments, scams and fads and identify misinformation. A critical health consumer also has a greater awareness of support services available and how to utilise them.


Quiz

Revise and summarise 2.6

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.
1 What is a critical health consumer?
2 Why is it important to be a critical health consumer?
3 What are the three most important things to consider when assessing the accuracy and credibility of health information, products and services? Justify your answer.

Think critically and apply 2.6

Justify why it's important to study critical health consumption in the school curriculum.

Skills: analysis

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2.7 Changes and challenges to the healthcare system

Learning objective 2.7
INVESTIGATE the current and emerging changes and challenges to the healthcare system.

Healthcare in Australia continues to grow and evolve as the needs of the nation change. Current and emerging challenges influence the allocation of funding and shape the structure and direction of the healthcare system.

As you have learned from Chapter 1 and this chapter, the major current challenges in the healthcare system are:

- a growing and ageing population
- chronic illness and disease
- equity of access
- expenditure on prevention versus healthcare
- sustainability.

These issues are also impacted by factors such as advancements in technology and emerging artificial intelligence (AI).

Some emerging changes and challenges include issues such as:

- the changing role of hospitals
- privatisation
- the use of AI in healthcare.

Activity 2.16


Depth Study

Investigation: Emerging changes and challenges to the healthcare system

Split into groups. Each group will be assigned one emerging change or challenge from the list above—or choose a new one the class suggests. As a group, research and answer the following questions.

1 What is the nature of the change or challenge?
2 What and who is driving the change? Why is it coming about?
3 In what way may it be beneficial to healthcare in Australia?
4 In what ways may it have a negative impact on healthcare in Australia?
5 What is the likelihood of this change coming about? Why do you think this?
6 Assess the impact that the change or challenge may have on access to healthcare for those who experience inequity in health.

Skills: research, communication, collaboration, analysis

Revise and summarise 2.7


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Outline the current challenges to the healthcare system.
2 Outline the emerging challenges and changes to the healthcare system.

Think critically and apply 2.7

For one of the areas identified above or another in which you are interested

1 Research the main challenges experienced in relation to healthcare in Australia in this area:
   a currently
   b in the future.
2 What are the changes that have led to this point?
3 Propose three strategies to address these challenges.

Skills: research, analysis

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Chapter summary

- Australia's healthcare system is comprised of a mixture of government and non-government services providing primary care, specialist services, hospitals, aged care, health promotion activities and Medicare.
- Public hospitals offer free services under Medicare and private hospitals mainly focus on elective procedures.
- Public health focuses on prevention and health promotion rather than curative services but the expenditure on these areas is low.
- Digital technologies are becoming increasingly important in increasing access and improving equity for some groups, such as people living in rural and remote areas and Aboriginal and Torres Strait Islander people.
- Inequities exist within the healthcare system, with some groups experiencing limited access to healthcare services and poorer health outcomes.
- There is shared responsibility for the health system between government and non-government organisations.
- Person-centred healthcare improves patient satisfaction, increases safety and is more cost-effective.
- The majority of healthcare expenditure is spent on hospitals and primary care.
- Complementary healthcare such as acupuncture and naturopathy can be used to assist in the prevention or treatment of a condition.
- Consumers need to be able to discern between reliable and unreliable health information and use criteria to make informed decisions.

Multiple-choice questions

1 Despite its strengths, which issue still affects Australia's healthcare system?
- A no access to private healthcare
- B inequities in health outcomes between groups
- C lack of Medicare coverage for any services
- D no support for chronic disease management

2 What is the universal healthcare program in Australia called?
- A PBS
- B Medicare
- C Telehealth
- D NDIS

3 What distinguishes public hospitals from private hospitals in Australia?
- A public hospitals only provide care for the elderly
- B private hospitals are owned and managed by the government
- C public hospitals offer free emergency and outpatient services under Medicare
- D private hospitals do not perform elective procedures

4 What is a key feature of the My Health Record system?
- A replaces all visits to doctors
- B an online summary of an individual's medical information
- C provides automatic free prescriptions
- D only available to rural patients

5 Which of the following is NOT a major current challenge for Australia's healthcare system?
- A growing and ageing population
- B sustainability of healthcare
- C increased funding for public health initiatives
- D chronic illness and disease

6 Why is it important to integrate complementary healthcare with conventional treatments?
- A to replace evidence-based medicine
- B to ensure a more holistic approach without interfering with conventional care
- C to eliminate the need for professional medical advice
- D to discourage the use of pharmaceuticals

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Exam practice

How to answer an exam question

Example question

For one complementary healthcare approach, explain how it can be used to treat a particular health issue. (4 marks)

What is the question asking?

The key verb in this question is **explain**, which means you should try to show the relationships between things, such as what a complementary healthcare approach does, and how it has an effect.

Note that the question asks you to write about **one** complementary healthcare approach, and **one** particular health issue. While you may have knowledge of a range of approaches, and different heath issues they are used for, your answer should be focused on just one of each.

Also, note that it talks about how the approach can be used to **treat** a health issue: the question is not about prevention, nor is it about supplementing other medical treatments.

Marking criteria

Criteria	Marks
• Explains how ONE complementary healthcare approach can be used to treat ONE health issue	4
• Describes how ONE complementary healthcare approach can be used to treat ONE health issue	3
• Outlines a complementary healthcare approach AND/OR how it can be used to treat ONE health issue	2
• Provides some relevant information	1

Sample response

Acupuncture is a form of complementary healthcare based on ancient Chinese beliefs. It involves inserting very fine needles into the skin, in places where it is believed the body's natural energy flows.

Many people turn to acupuncture as a treatment for chronic pain, such as back or neck pain. Stimulation of the specific points in the body used by acupuncture is said to help reduce inflammation, improve the flow of blood, and spur the body to release natural pain-relief chemicals.



Video 2.1 Answering the exam question

Exam-style questions

1. Explain the concept of person-centred healthcare and describe one benefit it offers to the Australian healthcare system. (3 marks)
2. Identify and briefly discuss two major challenges currently faced by Australia's healthcare system. (4 marks)
3. Using a specific example, outline how a consumer of health products and services can make an informed decision relating to health information, products and services. (4 marks)
4. Discuss the impact of health expenditure on the sustainability of Australia's healthcare system. In your answer, include the challenges and strategies to address them. (6 marks)
5. Using specific examples, examine the future opportunities that exist for the healthcare system in Australia. (6 marks)
6. Evaluate the collaborative nature of healthcare in Australia, with reference to the responsibilities of government and non-government organisations. (8 marks)
7. Critically analyse the impact of prioritising expenditure on preventive strategies on future populations. (10 marks)

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Chapter 3
Impact of technology and data on Australia's health system

After completing this chapter, you will be able to demonstrate knowledge of:

- the relationship between health and technology
- new healthcare technologies and treatments
- the impact of digital health on the system
- big data and the health of Australians.

Key terminology

Syllabus terminology:
assistive technology
big data
digital health

Other important terms:
artificial intelligence (AI)
diagnosis
prognosis





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Driving questions

1 Thinking historically, what are some major technological developments that altered human history, leading to a significant step in human progress?
2 How have these technological developments influenced health and medicine?
3 Make a list of specific medical technologies which have led to a significant improvement in human health outcomes.
4 Overall, to what degree has technology improved human health and wellbeing?

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Introduction

At all points of human history, technological developments have advanced human flourishing. Consider the effect of the following major technological developments:

- Ancient period: use of metals for tools and writing systems to record information.
- Middle age period: printing press to increase education and sharing of information.
- Early modern period: electricity which revolutionised the fabric of society.
- Middle modern period: transportation including trains, cars and aeroplanes as well as telecommunications using telephone and radio.
- Late modern period: computers, internet, mobile technology (smartphones), biotechnology and artificial intelligence.

Despite some notable exceptions (increased sedentary living from mechanisation and environmental harm), technology has largely been used to improve human health and will continue to do so with emerging technologies and treatments.

Australia's healthcare system is globally recognised as a quality model of a two-tiered system with public and private healthcare sectors. In 2022, the Foundation for Research on Equal Opportunity (a non-profit, non-partisan US think tank) ranked Australia 5th overall in the World Index of Health Care Innovation, with excellent performance in quality and choice, but below average performance for science and technology and economic sustainability. This is reflected in the 2024 data by AIHW, which recognises that Australia compares well with other OECD countries on many health measures. These include mortality rates, self-reported health status and health insurance coverage, but exceptions are alcohol consumption and rates of people who are overweight and obese.

Many new technologies have helped people live longer, healthier lives, but these benefits haven't been equally shared. Historically, medical research focused predominantly on male bodies, which means conditions primarily affecting women, intersex and gender-diverse people have often been overlooked, misunderstood, or inadequately researched. For example, chronic pain, reproductive disorders, and autoimmune diseases frequently remain undiagnosed or poorly understood. This reflects deeper inequalities in health research. When evaluating new health technologies, it's important to ask who they are designed for, and whose health needs might still be excluded.

Broadly speaking, modern technological developments in health and medicine have greatly improved the health outcomes of many individuals and the general population, and will continue to do so as technology innovates at an increasingly rapid pace.



Figure 3.1 Automated External Defibrillator at Copacabana Surf Club in NSW. Access to this technology significantly increases the survival rates from cardiac arrests.

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3.1 Relationship between technology and health

Learning objective 3.1
DISCUSS the relationship that exists between health and technology.

Through innovative technological research and development in the medical field, our understanding of human health continues to rapidly evolve. The important relationship between technology and health is most evident in the measurement and monitoring of health, as well as diagnostic technology and curative technologies such as precision surgery.

On an individual level, the healthy functioning of a particular body system or organ can be measured using advanced medical technology, allowing for the accurate and early **diagnosis** of a particular disease, illness or injury. Effective measurement of health will consequently lead to the prescription of effective treatment plans and intervention measures aimed at either curing the disease, slowing its progress or improving the quality of life and impact of the condition (depending on the **prognosis**). Ongoing monitoring can track the effectiveness of these interventions, allowing them to be progressively modified. In most cases, early diagnosis leads to a greater chance of survival and improved health outcomes, often requiring less invasive treatments and interventions. When a particular diagnosis requires a direct and physical intervention, precise surgical technologies, such as keyhole surgery, have greatly improved patient outcomes, and have a faster recovery rate, fewer post-surgery complications and economic benefits.

On a community level, measuring health involves gathering data which enables patterns of illness, injury and disease to be correctly identified and analysed, enabling effective interventions to be implemented to improve health. Ongoing monitoring is then used to track the effectiveness of these interventions to inform future direction. New technologies are providing high levels of analysis and insight into specific population health data, which is greatly improving the effectiveness of proposed interventions on targeted population groups.

In the following chapter, a range of current and emerging health technologies are investigated, highlighting their importance in improving health outcomes for all. However, with the advancement of medical technology that is able to keep people alive for much longer than ever before (and well beyond what 'nature' may have previously permitted), there is a significant question raised about the degree to which medical intervention should be used to keep someone alive, particularly if it comes at the cost of a greatly reduced quality of life in other areas. Medical bioethics must wrestle with these dilemmas as technology continues to improve.

diagnosis process of identifying the nature and extent of a particular health problem

prognosis estimating the likely outcome or course of a disease and the chance of recovery or recurrence

Activity 3.1

The integration of technology into daily living

Identify ways that technology is increasingly becoming integrated into our daily living habits and consider the ways this is leading to improved health.

Skills: analysis, critical thinking

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Figure 3.2 The ever-increasing integration of technology into health

Practical application 3.1

Debate: has technology improved health?

In groups, students are to prepare a range of arguments to defend a position that technology has either led to the deterioration or improvement of health.

Skills: collaboration, analysis, communication, critical thinking

Quiz

Revise and summarise 3.1

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What technological advancements in history have most greatly influenced health?
2 How has technology influenced the following aspects of health?
   a measuring
   b monitoring
   c diagnosis
   d treatment.

Think critically and apply 3.1

1 To what degree is it ethical to use medical technology to keep someone alive for as long as possible?
2 At what point could it be considered more ethical to reduce or cease the use of technology that may be keeping someone alive who would otherwise not be?
3 Research the ways the Australian Government and healthcare systems are giving people greater autonomy over the level of technology they elect to use in order 'to do everything to stay alive'?

Skills: analysis, critical thinking, research

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3.2 New technologies and treatments

Learning objective 3.2
INVESTIGATE a range of current and emerging health-related technologies and treatments.

Depth Study

There is a vast range of current and emerging health-related technologies which are improving health outcomes for individuals and communities. These present potential economic benefits, but can also be very expensive to develop and implement, offsetting these savings. The following examples provide a brief overview of some of these technologies. Students may further investigate them as part of a depth study.

Technology to measure, monitor and diagnose health conditions

Imaging technologies

Examples: X-ray, MRI, CT scans, nuclear imaging, medical (camera or scope) imaging.

Imaging technologies provide accurate images and information about the structure and function of human body systems and organs, leading to the exclusion or diagnosis of malfunction and disease. Common examples include cancer screenings (for example, breast, colon), hard and soft tissue MRI imaging for physical damage and deterioration (for example, spinal disc herniation), and camera pills which are swallowed to record images of the gastrointestinal system.

These technologies are used not only in the diagnosis of medical conditions, but also in the ongoing measurement and monitoring of conditions over the course of treatment, to assess the response to other medical interventions.



Figure 3.3 Medical imaging using CAT scan

Pathology technologies

Examples: analysis of bodily fluids (blood, saliva, urine or stool) or organ tissue

Pathology technologies test for the presence or absence of various chemical markers indicative of disease, organ malfunction and ill health. Common examples include testing blood for the levels of iron, calcium, cholesterol and other chemical markers, hormones and indicators of disease and ill health. Pathology tests are also used to detect the presence of infectious diseases – for example, the RAT/PCR testing used for COVID-19.



Figure 3.4 Pathology testing being used to analyse bodily fluid and tissue samples

Genetic testing

Genetic testing involves analysing a patient's genetic (DNA) sequence to identify specific variations/mutations or to assess the predisposition a person might have for a particular disease in their life. For example, if someone has an increased likelihood of developing breast cancer, this could lead them to alter their lifestyle and increase the use of preventive measures, even possibly going so far as to have an early mastectomy.

Epigenetic testing

Epigenetic testing measures changes in gene expression due to lifestyle habits and environmental exposures which may lead to ill health. These scans may find indications of a cancer in its early stages. Further scans can then be done to confirm the presence of cancer before

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other signs may have appeared. For example, blood and stool screening can detect indicators of colorectal (bowel) cancer, leading to investigations that can confirm the location and extent of a possible cancerous tumour.

Technology to treat health conditions

Pharmaceutical or medication technologies

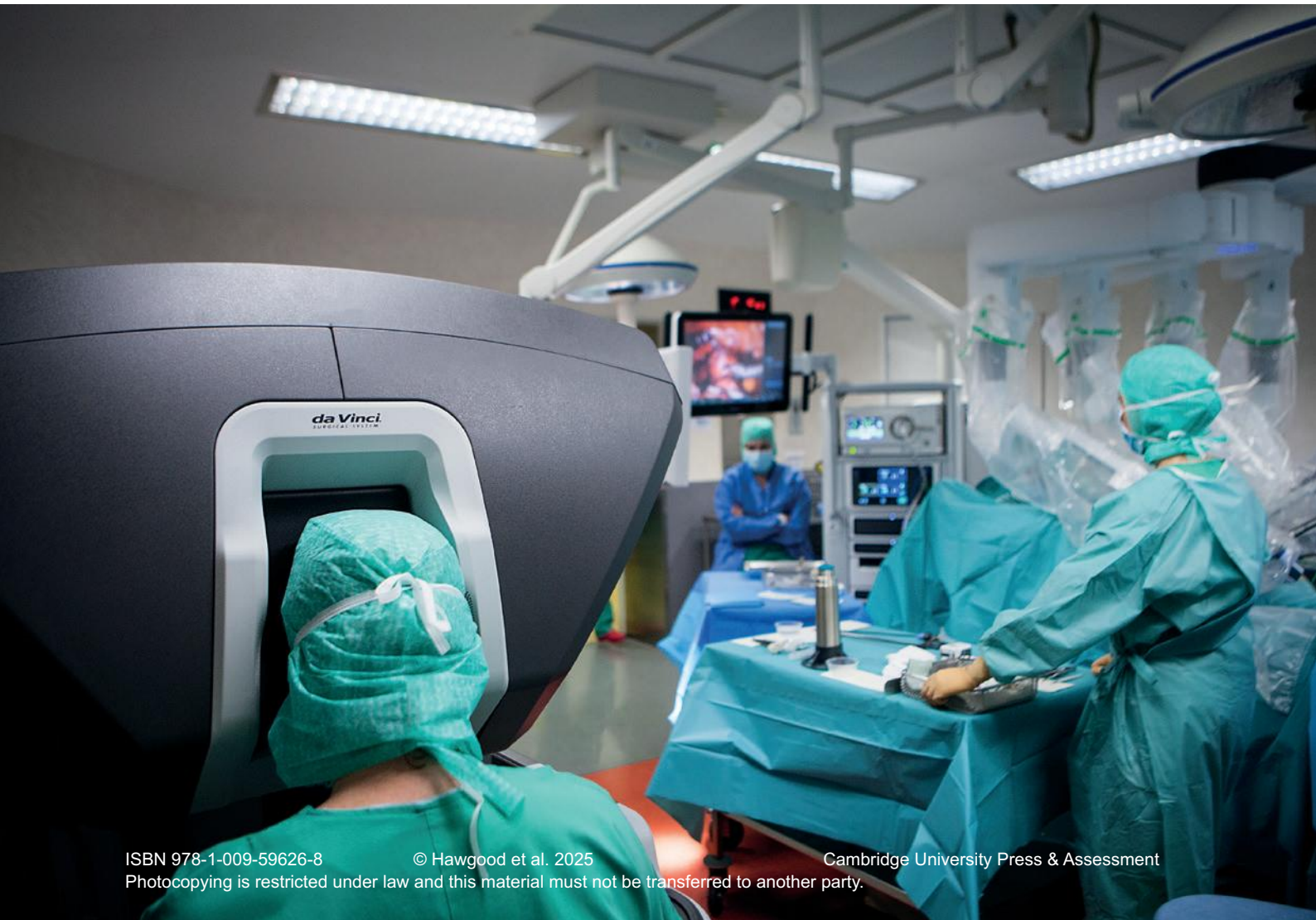
Developments in pharmaceuticals are being used to treat a myriad of health conditions, illnesses, diseases and injuries. The developments are constant, leading to higher quality of life and improved health outcomes for all. AI-powered analysis is assisting with the research and effectiveness of new medications. Automated medication dispensing machines are being used in hospitals and at home to increase the likelihood of controlled and accurate dosage release. Radiation and chemotherapies are increasingly precise in targeting tumours, while having fewer side effects. This leads to higher survival rates from common cancers and improved patient quality of life.

Surgical interventions

The most innovative technological developments in medicine are often seen within surgical theatres. These include surgical tools, equipment and procedures that are less invasive, more precise and more effective, using new materials and advanced electronics.

Robotic-assisted surgeries are increasing the precision of surgery and reducing the risk of human error. These are controlled remotely at a distance away from the patient. The technology could potentially even be controlled in a different location from the patient, where a doctor with particular expertise is located. An example might be a surgeon in a city performing an operation in a rural health centre using such technology.

Figure 3.5 Assistant robots increase the precision of surgery.



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Depth Study

Artificial intelligence (AI) technology in health

Artificial intelligence (AI) technology is increasingly being used across all sectors of medical care and administration.

It is currently used as an aid in diagnostics and analysis, but as AI continues to develop, we can expect to see the use expand across other areas of health.

Diagnostics

The power of AI can be used to aid the diagnostic process by more effectively analysing medical images for abnormalities, and therefore also reducing the potential for human error during the process. For example, when trained using high quality visual data and algorithms, machines can learn to better detect intricate abnormalities in patient samples.

Case study 3.1

Harrison.rad.1

Harrison.ai is a company that develops AI diagnostic tools to support clinicians. It has a focus on addressing inequity in the healthcare system, as well as addressing the shortages and pressures on specialists and doctors.

Its solutions include **annalise.ai**, which offers AI clinical decision support for chest X-rays, and **franklin.ai**, which is a joint venture with global healthcare provider Sonic Healthcare to develop AI tools that will support pathologists.

Video 3.1
Harrison.rad.1 (02:21)

Harrison.rad.1 is an LLM (large language model) AI system that has been trained in radiology diagnostic tasks. Scan the QR code to watch the video before answering the questions below.

1 Research this AI-powered technology and outline how it is intended to be used in the field of medical diagnostics.
2 What are the challenges to the healthcare system and services that this technology aims to help overcome?
3 How can this technology help improve patient services and health outcomes?

Skills: analysis, critical thinking, research

Analysis

Common examples of AI data analysis which directly link to improved health outcomes include:

- analysis of large data sets of patient records to identify patterns and help diagnose diseases and suggest personalised intervention and treatment plans
- more efficient analysis of genetic sequencing which saves time and increases accuracy
- supporting primary healthcare workers with diagnosis by analysing patient signs and symptoms during live and virtual consultations and helping predict disease outcomes and patient prognosis. This can then be used to help them make more informed decisions about the best steps for future medical intervention.
- intricate analysis of medical images to more accurately detect smaller abnormalities
- helping patients to monitor their own health and better manage chronic conditions by analysing personal data and making recommendations to assist

Other uses of AI

Other uses of AI can include:

- monitoring and reporting vital signs from wearable devices for early detection of falls, seizures or cardiac events
- identifying potential risks in complex patient care, such as possible drug reactions.
- offering mental health support through chatbots, although there are concerns with over-reliance on this technology

As advances in AI continue, there will be an increasing number of areas in which it will be able to benefit the health system.

artificial intelligence (AI) technology that enables machines to learn and perform tasks that generally require human intelligence, such as understanding language, recognising patterns, solving problems and making decisions based on gathered data and algorithms

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Other current and future technologies in health

Wireless health monitoring devices are worn to measure real-time bodily functions, detect abnormalities and send data directly to health professionals. These are commonly used to measure cardiorespiratory data – for example, complex heart rate monitors. Emerging wearable technology is being developed for use in neurology (measuring falls and seizures), respiratory health, orthopaedics, obstetrics (measuring a foetus's health), endocrinology (measuring glucose and insulin levels), mental health and smart bandages that can measure the progress of wound healing and care.

Telehealth and **remote patient monitoring** involves using telecommunication technology to provide healthcare remotely. This provides greater access to specialists and enables ongoing interactions outside of the traditional medical and healthcare settings. The use of video conferencing technology has become common in many health practices and the increased availability of mobile and satellite broadband internet has enabled almost everyone in Australia to have access. The lockdowns associated with COVID-19 accelerated the use of these technologies.

Augmented or virtual reality helps surgeons prepare and practise for intricate surgeries using 3D modelling of the human body.

Assistive technologies include a wide range of equipment, devices, software and tools to help people living with disabilities to better perform daily tasks that they may otherwise struggle to complete. Common forms of assistive technologies include mobility aids, hearing aids, vision aids, communication aids, computer and smart phone access aids, cognitive aids (reminders and organisers), learning aids (e-readers), environmental control systems (smart homes) and health monitors (wearable devices and medical alert systems such as fall detectors).

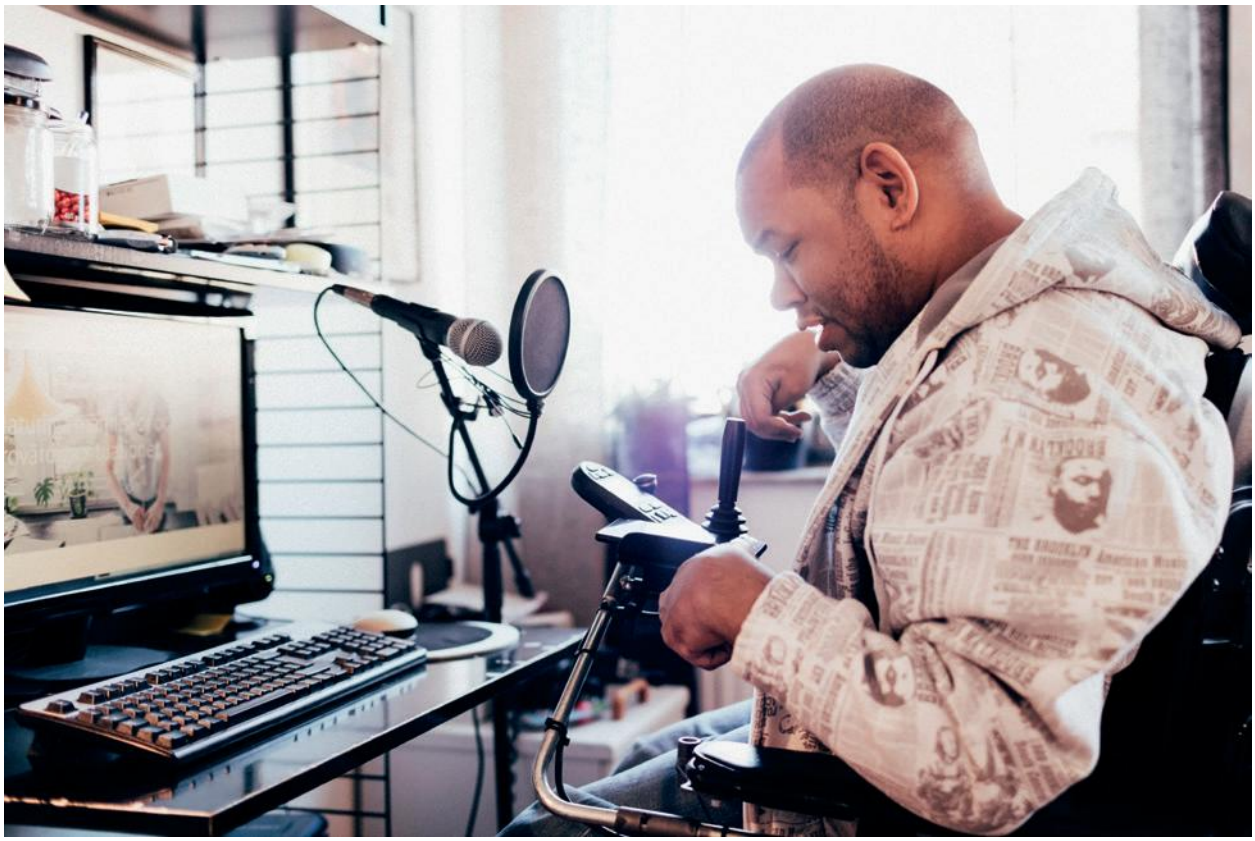


Figure 3.6 Assistive technologies help people overcome functional disabilities.

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Figure 3.7 3D bioprinting being used to create a digitally engineered prosthesis for a cancer survivor who lost her right eye and jaw due to cancer

Smart phones and health apps are being used by health professionals to enhance clinical knowledge, assist them in their diagnostic processes, provide telehealth and assist with patient care. For individuals, a range of beneficial health apps can be used:

- **General health and wellness apps** help people to better understand the pillars of good health and wellbeing, and can track a range of helpful markers such as sleep, movement and nutritional intake.
- **Telehealth and video conferencing** can increase access to healthcare professionals.
- **Digital therapeutic apps** can help support patients with specific conditions, providing opportunities to report their health, integrate with wearable technology and receive reminders and support to empower them to take greater control over their health. There are excellent examples of these for type 2 diabetes and for mental health.

Regenerative medical technologies use 3D bioprinting, where living tissues are mixed with 3D-printed forms to construct natural tissue for implants. 3D scanning and printing is also being used to produce highly precise prosthetics for amputees and for use in surgeries such as joint replacements where individualised surgical components are being produced and inserted, leading to greater patient outcomes.

Gene editing technology, specifically the use of CRISPR-Cas9, is being used to remove, add or alter parts of the genetic sequence linked with ill



Figure 3.8 Bioelectronic prosthesis that communicates with sensors on the healthy limb and uses AI to learn how to move better

health. Any disease with a genetic component is potentially able to be influenced, such as various cancers, high cholesterol or a specific genetic condition such as sickle cell anaemia.

Smart implants and **bioelectronic devices** are implanted into the body and interface with body organs and the nervous system. They offer diagnostic support (e.g. blood pressure monitoring), therapeutic benefits such as neural stimulation (e.g. cochlear implant to aid hearing loss), pain relief (devices that interrupt pain signals before they reach the brain) and enhanced motor function (by rerouting neural signals around damaged parts of the nervous system, leading to restored movement in affected limbs, or by integrating neural control over limb prosthesis, allowing them to be controlled by the brain and have more precision).

Nanotechnology uses minuscule materials (of the scale of a billionth of a metre) to improve health. Specific examples include:

- nanoparticles to aid in drug delivery to targeted cells and tissues and decrease impact on healthy cells and tissue
- nanoparticles to build tiny 3D scaffolds that can help regenerate healthy tissue and replace damaged or diseased tissue
- nanobiosensors to detect biomarkers of disease at incredibly small scales, leading to more accurate diagnosis.

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Activity 3.2

Select THREE of the health technologies outlined in this chapter and complete a more critical investigation. Prepare a presentation that demonstrates how the technology works to improve health.

Skills: analysis, communication, critical thinking, research

Quiz

Revise and summarise 3.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Outline how new technology is being used in each of the following areas:

- measure
- monitor
- diagnose
- treatment/surgery
- health administration
- research.

Think critically and apply 3.2

1 Debate as a class the degree to which new technology should focus on diagnosis as opposed to treatment.
2 From your answers to 'Revise and summarise 3.2', choose technologies from at least two of the categories and attempt to rate their potential impact on future health trends and needs.

Skills: collaboration, analysis, communication, critical thinking



Figure 3.9 A teenage girl uses a continuous glucose monitor that connects to her smartphone.

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3.3 Digital health

Learning objective 3.3
EVALUATE the impact that digital health will have on current and future healthcare systems.

In Australia, digital health is defined as the systems, tools and services that use communication technology and information technology to help diagnose and treat patients, collect their personal information and share this information appropriately (AIHW, 2024). Ultimately, digital health aims to increase the quality and efficiency of the **information that is shared** between patients and all providers and sectors of the healthcare system.



Figure 3.10 Increasing use of mobile phone technology is improving patient access to information and services.

Digital health services

Common examples of services that use digital health in Australia include:

- use of **smartphone technology and apps** to increase communication and information to the patient (app reminders, mobile SMS messages, health apps), as well as between the patient and the healthcare provider (health monitoring information such as blood glucose levels and self-reported patient surveys to track mental health and wellbeing)
- **electronic prescriptions** which are safer and more convenient for all. Digitising the prescription of pharmaceuticals increases efficiency, tracks usage more accurately and increases the sharing of information between relevant providers.
- **electronic health records**, which are used to centralise the collection and storage of personal and private medical information (My Health Record and **my health** app), allowing for increased access and sharing of information between authorised users
- **telehealth** using video conferencing and AI support to improve access, communication and decision making between the patient and healthcare provider
- **electronic referrals** to increase the efficiency of administrative processes between related services
- **using AI to support complex technological research and development** by analysing large data algorithms and evidence-based publications
- **using AI to assist with the complex administration of human and IT resources**. For small operators, this is used to help with scheduling and billing, increasing time for patient care. At the institutional level, large hospitals can greatly benefit from AI in helping them better manage the enormous complexity of the resources and processes involved, leading to greatly improved hospital efficiency.



Figure 3.11 Telehealth using video conferencing technology enables doctors to connect with patients remotely.

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Successes of digital health

There are many examples of the substantial impact that digital health has had on successfully connecting the health information of the individual with the healthcare system. These include:

- **improved access** to healthcare through telehealth which can extend services and overcome geographic, language and cultural barriers
- **enhanced patient engagement** as the integration of smartphones, wearable devices and apps can increase the awareness people have of lifestyle and health factors they need to maintain.
- **improved patient health outcomes** through more accurate diagnostic procedures, and suggestions for best practice intervention based on all available information
- **increased efficiency** with streamlined hospital administration, enhanced communication between healthcare professionals and greater access and analysis of patient records
- **economic savings** as medical technologies can require less invasive and ongoing treatments and overall lower administrative costs
- **advanced analytics** of epidemiological data using powerful AI, which allows for greater detection of the patterns of ill health in population groups, leading to more targeted interventions and improved population health.

While Australia has been actively building a strong platform for the future of digital health, there are **ongoing challenges and opportunities** that it can provide for individuals and organisations. The Australian Government has established the Australian Digital Health Agency to oversee digital innovation, accessibility and connection as an integrated and vital aspect of the Australian healthcare system.

Opportunities and challenges

The **opportunity** that digital health presents in improving health outcomes was paramount during the COVID-19 pandemic. The systematic integration and collaboration of various government and health organisations was essential for an effective and coordinated public health approach, which sought to minimise the harm associated with the infectious threat that COVID-19 posed to the health and economic welfare of Australians.

Some of the **challenges** that digital health faces include:

- **equity of access** and ensuring that all Australians have an equal opportunity to use the various tools of digital health, regardless of social, cultural or economic background
- ensuring **health information systems are compatible**, allowing for data to be shared between them accurately and meaningfully
- ensuring that all individuals and organisations are **educated about personal data**, so that they understand their rights and are equipped to manage their own data responsibly through active data literacy (able to explore, understand, and communicate with data in a meaningful way) and data citizenship (citizens are proactive in the agency or management of their own data)
- ensuring the **security and privacy** of the very sensitive information that is stored and shared from the My Health Record database.


Quiz

Revise and summarise 3.3

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Define digital health and provide examples from the Australian healthcare system.
2 Outline the advantages of digital health.
3 Outline the challenges of digital health.

Think critically and apply 3.3

Explore the opportunities and challenges that digital health can offer those who suffer from ill health as a result of social disadvantage.

Skills: analysis, critical thinking, problem solving

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3.4 Big data and the health of Australians

Learning objective 3.4
EXAMINE the impact that big data is having on healthcare systems and the health of Australians.

In the context of health, as all health sectors become connected via **digital health**, there is an overwhelming surge of varied data being collated at increasing speeds. This **big data** is collected from a range of sources, and whenever someone interacts with a healthcare provider or completes a survey, anonymised information is collected. This may include health challenges, lifestyle behaviours and treatments being used. Within these health-related data sets, critical information is able to be harnessed to guide evidence-based decision making that will lead to improved health outcomes for individuals and communities.

How big data is used

Depth Study

There is a range of ways big data can be used in the healthcare system. Big data can be used to:

- inform and review health promotion activities and interventions, particularly for targeted population groups that may suffer higher rates of ill health
- guide future health-related policies and funding decisions
- improve healthcare system administration and delivery
- direct future health research and development by targeting specific intervention needs.

Ultimately, big data is being used to improve individual and population health measures.

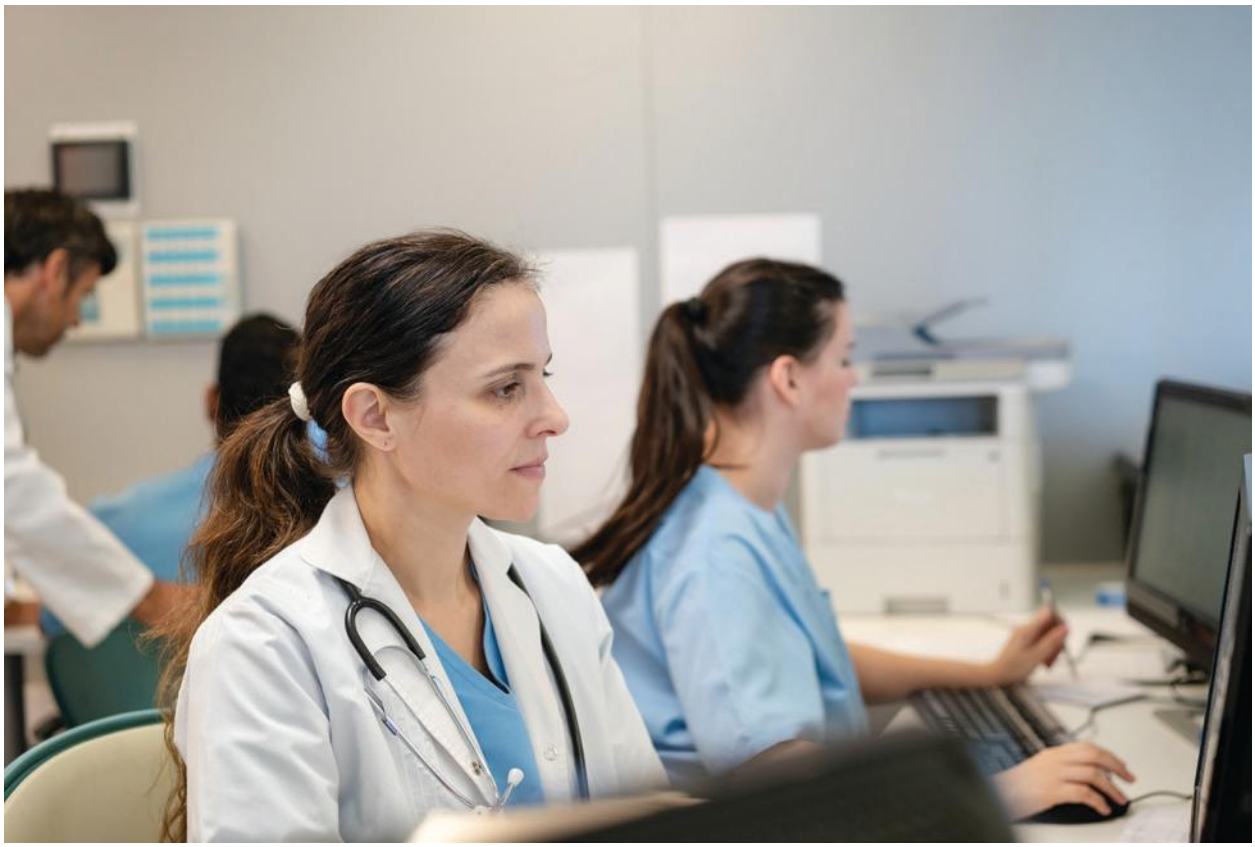


Figure 3.12 Big data can improve healthcare system administration and delivery.

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Case study **3.2**

NEWS REPORT

Using big data to find the best healthcare for older Australians

Australian Government Department of Health and Aged Care, 1 February 2023

Registry of Senior Australians (ROSA)

Professor Maria Inacio is Director of the Registry of Senior Australians (ROSA) at the South Australian Health and Medical Research Institute. Maria helped set up ROSA in 2017. The registry combines healthcare and aged care data from around Australia. This combined data gives a whole picture of Australia's ageing pathways for the first time.

'I'm a technical person. I love the challenge of working with data to learn new things,' Maria says. 'I'm passionate about how we can use this information to improve care for older people.'

Evidence on aged care quality and safety

In the past, Maria used data from ROSA to give evidence to the Royal Commission into Aged Care Quality and Safety. 'Our data influenced the Royal Commission's recommendations. It helped drive reforms to aged care,' Maria recalls.

'For example, our data showed that when older people entered aged care facilities, they received more psychotropic drugs. That evidence supported a recommendation to reduce the use of psychotropic drugs in aged care facilities.

'Since the Royal Commission, there has been better quality and safety monitoring and a better data strategy to evaluate aged care quality,' Maria says.

Finding the best healthcare for older Australians

Maria is now leading the first comprehensive nationwide evaluation of older people's use of primary healthcare and the effectiveness of this care in aged care settings.

Older people have more frailty, falls, chronic conditions and co-existing diseases. This means they have a high risk of emergency department presentations and hospital admissions.

These events often have poor health results including decline in function and quality of life. 'Better primary healthcare could improve older people's health and wellbeing,' Maria says.

'We want to find out how much primary healthcare older people get. We also want to know how care changes when people enter aged care facilities.'

Which healthcare services are best?

'93% of people in aged care facilities visit a GP about 25 times a year,' Maria reports. 'But we don't know the results of these visits or if they meet older people's needs.'

To answer that question, Maria is examining the relationship of primary healthcare services with:

- hospitalisations
- subsequent health encounters
- the length of stay at home or in residential care.

'I want to be able to find the services or best combination of

continued

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Case study 3.2 *continued*

services that an older person can get to do the best they can. So, it's better for them, better for the system and less expensive,' Maria explains.

The positive effect of preventive healthcare

In early results, Maria found there are three healthcare pathways for older people in aged care facilities. They have different mortality results:

- Older people who have preventive or multidisciplinary healthcare have the lowest mortality. This includes:
  - health assessments
  - chronic disease management plans or multidisciplinary care plans
  - medication reviews
  - allied health services
- People who see a GP a few times a year and receive minimal other services have mid-level mortality. Maria says this is likely due to them having less health issues.
- People who see a GP frequently, including urgent, after-hours consultations have the highest mortality. Maria says this may be because they have declining health, but it also may be because their healthcare is not well managed. She is trying to work through this question now.

'It is reassuring to know that preventive healthcare can have a positive impact. We need to give people in aged care the best quality of life and the best experience they can have,' Maria concludes.

How much preventive healthcare do older people get?

But Maria's study shows that older people do not get as much preventive healthcare as they should.

'They should have chronic disease management plans and a health assessment and medication review every year. They should get more mental health and allied health services. This may be enough to keep older people healthy with a stable level of functional capacity and prevent cognitive decline.'

'But only about half of the people who are eligible for chronic disease management plans get them. The use of other services is even lower. This doesn't change much or gets worse once they enter aged care settings, which is unfortunate.'

Maria's research indicates more coordinated and comprehensive primary healthcare could improve the health of older people. This could translate into a lower risk of hospitalisations and other health events. 'This approach could also make immense cost savings,' Maria notes.

A community of stakeholders

Stakeholders who deliver primary healthcare to older people in aged care settings guide Maria's research. 'That community will also help put our findings into practice,' Maria says.

Maria's project 'Using Big Data to Create Evidence-based Primary Health Care Service Delivery and Policy for the Australian Aged Care Sector—A Nationwide Study' received a $1.435 million grant from the MRFF. In 2021 the MRFF contributed to supporting ROSA with a grant of $2 million.

continued

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Case study 3.2 *continued*

1 Summarise the relationship that exists between the quantity and range of healthcare services that older Australians access and their level of mortality.
2 What recommendations are made to the type of healthcare services that older Australians should access if they are to improve their health outcomes?
3 In this context, how has big data been used to identify issues of healthcare access and proposal of solutions to these issues?

Skills: analysis, communication, critical thinking, research

Big data and healthcare spending

Using big data in these ways ultimately leads to the provision of higher value healthcare, while also reducing low-value healthcare. High-value healthcare seeks to allocate available resources to provide the best possible care at the lowest possible cost to benefit the largest number of people in need. Additionally, reducing low-value healthcare seeks to decrease wasteful healthcare costs that are not cost-effective and are not having the desired impact on health.

Big data helps to redirect low-value healthcare towards more cost-effective measures with the greatest need. Evidence-based reviews have demonstrated many cases in which the use of expensive resources on specific services was not leading to improved health outcomes, and therefore was able to be redirected. An example of this occurred in the Victorian healthcare system, where it was shown that a large proportion of colonoscopies were not resulting in early detection of cancer or better cancer survival rates.

Big data and disease management

Big data is used to more accurately identify epidemiological data that shows specific population groups who are suffering from higher rates of chronic conditions. It is also used where infectious outbreaks are identified using surveillance measures, allowing for more rapid and targeted responses and preventive measures.

Big data that leads to early detection and diagnosis of disease allows for more effective measures and treatments to be used, leading to high curative rates and better management of chronic conditions. This improves patient quality of life and presents a cost saving to all. It can also highlight population groups who are less engaged in preventive measures such as cancer screenings and therefore will likely suffer more in the future, thereby promoting social justice.

Privacy and confidentiality of patient information

Navigating the complex fields of big data amid privacy and confidentiality concerns is a significant challenge for all policy makers and healthcare professionals to be aware of. There is a range of measures which can be put in place to protect and secure this potentially valuable information which can be misused.

- **Data encryption** helps protect information from being accessible by unauthorised users.
- **Data controls and security technologies** restrict and protect access to health information by unauthorised users.
- **Data anonymisation and de-identification** disconnects personal information from data so that individuals cannot be identified.
- It is crucial to ensure that all sectors and organisations comply with the **legal and regulatory standards** relating to health data privacy and security.
- It is important to implement **training and awareness** for all authorised employees who have some level of access.
- **Data minimisation** measures ensure that only necessary data is collected.

The Australian healthcare system faces future challenges regarding big data and digital health. Australia has a fragmented healthcare system, which could be an obstacle to sharing of information. Each state is responsible for primary healthcare while operating under many federal governing bodies, as well as the challenge of a two-tiered system with public and private sectors. There is also the need to promote and improve the consistency of health data that is collected and the need to develop coordinated strategies to harness the potential power of big data. Government regulation and legislation must facilitate the potential benefits of big data, while minimising the possible harms and negative consequences of data breaches.

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Activity 3.3

Information privacy

In 2024, it was reported that medical imaging lab I-MED was giving harrison.ai (see Case study 3.1) access to patient scans, possibly without obtaining consent from the patients. You can hear a report on this at https://cambridge.edu.au/redirect/11394.

Listen to this report, or research another case of actual or potential misuse of medical data. This could involve a business sharing the data, a company being hacked, or an individual unknowingly providing access. Write a short report detailing:

- how the medical data was accessed
- why it is essential to protect privacy.

Skills: research

Revise and summarise 3.4

Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Define big data and provide examples from the Australian healthcare system.
2 Outline the advantages of big data in improving Australia's health.
3 Outline the challenges of big data in improving Australia's health.

Think critically and apply 3.4

Analyse the Australian healthcare system and how it ranks globally in terms of its use of both digital health and big data.

Skills: analysis, critical thinking, research

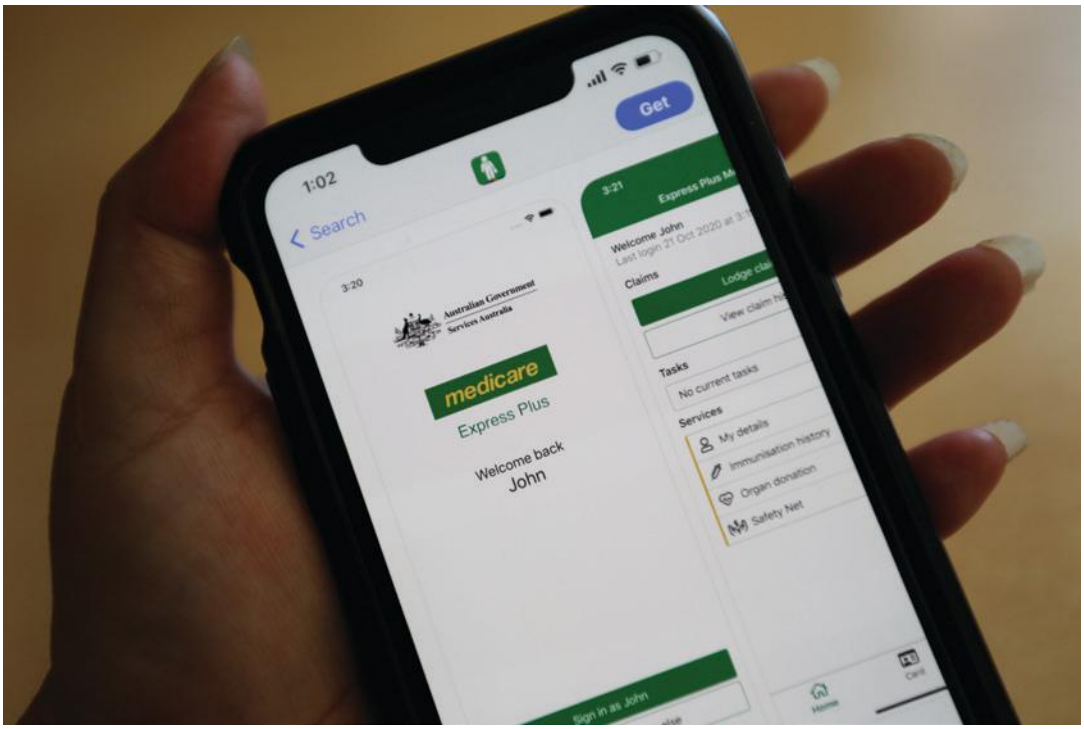


Figure 3.13 Privacy and confidentiality of patient information is a challenge for policy makers and healthcare professionals.

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Chapter summary

- Technology has had a remarkable influence on healthcare systems and the health outcomes of all Australians, particularly in the areas of measurement, monitoring and treatment of ill health in individuals and populations.
- There are a wide range of health-related medical technologies that are leading to improved health outcomes. Some of the areas in which these are most evident include:
  - technology to measure, monitor and diagnose health conditions
  - technology to treat health conditions
  - artificial intelligence (AI) in health
  - telehealth and remote patient monitoring
  - gene editing technology
  - smart implants and bioelectronics
  - nanotechnology.
- Digital health is an emerging framework which aims to improve the collection, storage and sharing of health data between authorised users, leading to improved health outcomes.
- Through digital health, big data is being gathered. This data must be accurately analysed in order to inform evidence-based decision making to improve health, while precautions must be taken to mitigate against potential consequences such as privacy and security concerns.

Multiple-choice questions

1 What is assistive technology primarily designed for?
- **A** to entertain users
- **B** to improve an individual's functioning and independence
- **C** to enhance social media interaction
- **D** to provide financial support

2 What does 'big data' refer to in the context of health?
- **A** small data sets used for local health studies
- **B** personal health information stored on mobile devices
- **C** extremely large data sets analysed to reveal health patterns, trends and associations
- **D** financial data of healthcare institutions

3 Which of the following best defines 'digital health'?
- **A** use of paper records for health information
- **B** management of health information electronically
- **C** manual collection of health data
- **D** traditional methods of patient treatment

4 How does artificial intelligence benefit the health sector?
- **A** by replacing human doctors completely
- **B** by learning and performing tasks requiring human intelligence, such as diagnosing diseases
- **C** by entertaining patients during their hospital stay
- **D** by reducing the need for any medical data

5 Which measure ensures the privacy and confidentiality of patient information in digital health?
- **A** sharing all data publicly
- **B** data encryption and access controls
- **C** ignoring legal standards
- **D** allowing unrestricted access to all health data

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Exam practice

How to answer an exam question

Example question

Discuss the use of artificial intelligence (AI) technology in health. Give examples to support your answer. (6 marks)

What is the question asking?

The key verb in this question is **discuss**, which means you need to identify issues. You should also provide points for and against the use of artificial intelligence in health.

Note that the question specifically asks you to support your answer with examples.

Marking criteria

Criteria	Marks
• Provides detailed points for AND/OR against the use of artificial intelligence in health • Supports response with relevant examples	6
• Provides points for AND/OR against the use of artificial intelligence in health • Provides relevant examples	5
• Describes the use of artificial intelligence in health • Provides examples	4
• Outlines the use of artificial intelligence in health • May provide example(s)	2-3
• Provides some relevant information	1

Sample response

AI can aid the diagnostic process by analysing medical images for abnormalities. The AI engine can be trained using hundreds or thousands of images, with information on what is normal and what is of concern. It can use what it has learned to detect abnormalities in new images, reducing the possibility of human error.



Video 3.2 Answering the exam question

AI can also be used for data analysis, which is a big part of healthcare. For example, it can analyse large data sets more quickly and efficiently than people, which can help identify patterns in the community. It can also offer more efficient analysis of genetic sequencing, which saves time and increases accuracy. AI may also play a part in analysing data from wearable health devices, and giving advice to users.

However, an AI engine needs to be properly trained using high-quality materials, which may require lengthy development time, and there is a risk this may not be properly done, leading to incorrect information/recommendations. Also, the use of AI increases the energy consumption of data centres, which has an impact on the world's climate.

Exam-style questions

1 Discuss the relationship between technology and health. (4 marks)

2 Evaluate the impact of THREE new technologies and treatments on health outcomes. (6 marks)

3 Assess the impact of digital health on the healthcare system. (5 marks)

4 Analyse how big data is shaping the health of Australians. (4 marks)

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Chapter 4
Promoting and improving the health of Australians



After completing this chapter, you will be able to demonstrate knowledge of:

- the key features of the following Sustainable Development Goals (SDGs):
  - SDG 3: Good health and wellbeing
  - SDG 4: Quality education
  - SDG 10: Reduced inequalities
  - SDG 11: Sustainable cities and communities
- how these SDGs are being used to guide the health-promoting strategies of Australian communities.

Key terminology

Syllabus terminology:

community
culturally and linguistically diverse (CALD) populations
health promotion
health status
Sustainable Development Goals (SDGs)
World Health Organization
wellbeing

Other important terms:

urbanisation

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Driving questions

1 In what ways is prevention better than cure and in what ways is it not?
2 Identify some health trends in Australia that are moving in a positive direction. Why do you think this is happening?
3 Identify some health trends that are moving in a negative direction. Why do you think this is happening?
4 Think of a successful health promotion campaign or initiative that you are familiar with. Create a list of these and identify possible reasons why they have been effective.
5 Generally speaking, why is it better to engage the local community in the health promotion process, rather than governments and health services seeking to influence individuals directly?



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Introduction

Improving population health through effective health promotion on a large scale is complex and challenging. Health outcomes are shaped by interconnected social, cultural, economic, political, and environmental factors that vary across communities. Because of this, health promotion is often most effective when tailored to specific population groups and grounded in local contexts.

Empowering communities, especially those who have historically been marginalised, to take control of their health requires acknowledging the structural determinants that limit access and wellbeing. While everyone belongs to a broader national and global community, the most meaningful health gains come from focusing efforts on those experiencing the greatest disadvantage.

Success should not be measured solely by raising average health outcomes, but by closing the gap between those with the highest and lowest levels of health, ensuring equity, not just improvement.

Chapter 4 of the *Cambridge Health and Movement Science Year 11* textbook explored the concept of health promotion in the Australian context, and considered various initiatives at the global, national, state and local levels. It explored how all sectors of society play a crucial role in improving health, particularly the actions of governments, community groups and individual citizens. When these sectors all contribute and partner towards the goal of improved health, a vast array of positive outcomes ensue. Chapter 4 also focused on Australia's participation and application of the Sustainable Development Goals (SDGs) developed by the World Health Organization (WHO) for the United Nations.

This chapter focuses on four specific goals that have a direct relationship to the health of individuals and communities. Students should prepare a range of case studies and examples of local communities and health-promoting actions and initiatives which reflect SDGs 3, 4, 10 and 11.

All Sustainable Development Goals (SDGs) are relevant in promoting and improving the health of Australian communities, sensitive to the diverse needs and challenges of each. This chapter seeks to explore how **four** of the 17 SDGs are being used in the Australian context to promote and improve health, both for today and for future generations. Students should revise Chapter 4 from the *Cambridge Health and Movement Science Year 11* textbook as required, which provided an overview and examples of the application of the SDGs.

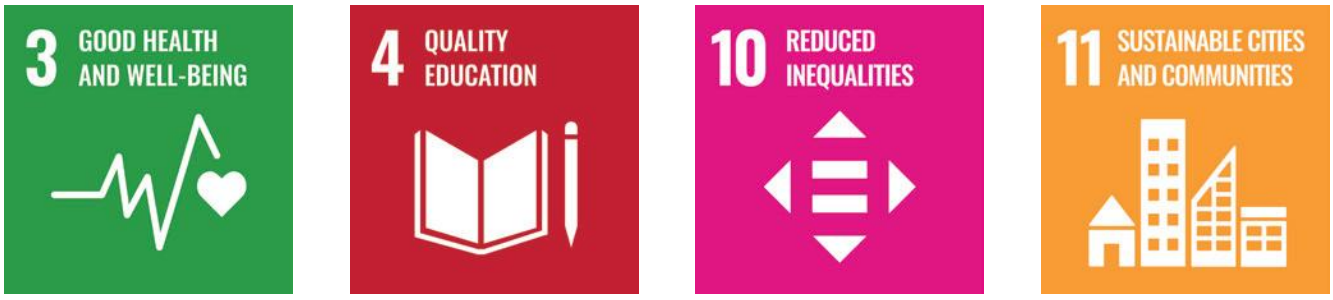


Figure 4.1 We will be looking at SDGs 3, 4, 10 and 11.

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4.1 SDG 3: Good health and wellbeing

Learning objective 4.1
DESCRIBE key features of SDG 3.

'Ensure healthy lives and promote wellbeing for all at all ages'

(UN)

SDG 3 is considered one of the cornerstone goals of the UN's broader vision for a more just, equal and sustainable world. It recognises the immense value of good health to an individual's quality of life, as it is foundational to being able to be productive and contribute positively to society. Good health and wellbeing has a positive impact on the social and economic wellbeing of the broader community. There is a strong relationship between SDG 3 and other areas of development such as poverty, hunger, education and more sustainable environments. It is not a goal which can be developed in isolation without addressing the broad external factors which influence health beyond individual behavioural change.

SDG 3 aims to achieve the following measures of epidemiology and health targets:

- higher life expectancy in disadvantaged communities through lower rates of mortality for all
- reduced rates of morbidity from accidents and lifestyle diseases, and a focus on mental health
- reduced rates of communicable and infectious diseases
- increased focus on maternal health and the health of children and young people
- improved access to high-quality and affordable healthcare and medicines
- improved personal health behaviours focused on rates of smoking, physical activity and diet.

Achieving the targets of SDG 3 will have a range of positive effects, including:

- reduced inequalities in the health outcomes of population groups
- reduced inequities in access to health for vulnerable and disadvantaged people
- economic and social development through better health, leading to less strain on healthcare systems and services and greater capacity for individuals to positively contribute to society
- increased ability to respond to national and global health threats and challenges, as was seen during the COVID-19 pandemic.

In the Australian context, there are many positive signs that Australia is doing well in setting a benchmark for how to achieve SDG 3 at a national level. Measures of health which are encouraging include life expectancy, mortality rates and certain causes of morbidity (largely due to medical technology and government investment in health). Public healthcare through Medicare, the PBS and the NDIS provides more equitable access to health and there is a strong investment in medical research.



Figure 4.2 A drive-through COVID-19 testing centre at Bondi Beach, 13 May 2020. One of the effects of achieving SDG 3 targets will be increased ability to respond to national and global health threats and challenges.

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However, there are some patterns and trends of concern, including:

- an increasing and ageing population, particularly in dense areas, placing more strain on services
- high rates of preventable lifestyle disease, such as cancer, cardiovascular disease and diabetes, as well as very high rates of obesity
- significant health inequities affecting certain population groups, including people living in rural and remote areas, those experiencing socio-economic disadvantage, and people living with disability
- health injustices experienced by Aboriginal and Torres Strait Islander Peoples due to colonisation, systemic racism and limited access to culturally safe, community-led healthcare—especially in rural and remote areas.
- significant differences in health outcomes between Australia and countries in the Asia-Pacific region reflect global inequities. Australia has a responsibility to work in respectful partnership with countries experiencing structural disadvantage, supporting locally led responses to health challenges rather than imposing external solutions.

Revise and summarise **4.1**

Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Outline the key features of SDG 3.

Think critically and apply **4.1**

Analysing the SDG Report Cards

Visit the Sustainable Development Report website via this link https://cambridge.edu.au/redirect/11395 and review the global patterns and trends of the SDGs, focusing on SDG 3. Compare how Australia is progressing with these goals, identifying areas of strength and areas for improvement. Attempt to explain why Australia is scoring at the level it is in each goal and predict the impact this will have on future generations.

Skills: research, analysis



Figure 4.3 Good health and wellbeing is a virtuous goal for all citizens with a range of benefits for the individual and their community.

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4.2 SDG 4: Quality education

Learning objective 4.2
DESCRIBE key features of SDG 4.

'Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all'

(UN)

SDG 4 recognises the value of providing inclusive, equitable access to high-quality education throughout an individual's life, especially in the first four years. Educational access is considered a fundamental human right and is one of the key driving forces and enablers of many other SDGs. Education empowers individuals to take increased control over their life. It provides an awareness of societal issues and the opportunity to develop the knowledge and skills required to be independent and productive. There should be no socio-economic, age, gender, ethnic or geographic barrier to education.

SDG 4 aims to achieve the following educational targets:

- equitable access to education, particularly overcoming the barriers that vulnerable, disadvantaged and marginalised groups face. Disparities in educational access stem from differences in income, location, gender, disability and sociocultural factors.
- high-quality education focused on quality learning outcomes which help learners acquire the knowledge and skills required to live independent and productive lives
- in the early primary years, a focus on literacy and numeracy which has a strong relationship with reductions in poverty
- in the secondary years, education is to be more tailored to the needs and aspirations of the individual and community, allowing them to prepare for future employment opportunities
- in the years post-school, access to technical, vocational and higher education is important for adults. Here they can learn the targeted knowledge and skills required to access new employment pathways.
- Recognise that educational opportunities can be provided outside of formal schooling and be available to people of all ages. Technological advancement has enabled adult education to successfully occur outside of schools, through access to the internet and online learning materials.

Achieving the targets of SDG 4 will have a range of positive effects, including:

- empowering individuals and promoting equality through education, enabling individuals to be more productive. Communities benefit greatly from being more educated in general.
- poverty reduction and economic growth through increased opportunities to earn income
- Access to education for disadvantaged population groups is a foundational step in reducing overall life inequalities for future generations.
- Education focused on future skills will help generations to be ready to live and participate in future communities. Technological change is a key driver in this process.
- Higher rates of educational attainment promote social and political stability through the social cohesion and civic participation which quality education should promote.



Figure 4.4 One of the targets of SDG 4 is to have a focus on literacy and numeracy in the early primary years.

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In the Australian context, we perform reasonably well on global educational metrics. Public education provides free and high-quality education to everyone. Current and future challenges that educational systems in Australia face include:

- overcrowded schools in areas of rapid population growth as well as ageing school infrastructure requiring investment to better suit twenty-first century education
- curriculum design which prepares learners for future jobs which do not currently exist. The focus needs to be on empowering individuals to be lifelong learners, able to continue to be upskilled and learn new knowledge as required. Skills in critical and creative thinking, communication, collaboration, problem solving, and research enable people to become lifelong learners.
- disparities in educational attainment between different population groups from different socio-economic, cultural, language and geographic backgrounds
- ensuring all pre-school aged children have access to foundational and quality early education.
- ensuring government funding for education is sufficient to address these barriers equitably.

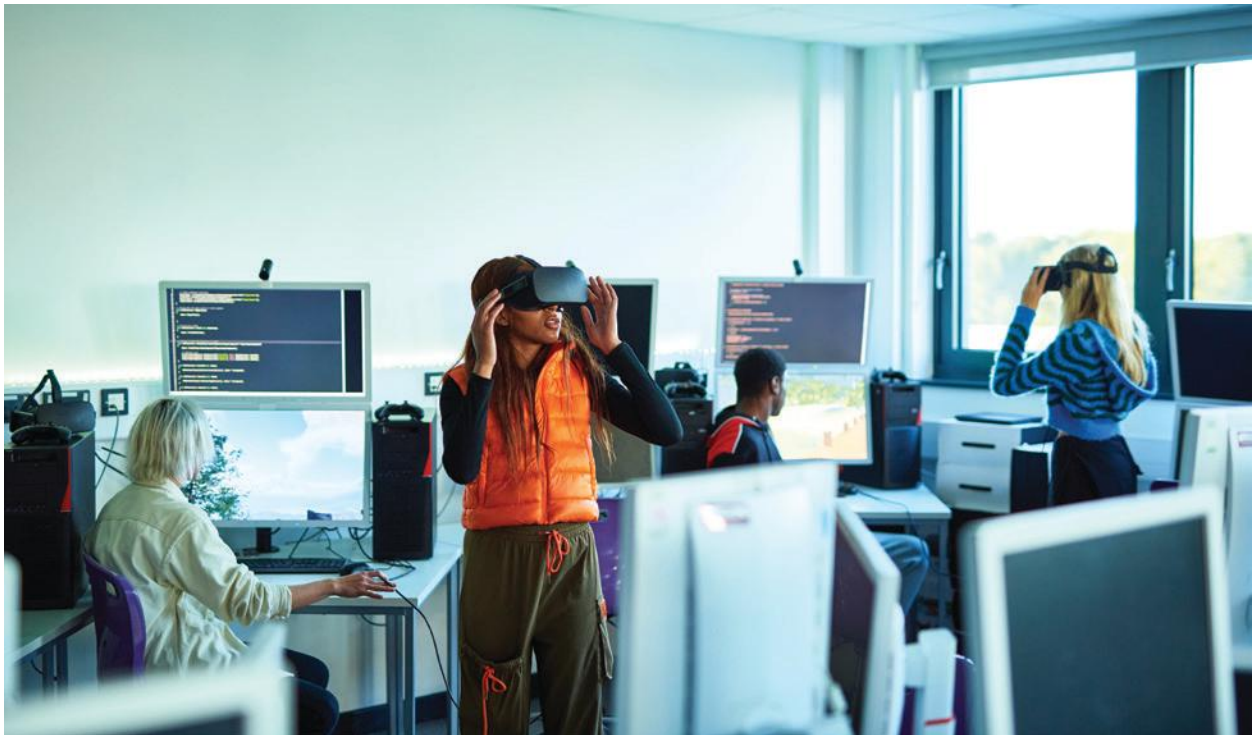


Figure 4.5 Contemporary education seeks to develop knowledge and skills for the world of the future.

Quiz

Revise and summarise 4.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Outline the key features of SDG 4.

Think critically and apply 4.2

Analysing the SDG Report Cards

Visit the Sustainable Development Report website https://dashboards.sdgindex.org/ and review the global patterns and trends of the SDGs, focusing on SDG 4. Compare how Australia is progressing with these goals, identifying areas of strength and areas for improvement. Attempt to explain why Australia is scoring at the level it is in each goal and predict the impact this will have on future generations.

Skills: research, analysis

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4.3 SDG 10: Reduced inequalities

Learning objective 4.3
DESCRIBE key features of SDG 10.

'Reduce inequality within and among countries'

(UN)

To reduce inequalities that exist between population groups, Australia must collectively address the economic, social and political disparities that are contributing to these. Measuring and analysing inequality involves focusing on past actions and outcomes and making future economic, social and political decisions aimed at decreasing these gaps. The causes and solutions to social and health inequalities are complex. The most effective means of achieving future generational change and reducing inequalities is to seek to empower individuals and communities to make positive changes within their own lives for the sake of positive future outcomes.

SDG 10 aims to achieve the following reduction of inequalities:

- reduce income inequality and narrow the gap between the lowest socio-economic groups and the rest of society, ensuring employment opportunities and fair wages for all
- promote social inclusion ensuring marginalised and minority communities have equal access to opportunities, resources and services. These groups include ethnic minorities, migrants and refugees, people with disabilities and others.
- remove barriers that hinder marginalised communities from being able to access healthcare, education, employment and socio-political participation.
- globally, promote fair trade agreements and fair global governance that improves access to global markets, ensuring all countries can participate in economic growth and globalisation.

Achieving the targets of SDG 10 will have a range of positive effects, including:

- equal opportunities and access for all population groups to education, healthcare, employment and social services regardless of ethnicity, gender, age, disability or migration status
- reduced income inequality benefiting future generations by more evenly distributing economic resources. Progressive taxation, safety nets and social welfare can also support the most vulnerable communities, leading to reduced inequalities.
- improved social cohesion and promotion of harmony, peace and stability within communities. Places with more inequality often face more problems, such as higher crime rates, worse mental health, and less stable housing. By eradicating poverty, reducing inequalities and improving the standard of living for disadvantaged communities, there is less likely to be civil conflict and unrest, and people are more likely to participate constructively in social and political activities.
- improved health and wellbeing are closely related to reduced inequalities and as the gap between population groups narrows, there will be a distinct improvement in quality of life.



Figure 4.6 One of the aims of SDG 10 is to promote social inclusion.

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In the Australian context, many inequalities stem from systemic and historical injustices, particularly those caused by colonisation. To reduce inequality, future decision-makers must prioritise economic, social and political reforms that centre equity and self-determination, especially for communities who have been historically marginalised. Empowering individuals and communities to have greater control over their lives will help shift outcomes. Challenges to reducing inequalities include:

- the ongoing injustices experienced by Aboriginal and Torres Strait Islander Peoples, rooted in colonisation, dispossession and systemic racism. Many First Nations Peoples have been excluded from decision making and feel disconnected from services and systems that were not designed with them in mind. Truth-telling, structural reform and strong support for community-led initiatives are critical to addressing these inequalities.
- Australia's demography (spread of population) is a unique challenge. The northern half of Australia covering 53% of the land mass contributes 12% of the GDP, but only includes 5% of the population. Remote communities, particularly in northern Australia, often face reduced access to services and infrastructure and require place-based, sustainable solutions.
- Australia's cultural and linguistic diversity. To reduce inequality, services like healthcare, education and employment must be inclusive and responsive to the needs of culturally and linguistically diverse (CALD) communities, ensuring equitable access and culturally safe support.





Figure 4.7 Equal participation and opportunities helps build stronger communities and a better future with less inequality.

Quiz

Revise and summarise 4.3

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Outline the key features of SDG 10.

Think critically and apply 4.3

Analysing the SDG Report Cards

Visit the Sustainable Development Report website https://dashboards.sdgindex.org/ and review the global patterns and trends of the SDGs, focusing on SDG 10. Compare how Australia is progressing with these goals, identifying areas of strength and areas for improvement. Attempt to explain why Australia is scoring at the level it is in each goal and predict the impact this will have on future generations.

Skills: research, analysis

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4.4 SDG 11: Sustainable cities and communities

Learning objective 4.4

DESCRIBE key features of SDG 11.

'Make cities and human settlements inclusive, safe, resilient and sustainable'

(UN)

As the world experiences globalisation driven by technological advancement, there is a wide trend of increasing **urbanisation**. Globally, about half of all people live in cities and this is predicted to increase to 70% by 2050, along with an increasing population. Comparatively in Australia, over 70% of people are already living in cities, with about 25% in regional areas and less than 5% in remote areas. This places significant strain on infrastructure, and when adequate services, employment and housing are not available, systemic conditions can lead to people living in under-resourced and structurally marginalised communities. While urbanisation can lead to economic growth, it can also contribute to urban inequalities. Most large cities show a stark contrast between very wealthy areas and communities that have been structurally excluded from access to resources, where residents do not have the same access to public facilities and services. While poverty is difficult to measure, assess and compare between countries, it is estimated that about one in seven people globally live below the international poverty line. Fortunately, Australia has much lower rates of extreme poverty, but we still have a number of people living at high levels of socio-economic disadvantage. While rates of disadvantage are similar in both metropolitan and non-metropolitan areas, Aboriginal and Torres Strait Islander Peoples continue to face disproportionate levels of health and social inequity. These inequities are not due to geographic location alone, but are rooted in the ongoing impacts of colonisation, systemic racism and exclusion from decision making about their own communities and lands.

urbanisation movement of people from rural areas to live in cities

Future cities and communities will come under increasing pressure to provide sustainable and effective infrastructure to support the increasing demands of these population trends. Consider the importance of housing, transport, sanitation, water, energy, communications, health, education facilities and services to quality of life for residents. There is also a high degree of environmental degradation from urbanisation and globalisation, and increasing pollution and waste are great challenges to overcome, which often impact poor communities the most.



Figure 4.8 Tokyo, Japan, has a population of over 37 million people – over ten per cent of the total population of Japan.

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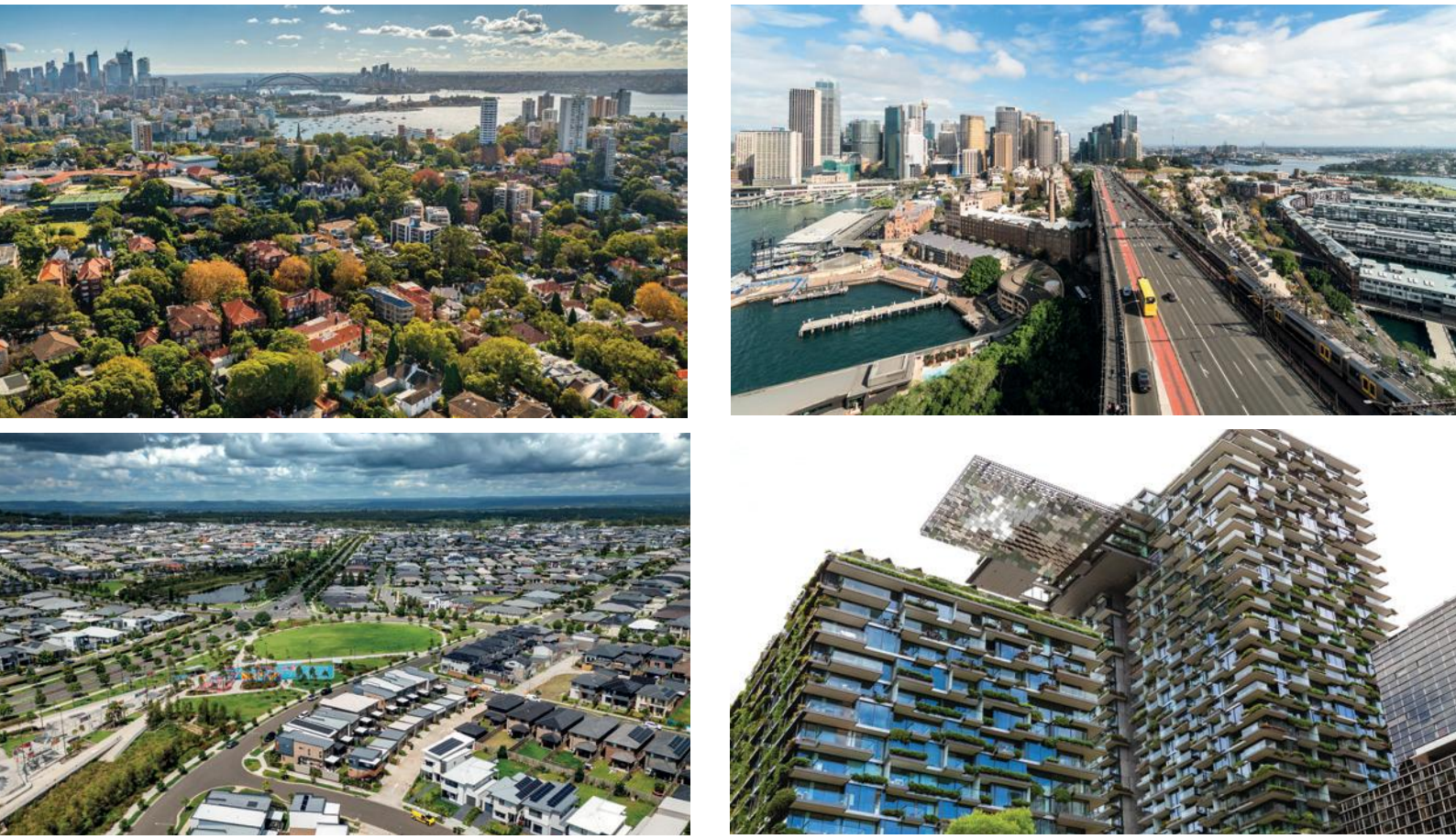


Figure 4.9 Sydney is considered to be Australia's most sustainable city, ranking in the top 35 globally. There is an active focus on green and social sustainability, and a focus on new projects which can better support community health, wellbeing and productivity.

SDG 11 aims to achieve the following targets in the creation of sustainable cities and communities:

- affordable housing and access to clean water, sanitation and energy for the most economically marginalised of areas
- an increase in access to secure, adequate housing and essential services in urban areas, particularly across parts of Asia and Africa where communities have historically been underserved due to colonisation and structural inequality
- sustainable urban planning that balances the allocation of resources in equitable ways, ensuring equitable access to water, energy and public facilities, while reducing environmental impact
- effective and accessible transport systems with a reduced impact on the environment
- urban development that supports quality of life for residents and encourages good health and wellbeing for the local community. Planning for green, open and recreational spaces promotes physical and mental wellbeing, as well as community engagement
- preparation and risk mitigation for increasing natural disasters (cyclones, droughts) and ongoing environmental degradation such as changes in air quality and water levels
- inclusive urban governance which engages the community voice in decisions which affect them.

Achieving the targets of SDG 11 will have a range of positive effects, including:

- reduced inequalities and higher standards of living for all residents regardless of age, income, ethnicity, gender or disability with well-planned and effective public infrastructure (housing, transport, sanitation, water, energy, communications, health and education)
- reversal of negative trends in climate change and environmental degradation from urbanisation and globalisation
- improved equality of economic outcomes with increased employment opportunities
- reduced impact of natural disasters through risk mitigation and an improved ability to prepare and respond
- improved health outcomes for people living in cities where they are safe and can connect inclusively with their community.

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In Australia, the combination of highly urbanised cities and sparsely populated regional, rural and remote areas creates unique challenges in building communities that are safe, inclusive, resilient and sustainable for all. All levels of government are actively engaged in ensuring that major cities and regional centres are well connected as they look to maintain and improve the liveability and productivity of our regions. Some of the barriers and challenges we face include:

- high-density cities in comparison to the vast stretches of land with very low populations. The distance between cities and regional areas is a challenge to future transport infrastructure.
- the urban sprawl of major cities, expanding the physical size of cities and placing increased pressure on all infrastructure to meet the needs of communities in equitable ways
- relatively small population in comparison to other countries, which entails lower economic growth potential and greater vulnerability to global economic forces.

Revise and summarise 4.4


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Outline the key features of SDG 11.

Think critically and apply 4.4

Analysing the SDG Report Cards

Visit the Sustainable Development Report website https://dashboards.sdgindex.org/ and review the global patterns and trends of the SDGs, focusing on SDG 11. Compare how Australia is progressing with these goals, identifying areas of strength and areas for improvement. Attempt to explain why Australia is scoring at the level it is in each goal and predict the impact this will have on future generations.

Skills: research, analysis



Figure 4.10 Unregulated housing near Cape Town, South Africa. One of the aims of SDG 11 is an increase in access to secure, adequate housing and essential services in urban areas.

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4.5 Using SDGs 3, 4, 10 and 11 to improve a community's health status

Learning objective 4.5
EVALUATE the implementation of SDGs 3, 4, 10 and 11 to guide strategies to improve the health status of a community.

Comprehensive health promotion initiatives bring together government agencies, community groups and individuals in the design, implementation and evaluation of strategies aimed at improving the health status of the wider community. In the following research task, you will deeply analyse examples of health promotion initiatives and evaluate how effectively SDGs 3, 4, 10 and 11 have been used to help improve the health of the targeted community.

Depth Study

Activity 4.1

Research and source a list of comprehensive health promotion initiatives being implemented by a community and select **three** to evaluate as a case study of how SDGs 3, 4, 10 and 11 are being applied.

Choose a local government area (LGA) where there is an active effort to improve health through the collaborative efforts of government agencies, non-government and community groups and individual engagement. Research and focus on this target community, making comparisons with your own.

Guiding questions which should be used for this analysis and evaluation include the following:
- How have SDGs 3, 4, 10 and 11 been applied to improve the health of the community?
- What lessons could be drawn that could be applied within your own community?
- What major health issues is the targeted community facing?
- What strategies can be used to advocate and improve a community's health status?
- How would it be known if the strategies were having a positive effect?

An example of a community being positively impacted by a health promotion initiative is **Healthy Cities Illawarra**. Students may use this example or source their own. There are also a range of examples of initiatives to analyse which are being applied across NSW communities, including:
- Live Life Well @ School
- NSW Regional Health Strategic Plan 2022–2032
- Future Health: Guiding the next decade of healthcare in NSW 2022–2032
- NSW Aboriginal Health Plan 2024–2034.

Skills: analysis, research

Quiz

Revise and summarise 4.5

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.
Explain how SDGs 3, 4, 10 and 11 can be used to improve the health of a community.

Think critically and apply 4.5

Actions to achieving SDGs

Source an Australian Government report on the progress we are making towards achieving each SDG (e.g. https://cambridge.edu.au/redirect/11396. Using this and other sources, create a list of the specific programs and initiatives being implemented to help work towards each SDG.

Skills: research, analysis

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Chapter summary

- This chapter explores the importance of Sustainable Development Goals (SDGs) 3, 4, 10 and 11 in guiding governments, communities and individuals in working towards better health for all.
- **SDG 3: Good health and wellbeing** focuses on improving life expectancy, reducing lifestyle diseases and increasing healthcare access. This benefits individuals and society by promoting productivity and reducing healthcare costs. Australia faces challenges such as increasing lifestyle diseases and Indigenous health disparities.
- **SDG 4: Quality education** emphasises equitable, inclusive education to promote lifelong learning for all. This empowers individuals and communities, promotes social cohesion and encourages economic growth. Australia performs well in providing public education but faces challenges in access and inclusivity.
- **SDG 10: Reduced inequalities** aims to decrease income disparities, promote social inclusion and ensure equal opportunities for all. It also fosters fairer access to health, education and employment opportunities. Inequality in Australia is particularly evident in health outcomes for Indigenous and remote populations.
- **SDG 11: Sustainable cities and communities** promotes communities which are safe, inclusive, resilient and sustainable. This requires well-planned housing, transport, sanitation, water, energy, communications, health, education facilities and services which contribute to quality of life for residents. Australia's urban planning challenges include population density in cities, urban sprawl, infrastructure demands and gaps and environmental concerns.

Multiple-choice questions

1 Which of the following is a key challenge for Australia in achieving SDG 3?
- A population density in urban areas
- B increasing lifestyle diseases and Indigenous health disparities
- C lack of education opportunities
- D water pollution

2 What is one of the challenges Australia faces in achieving SDG 4?
- A lack of quality housing
- B population growth
- C access and inclusivity in public education
- D decreasing energy costs

3 What is a specific area in which inequality is evident in Australia, according to SDG 10?
- A urban planning
- B Indigenous and remote population health outcomes
- C employment opportunities in cities
- D access to clean water

4 What is required for achieving SDG 11: Sustainable cities and communities?
- A well-planned housing, transport, sanitation and other infrastructure
- B more schools and universities
- C focus on reducing inequality
- D improvement in health outcomes

5 What are some challenges in Australia related to SDG 11?
- A increasing income disparities and lack of clean energy
- B population density, urban sprawl and infrastructure demands
- C lack of healthcare facilities in cities
- D over-reliance on renewable energy

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Exam practice

How to answer an exam question

Example question

Outline positive effects that will arise from achieving the targets of SDG 3. (3 marks)

What is the question asking?

The key verb in this question is **outline**, which means you need to present your answer in general terms, indicating the main features but not going into detail.

Note that the question is about the **positive effects**, so your answer should focus on this, rather than discussing the general aims of SDG 3.

Marking criteria

Criteria	Marks
• Demonstrates a sound understanding of positive effects that will arise from achieving the targets of SDG 3	3
• Demonstrates some understanding of positive effects that will arise from achieving the targets of SDG 3	2
• Provides some relevant information	1

Sample response

Achieving the SDG 3 targets will reduce inequalities in health access for disadvantaged and vulnerable people. It will also reduce inequalities in outcomes across population groups. Better health will lead to economic and social development, less strain on healthcare systems, and more capacity for individuals to contribute to society. There will also be a better ability to respond to national and global health threats.



Video 4.1 Answering the exam question

Exam-style questions

1 Describe the key features of TWO of the following Sustainable Development Goals: 3, 4, 10 and 11. (4 marks)

2 Analyse the importance of Sustainable Development Goals 3, 4, 10 and 11 in the process of government decision making to improve health. (8 marks)

3 To what extent could the application of Sustainable Development Goal 3 (good health and wellbeing) and Sustainable Development Goal 4 (quality education) assist in improving the health status of young people? (12 marks)

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TRAINING FOR IMPROVED PERFORMANCE



Chapter
Chapter 5: Personalising assessment and exercise prescription
Chapter 6: Influence of training on movement and performance
Chapter 7: Training for individual and group sports
Chapter 8: Impact of sleep, nutrition and supplementation on movement and performance
Chapter 9: Training for sustained movement and performance

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Chapter 5
Personalising assessment and exercise prescription

After completing this chapter, you will be able to demonstrate knowledge of:

- why pre-exercise questionnaires and relevant health screens are important
- how health, participation and performance of elite and recreational athletes is improved through performance/fitness testing
- how training programs are developed and assisted by exercise assessment.

Key terminology

Syllabus terminology:

fitness
physical fitness

Other important terms:

elite athlete
pre-screening
recreational participant
repetition maximum (RM)



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Driving questions

Could every member of your family and extended family commence a new sport or fitness activity today safely? How would you know?



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Introduction

pre-screening a tool used to identify people who may have medical conditions that put them at risk of an adverse event during physical activity/ exercise

In the field of exercise and fitness, ensuring the safety and effectiveness of any physical activity program is paramount.

Pre-screening is an important preventive measure that should be performed prior to the commencement of the training program or season. It assists in determining the health status of a person and their baseline fitness levels. It is extremely useful for detecting any existing physical or medical issues that may necessitate a change to the training type, frequency and intensity required. The components of a pre-screening assessment may vary depending on the sport in which the athlete is competing. Examples of components may include age, gender, underlying health issues and previous exercise experience.

Once someone has started a training program, ongoing performance and fitness testing to monitor their physical condition can improve their health, participation and performance by allowing them to understand their abilities and set realistic goals. Again, the types of tests may vary depending on the sport in which they are engaged. Specific tests include the 100 m sprint time, vertical jump height, horizontal jump length and beep test scores.

Testing and assessment can also be used by exercise and fitness professionals and athletes themselves, to develop tailored training programs.

5.1 Pre-exercise questionnaire and health screening

Learning objective 5.1
EXPLAIN why it is important for exercise and fitness professionals to use pre-exercise questionnaires and relevant health screening.

Using a pre-exercise questionnaire and undertaking relevant health screening are crucial steps for exercise and fitness professionals. Questionnaires and health screening provide a comprehensive overview of an individual's health status, medical history and fitness levels. They are therefore foundational elements of responsible and personalised fitness planning.

Here are some key reasons for this:

Identifying health risks: These tools help identify individuals who may have medical conditions or risk factors that could lead to adverse events during physical activity.

Personalising exercise programs: By understanding a client's health status, fitness professionals can tailor exercise programs to meet individual needs and limitations.

Preventing injuries: Health screenings can reveal musculoskeletal issues or other physical limitations that might require modifications to exercise routines.

Legal and professional responsibility: Conducting thorough pre-exercise screenings is part of a fitness professional's duty of care.

Building trust: When clients see that their health and safety is being prioritised, it builds trust and confidence in the fitness professional's trust and care.

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Figure 5.1 Pre-screening is an essential part of fitness programs.

Pre-screening is particularly important for certain groups within the community, such as:

- previously inactive people
- males over the age of 40
- females over the age of 50
- asthmatics
- smokers
- overweight or obese people
- people with a family history of heart disease
- people with high blood pressure
- people with a history of back or knee pain.

Pre-exercise questionnaire

A pre-exercise questionnaire serves as a foundational step in designing a safe and effective exercise program tailored to an individual's unique needs and circumstances. By gathering comprehensive information about a person's health status, exercise history, lifestyle habits and fitness goals, these questionnaires help identify potential risks and ensure that any exercise regimen is both appropriate and beneficial. This proactive approach not only enhances the safety of the exercise program but also maximises its effectiveness, helping individuals achieve their fitness objectives while minimising the risk of injury or adverse health events. In essence, a pre-exercise questionnaire is an essential component of responsible and personalised fitness planning.

elite athlete generally participates at a national, international or professional level

recreational participant participates in sport primarily for fun, physical fitness and social involvement

For **elite athletes**, these questionnaires often include detailed sections on previous injuries, current training regimens and specific performance goals. They may also assess psychological factors, nutritional habits and recovery strategies to ensure that the athlete can perform at their peak while minimising the risk of overtraining or burnout.

For **recreational participants**, the focus might be more on general health status, exercise history and lifestyle habits. These questionnaires help identify any underlying health conditions that could be exacerbated by physical activity and ensure that the exercise program is enjoyable and sustainable.

By tailoring the questionnaire to the specific needs of elite and recreational athletes, fitness professionals can create more effective and individualised exercise programs that cater to the unique demands of each group.

Practical application 5.1

Young people screening tool

An example of a pre-screening tool for young people has been developed by Exercise and Sports Science Australia (ESSA) in conjunction with Sports Medicine Australia. This complements their adult pre-screening tool.

These two questionnaires are available in the digital version of this textbook and can also be downloaded from the internet at https://cambridge.edu.au/redirect/11397 (pre-exercise screening system for young people) and https://cambridge.edu.au/redirect/11398 (adult pre-exercise screening system).

continued

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Practical application 5.1 *continued*

1 Complete the young people screening tool.
   a Did you find anything interesting from your results?
   b Do you think you would require a medical clearance before starting an exercise program?
2 What sorts of questions were asked in the compulsory section of the questionnaire? Why are they important?
3 How might the questions in the recommended section assist a trainer in gauging whether an activity is suitable and safe for a young person?
4 Compare the young person's pre-screening questionnaire with the adult pre-screening questionnaire.
   a What additional questions are asked in the adult questionnaire?
   b Why is this the case?
5 Consider the flow chart in the adult questionnaire and in the user guide. Explain how the various steps support the health of adults undertaking a new exercise program.

Skills: analysis

Health screening

Sometimes the answers given to a pre-exercise questionnaire suggest that a more detailed health screening will be appropriate before beginning an exercise program. These include:

- heart condition
- suffered a stroke in the past
- unexplained chest pains
- faintness or dizziness during exercise
- serious asthma attack in the past year
- muscle, bone or joint problems that could be made worse by exercising.

In some sports, pre-screening of physical characteristics is an important consideration for directly preventing injury. For example, a baseball pitcher requires enough external rotation of the shoulder to generate a fast pitch and a player with a long, thin neck should not be placed on the front row of a rugby union scrum.


Quiz

Revise and summarise 5.1

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Identify three groups for which pre-screening is particularly important.
2 What would be the essential questions to ask in a pre-screening questionnaire?
3 Who should undergo pre-screening?
4 What risks exist for a client/athlete if the pre-screening tool is not performed or considered prior to commencing exercise or training?
5 Identify three medical issues which might require a health check before beginning exercise.

Think critically and apply 5.1

1 Explain the importance of using a pre-exercise questionnaire by exercise and fitness professionals.
2 Explain the importance of undertaking relevant health screening by exercise and fitness professionals.

Skills: problem solving

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5.2 Performance and fitness testing

Learning objective 5.2
DISCUSS the use of performance and fitness testing for improving the health, participation and performance of both elite athletes and recreational participants.

The purpose of performance and fitness testing is to assess particular aspects of an individual's physical condition. This means that training programs can be developed to focus on areas needing development and that realistic performance goals can be set. The tests measure the body's abilities, rather than sports-specific skills.

Performance and fitness testing is crucial for elite athletes and can also be beneficial for recreational participants aiming to improve their health, participation and performance.

Depth Study

Common fitness tests

There is a wide range of performance and fitness tests that can be undertaken. When deciding on appropriate tests, it is important to consider the reliability and validity of the test and the purpose of testing. You can find information about over 400 fitness tests and the protocols for these tests at Topend Sports via the link https://cambridge.edu.au/redirect/11399.

Fitness tests can be divided into a number of categories, some of which are explained below.

Cardiovascular tests

Cardiovascular tests focus on how well the heart and lungs can provide oxygen to the body during exercise and are valuable for participants in highly aerobic forms of sport and exercise. Some tests require participants to push their bodies to the limit, while others are quicker, with the heart rate being measured and then extrapolated to assess the effect of maximum effort. Examples of cardiovascular tests include the Cooper test, multi-stage fitness test and the yo-yo test.

Elite athletes will have access to scientific laboratories and sports scientists and therefore will be able to complete the more accurate VO_2 max test to measure aerobic capacity.



Figure 5.2 VO_2 max testing is more accurately completed in the laboratory.

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Strength tests

This category of testing includes both maximum strength tests (which measure how much force can be generated against resistance) and strength endurance tests (how often muscle contractions can be repeated before fatigue sets in).

An example of a maximum strength test is the one-rep max test, which identifies the maximum amount of weight the person can lift, using correct technique, for just one repetition. This can be used in a wide variety of exercises, including bench press, leg extension, lat pull-down and many more.

Strength endurance tests typically involve performing as many repetitions as possible. Some, such as burpees, work the whole body, but others focus on particular muscles or muscle groups, such as bicep curls, sit-ups or squats.



Figure 5.3 Bench press can be 5RM, 3RM or 1RM for testing strength.

Anaerobic tests

Anaerobic tests can measure anaerobic power (how much power is exerted) and anaerobic capacity (how much ATP is re-synthesised) during a short-duration, high-intensity exercise. They are particularly relevant for sports and exercises that require short bursts of energy, rather than a sustained effort.

Video 5.1
The Wingate test (01:03)

The Wingate anaerobic test was developed in the 1970s to measure anaerobic power and capacity. Lactate testing has been common in swimming and many other sports for decades. Force decks and other force measurement tools are available to elite athletes.

Flexibility tests

Flexibility is the absolute range of motion that a specific joint or group of joints can produce. Flexibility offers a number of benefits to athletes, including:

- enhanced movement performance
- reduced muscle soreness and tension
- reduced injury risk
- improved muscular coordination
- enhanced physical and mental relaxation.

The sit-and-reach test is an example of a test to evaluate flexibility.

Body composition tests

Body composition tests measure the proportions of fat, muscle and bone in the body. For example, body mass index (BMI), skinfold measurements and bioelectrical impedance analysis all assess body fat percentage. Access to dual-energy X-ray absorptiometry (DEXA) scans, which measure the strength of the bones, is becoming more available for both recreational participants and elite athletes, providing a far more accurate picture of lean body mass, skeletal muscles and body fat.



Figure 5.4 Skinfold testing can accurately measure body composition.

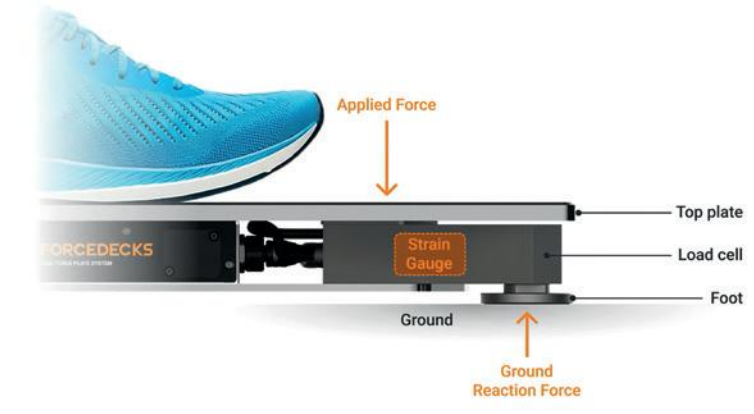
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Case study 5.1

VALD Performance force plates

Force plates can be used to measure the ground reaction forces when a person walks, runs or jumps on them. They can be used by elite athletes to test a wide variety of fitness components, including biomechanics, providing key evidence for coaches and trainers.

Video 5.2 How do force plates work? (08:24)



Video 5.2 How do force plates work? Scan the QR code to watch the video.

Table 5.1 Force plate tests

Jumps	
Countermovement jump (CMJ)	Single leg drop jump
Countermovement jump – loaded	Drop jump
Abalakov jump	Land and hold
Single leg jump	Single leg land and hold
Squat jump	Hop test
Squat jump – loaded	Single leg hop test
Countermovement rebound jump	Hop and return
Single leg countermovement rebound jump	

Functional
Squat assessment
Single leg squat assessment
Push-up
Sit-to-stand-to-sit

Balance
Quiet stand
Single leg stand
Single leg range of stability

Isometric
Isometric mid-thigh pull (IMTP)
Isometric squat
Isometric shoulder I-Y-T
Single leg isometric test
Custom isometric test

Source: Valdhealth.com

1 Would recreational participants benefit from accessing VALD Performance force plates?
2 How easily would they be able to be accessed for the recreational athlete?
3 Many elite athletes access this technology for testing. What benefit might they receive from this testing over 'field' performance tests?
4 Investigate where you could access VALD Performance force plates to complete some testing.

Skills: analysis, research

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Recreational participants

Even though recreational participants are not operating at an elite level, they can still benefit greatly from performance and fitness testing.

Health improvement

- **Baseline assessment:** Fitness tests provide a baseline measurement of various health parameters, such as cardiovascular fitness, muscular strength, flexibility and body composition. This helps in identifying any potential health risks and setting realistic health goals.
- **Monitoring progress:** Regular testing allows individuals to track their progress over time, which can be motivating and help in adjusting exercise routines to ensure continuous improvement.
- **Personalised exercise plans**: Based on test results, personalised exercise plans can be developed to address specific health needs, such as improving cardiovascular health or increasing muscle strength.

Enhanced participation

- **Goal setting**: Fitness tests help in setting specific, measurable, achievable, relevant and time-bound (SMART) goals. This can increase motivation and commitment to regular physical activity.
- **Injury prevention**: By identifying weaknesses or imbalances, fitness tests can help in designing programs that prevent injuries, making it safer for participants to engage in various activities.
- **Inclusivity**: Tests can be adapted to suit different age groups and fitness levels, making it easier for everyone to participate and benefit from physical activities.

Performance enhancement

- **Identifying strengths and weaknesses**: Fitness tests can pinpoint areas where an individual excels and areas that need improvement. This information is crucial for tailoring training programs to enhance overall performance.
- **Motivation and accountability**: Seeing tangible improvements in test results can be highly motivating. It also holds individuals accountable to their fitness routines.
- **Optimising training**: Data from fitness tests can be used to optimise training intensity, duration and frequency, ensuring that participants get the most out of their workouts.

Elite athletes

For elite athletes, performance and fitness testing provides detailed insights that can significantly enhance their health, participation and performance.

Health improvement

- **Baseline health metrics**: Fitness tests establish baseline health metrics, such as cardiovascular health, muscle strength and flexibility. This helps in identifying any underlying health issues that need to be addressed.
- **Injury prevention**: Regular testing can detect imbalances or weaknesses that might lead to injuries. By addressing these issues proactively, athletes can reduce their risk of injury.
- **Recovery monitoring**: Post-injury or post-competition, fitness tests help in monitoring recovery and ensuring that athletes are ready to return to full training.

Enhanced participation

- **Motivation and goal setting**: Fitness tests provide tangible data that can be used to set specific, measurable goals. This can be highly motivating for athletes, encouraging them to participate more actively in their training programs.
- **Customised training programs**: Based on results, coaches can design personalised training programs that cater to the specific needs of each athlete, ensuring they are engaged and challenged appropriately.
- **Team selection and strategy**: In team sports, fitness tests can help in selecting the right players for specific roles and developing strategies that leverage the strengths of each athlete.

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Performance enhancement

- **Identifying strengths and weaknesses**: Detailed fitness assessments help in pinpointing areas where an athlete excels and areas that need improvement. This information is crucial for optimising training regimens.
- **Tracking progress**: Regular testing allows for the monitoring of an athlete's progress over time. This helps in making necessary adjustments to training programs to ensure continuous improvement.
- **Optimising performance**: By understanding an athlete's capabilities, coaches can tailor training to maximise performance, whether it's improving speed, strength, endurance or agility.

NEWS REPORT

Aussie Rules: Top 5s | 2024 Preseason Testing – Coates Talent League

Michael Alvaro

***Rookie Me Central*, central.rookieme.com, 15 March 2024**

RECORDS tumbled at last week's Coates Talent League boys preseason testing day, as athletes from the 12 Victorian regions were put through their paces in Thornbury. In the event hosted by Rookie Me, Jett McLaughlan notched the best preseason Yo-Yo Test score ever recorded.

The Northern Knights top-ager's effort of 22.4 matched Andrew Brayshaw's unbeaten run at the 2017 National Draft Combine. It was part of an overall cohort which averaged the highest Yo-Yo Test scores over the last four years (20.6), according to the AFL.

Greater Western Victoria bottom-ager Archie Taylor also put his name in the record books with the fastest 20-metre sprint time recorded in preseason – 2.796 seconds. He and McLaughlin were among 13 all-time top 10 results across the five categories.

Other outstanding efforts across the day included Daniel Snell's running vertical jump. The Western Jets small rose to 102cm as the only athlete to chalk up triple-figures. His was the highest jump across all testing events nationwide this year. Snell is the son of 68-game former Geelong player, Jason.

A raft of top AFL Draft prospects were out in force, completing testing and media duties. Arguably the best performed all-round was Taj Hotton, who ran sixth-fastest in the agility test and placed seventh in the 20-metre sprint and running vertical jump.

Hotton's Sandringham Dragons teammate and AFL Academy member Luke Trainor also stood out with the fifth-best standing vertical leap. Meanwhile, pick one contender Finn O'Sullivan showed his wares with the fourth-highest running vertical jump.

The 2024 Coates Talent League season is scheduled to get underway on March 23, with six games making up the opening round. After 19 regular season rounds, Wildcard Round and a three-week knockout finals series, the Grand Final will be played on September 21.



Figure 5.5 Jett McLaughlan of Northern Knights in action during the Coates Talent League boys pre-season testing day

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Activity 5.1

Elite testing regime

1 Read the story '2024 AFL Preseason Testing' and justify why these tests were considered for pre-season.
2 What would the NRL, A-League and Super Netball teams potentially test for?

Skills: analysis, research

Quiz

Revise and summarise 5.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Identify three categories of fitness tests and give an example of a test in each category.
2 Discuss the value of performance/fitness testing for recreational participants.
3 Discuss the value of performance/fitness testing for elite athletes.
4 Compare reasons why a recreational participant and an elite athlete might conduct performance/fitness tests.

Think critically and apply 5.2

AFL, AFLW, NRL, NRLW, Super Netball, A-League and W-League sides and universities will often have facilities with testing tools. Some community organisations will also be able to provide access to elite testing options. Explore the viability of accessing and experiencing elite level testing for yourself.

Participate in a battery of fitness tests, which may be those relevant to your sport or available to you. Analyse the results to determine your strengths and weaknesses and set appropriate goals to improve performance.

Skills: analysis, research

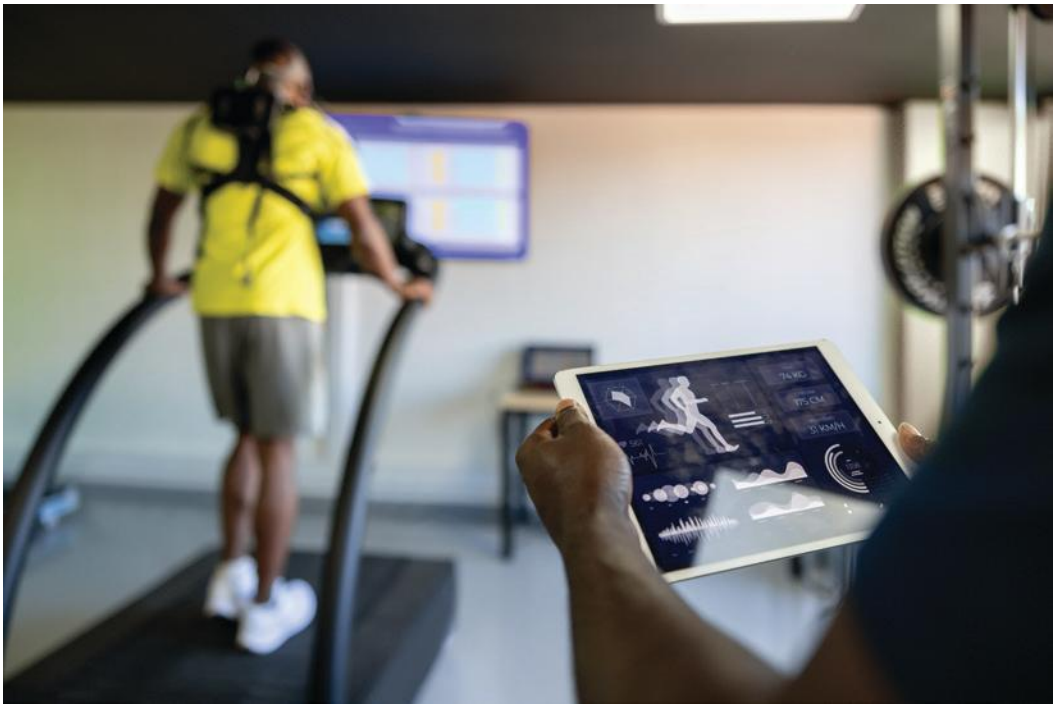


Figure 5.6 A personal trainer managing a fitness test.

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5.3 Developing fitness programs with the assistance of exercise assessment

Learning objective 5.3
EXPLAIN how exercise assessment can be used to guide the development of training programs.

Exercise assessments are crucial for developing effective and personalised training programs. By incorporating exercise assessments into the development of training programs, trainers can create more effective, safe and engaging fitness plans that cater to the unique needs of each athlete.

Identifying baseline fitness levels

Assessments help determine an individual's current fitness level across various components, such as cardiovascular fitness, muscular strength, endurance, flexibility and body composition.

This baseline data is essential for setting realistic and achievable goals. For example, a football player may complete a series of tests. With these assessments, the player and their coach can identify areas of strength and areas needing improvement. If the tests show that the player has excellent cardiovascular fitness but lower muscular endurance, the training program can be adjusted to include more endurance exercises. This baseline data helps in setting specific, measurable goals, such as improving the yo-yo test score or increasing the number of push-ups.

Personalising training programs

By understanding a client's specific needs, goals and limitations, trainers can design programs that are tailored to the individual. This personalisation ensures that the exercises are appropriate and effective.

Personalised training program for a basketball player

Assessment of needs and goals:

- **Needs**: improve vertical jump, enhance agility, increase endurance and strengthen core muscles.
- **Goals**: increase vertical jump by 12.5 cm, improve sprint speed and maintain high energy levels throughout the game.

Understanding limitations:

- **Limitations**: previous ankle injury, limited flexibility in the hamstrings and a busy schedule that allows for only four training sessions per week.

Designing the program:

- **Warm-up**:
  - dynamic stretches focusing on the lower body and core.
  - light jogging and mobility exercises to prepare the body for intense activity.
- **Strength training**:
  - **Lower body**: squats, lunges and calf raises to build leg strength and power.
  - **Core**: planks, Russian twists and medicine ball throws to enhance core stability and strength.
  - **Upper body**: push-ups, pull-ups and shoulder presses to ensure balanced muscle development.
- **Plyometrics**:
  - box jumps, depth jumps and bounding exercises to improve explosive power and vertical jump.
- **Agility drills**:
  - ladder drills, cone drills and shuttle runs to enhance quickness and change of direction.
- **Endurance training**:
  - high-intensity interval training (HIIT) sessions to boost cardiovascular fitness and stamina.
- **Flexibility and recovery**:
  - static stretching and foam rolling to improve flexibility and aid recovery, with a focus on the hamstrings and ankles.

Monitoring progress:

- regular assessments to track improvements in vertical jump, sprint speed and overall performance.
- adjustments to the program based on progress and any emerging needs or limitations.

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Detecting potential health risks

Assessments can identify potential health risks, such as obesity, cardiovascular issues or musculoskeletal imbalances. This information allows trainers to modify exercises to prevent injury and address these risks. For example, if a recreational runner identifies and addresses potential health risks early, the runner can train more safely and effectively. This proactive approach helps prevent injuries, manage chronic conditions and improve overall health and performance.

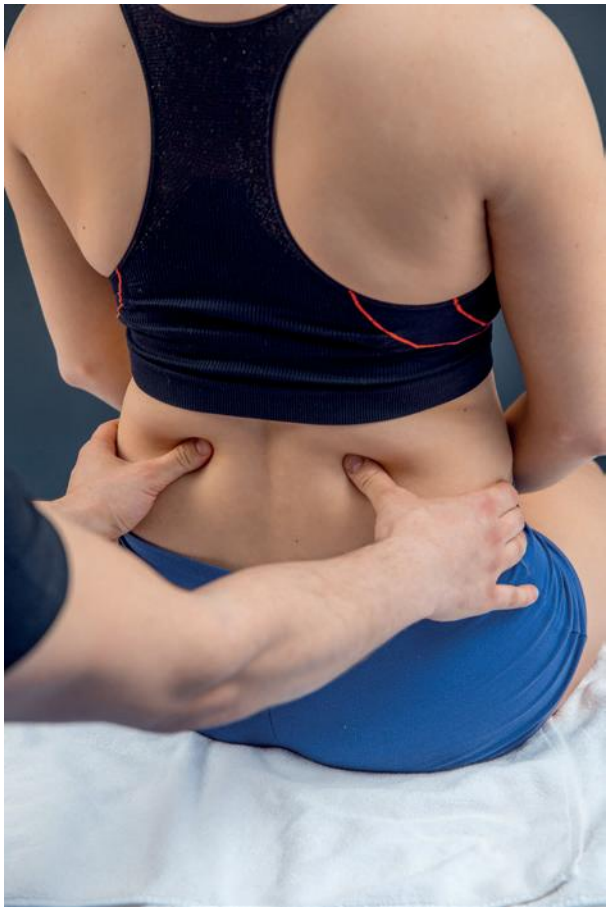


Figure 5.7 Assessments can help identify potential health risks.

Tracking progress

Regular assessments provide measurable data that can be used to track progress over time. This helps in adjusting the training program as needed to ensure continuous improvement and motivation. For example, by regularly assessing and tracking progress, a competitive swimmer can see tangible improvements, stay motivated and make informed adjustments to their training program. This ensures continuous improvement and helps the swimmer reach their performance goals.

Setting SMART goals

Assessments help in establishing specific, measurable, achievable, relevant and time-bound (SMART) goals. These goals provide clear direction and milestones for the training program. For example, if a tennis player wants to improve their serve, they can set SMART goals to give themselves clear, actionable targets to work towards. This structured approach helps maintain focus and motivation and ensures continuous improvement.

Enhancing motivation

Seeing tangible results from assessments can boost a client's motivation and commitment to their training program. It provides a sense of accomplishment and encourages them to stay on track. For example, a sprinter seeing tangible improvements, like faster sprint times and increased strength, gains a sense of accomplishment. This reinforces the sprinter's commitment to their training program. Such a continuous feedback loop helps maintain high motivation levels and encourages the sprinter to stay on track.

Quiz

Revise and summarise **5.3**

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Explain how exercise assessment can assist in developing training programs.

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Think critically and apply 5.3

1 An elite sprinter undergoes a battery of tests and returns the following results.

Test	Result
40 m sprint	5.45 s
multi-stage fitness test	Level 14–5
1 RM power clean	145 kg
1 RM squat	190 kg

How might this information be used to guide or adjust the athlete's training program?

2 An elite marathon runner undergoes a battery of tests and returns the following results.

Test	Result
body fat percentage	21%
1 RM power clean	110 kg
40 m sprint	4.87 s
50 m sprint	5.23 s

How might this information be used to guide or adjust the athlete's training program?

Skills: analysis, problem solving



Figure 5.8 After completing an exercise assessment, a trainer can create an effective, safe and engaging fitness plan for the athlete.

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Chapter summary

- Pre-exercise questionnaires and health screenings are crucial in the field of exercise and fitness. They provide a comprehensive overview of an individual's health status, medical history and fitness levels, allowing professionals to identify potential risks, tailor exercise programs and set realistic fitness goals. This proactive approach helps prevent injuries and adverse health events, enhancing the overall effectiveness of exercise regimens.
- Pre-screening is a preventive measure that determines a person's health status and baseline fitness levels before starting a training program. It detects existing physical or medical issues that may require adjustments to the training type, frequency and intensity. Components of pre-screening assessments vary by sport and may include factors like age, gender, health issues and specific fitness tests.
- Pre-screening is particularly important for certain groups, such as previously inactive people, older adults, asthmatics, smokers, overweight individuals and those with a history of heart disease, high blood pressure, or back/knee pain.
- In some sports, pre-screening physical characteristics is essential for injury prevention, such as ensuring a baseball pitcher has enough shoulder rotation or avoiding placing a player with a long, thin neck in the front row of a rugby scrum.
- Performance and fitness testing offers numerous benefits for recreational participants aiming to improve their health, participation and performance.
- Health improvement for recreational participants includes baseline assessment, monitoring progress and personalised exercise plans.
- Enhanced participation for recreational participants includes goal setting, injury prevention and inclusivity.
- Performance enhancement for recreational participants includes identifying strengths and weaknesses, motivation and accountability and optimising training.
- Performance and fitness testing is essential for elite athletes, providing detailed insights that significantly enhance their health, participation and performance.
- Health improvement for elite athletes includes baseline health metrics, injury prevention and recovery monitoring.
- Enhanced participation for elite athletes includes motivation and goal setting, customised training programs, team selection and strategy.
- Performance enhancement for elite athletes includes identifying strengths and weaknesses, tracking progress and optimising performance.
- Exercise assessments are essential for developing effective and personalised training programs.
- Assessments determine an individual's current fitness levels across various components, such as cardiovascular fitness, muscular strength, endurance, flexibility and body composition.
- Understanding a client's specific needs, goals and limitations enables trainers to design tailored programs. This personalisation ensures that exercises are appropriate and effective.
- Assessments can identify health risks like obesity, cardiovascular issues or musculoskeletal imbalances. This information allows trainers to modify exercises to prevent injury and address these risks, ensuring safer and more effective training.
- Regular assessments provide measurable data to track progress over time. This helps in adjusting the training program as needed to ensure continuous improvement and motivation.
- Assessments help establish specific, measurable, achievable, relevant and time-bound (SMART) goals. These goals provide clear direction and milestones for the training program, helping maintain focus and motivation.
- Seeing tangible results from assessments boosts a client's motivation and commitment to their training program. It provides a sense of accomplishment and encourages them to stay on track.
- Incorporating exercise assessments into training programs helps trainers create more effective, safe and engaging fitness plans tailored to the unique needs of each athlete.

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Multiple-choice questions

1 Why is it important for exercise and fitness professionals to use a pre-exercise questionnaire?
- A to increase the cost of the fitness program
- B to gather comprehensive information about an individual's health status
- C to reduce the number of clients
- D to avoid creating personalised exercise plans

2 What is one of the key benefits of conducting health screenings before starting an exercise program?
- A to ensure the client exercises without any breaks
- B to identify potential health risks and prevent injuries
- C to make the exercise program more challenging
- D to reduce the duration of the exercise program

3 How do pre-exercise questionnaires help in personalising exercise programs?
- A by providing a one-size-fits-all exercise plan
- B by understanding a client's specific needs, goals and limitations
- C by ignoring the client's medical history
- D by focusing only on cardiovascular fitness

4 Which of the following groups particularly benefit from pre-exercise health screenings?
- A young, healthy athletes only
- B individuals with no medical history
- C previously inactive people, older adults and those with chronic conditions
- D people who exercise regularly without any issues

5 How do fitness tests benefit recreational participants in terms of health improvement?
- A by providing a one-size-fits-all exercise plan
- B by establishing baseline health metrics and identifying potential health risks
- C by focusing only on elite athletes
- D by reducing the need for regular exercise

6 What is a key reason for using fitness tests to enhance participation among recreational participants?
- A to discourage participation in physical activities
- B to set SMART goals and increase motivation and commitment
- C to make the exercise program more difficult
- D to ignore individual fitness levels

7 Why are fitness tests crucial for elite athletes in terms of performance enhancement?
- A to provide generic training programs
- B to identify strengths and weaknesses and optimise training regimens
- C to reduce the frequency of training sessions
- D to focus only on recreational participants

8 How do exercise assessments help in setting realistic and achievable fitness goals?
- A by ignoring the individual's current fitness levels
- B by determining baseline fitness levels across various components
- C by providing a generic exercise plan for everyone
- D by focusing only on flexibility

9 In what way do exercise assessments contribute to personalising training programs?
- A by using the same exercises for all clients
- B by understanding a client's specific needs, goals and limitations
- C by avoiding any modifications to the exercise routine
- D by focusing only on cardiovascular fitness

10 Why is tracking progress through regular exercise assessments important?
- A to maintain the same exercise routine indefinitely
- B to provide measurable data for adjusting the training program as needed
- C to discourage changes in the exercise plan
- D to focus only on short-term results

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Exam practice

How to answer an exam question

Example question

Explain, with an example, how exercise assessments can be used to personalise training programs. (4 marks)

What is the question asking?

The key verb in this question is **explain**, which means you should try to show the relationships between things, such as what an assessment looks at, and how it applies to a training program.

Note that the question asks you to include an example.

Marking criteria

Criteria	Marks
• Explains how exercise assessments can be used to personalise training programs • Supports response with relevant example	4
• Describes how exercise assessments can be used to personalise training programs • Provides relevant example	3
• Outlines exercise assessments AND/OR how they can be used to personalise training programs • Provides example	2
• Provides some relevant information	1

Sample response

Assessments help determine a person's current fitness level in areas such as cardiovascular fitness, muscular strength, endurance, flexibility and body composition.

The trainer can use this baseline data about strengths and weaknesses to set realistic, achievable goals, and design a personalised program with exercises that are appropriate and effective for the individual.

For example, a hockey player's assessment may show that she has excellent cardiovascular fitness but lower muscular endurance. As she needs muscular endurance for hockey, the training program can include a focus on endurance exercises, with specific, measurable goals, such as increasing the number of push-ups.



Video 5.3 Answering the exam question

Exam-style questions

1 Explain the role of pre-exercise questionnaires in identifying potential health risks before starting an exercise program. Provide examples of specific health conditions that can be detected through these questionnaires. (3 marks)

2 Discuss how health screenings can contribute to the personalisation of exercise programs. Include in your answer how these screenings help in setting realistic fitness goals and preventing injuries. (4 marks)

3 Evaluate the legal and professional responsibilities of exercise and fitness professionals in conducting pre-exercise questionnaires and health screenings. How do these practices build trust and ensure client safety? (8 marks)

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4 Analyse how fitness testing can be used to set SMART goals for recreational participants. Discuss the impact of these goals on their motivation and commitment to regular physical activity. (5 marks)

5 Compare the benefits of fitness testing for recreational participants and elite athletes in terms of injury prevention and performance enhancement. Provide specific examples to support your answer. (5 marks)

6 Evaluate the role of fitness testing in identifying strengths and weaknesses in elite athletes. How does this information contribute to the development of personalised training programs and overall performance improvement? (8 marks)

7 Discuss the importance of establishing baseline fitness levels through exercise assessments. How does this information help in setting realistic and achievable fitness goals? Provide examples to support your answer. (4 marks)

8 Evaluate the role of regular exercise assessments in tracking progress and adjusting training programs. How do these assessments contribute to continuous improvement and motivation? (8 marks)

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Chapter 6
Influence of training on movement and performance

After completing this chapter, you will be able to demonstrate knowledge of:

- how types of training and training methods are utilised in different sports
- how principles of training are applied to enhance aerobic and strength training
- the relationship between the principles of training and physiological adaptations required for improved performance.

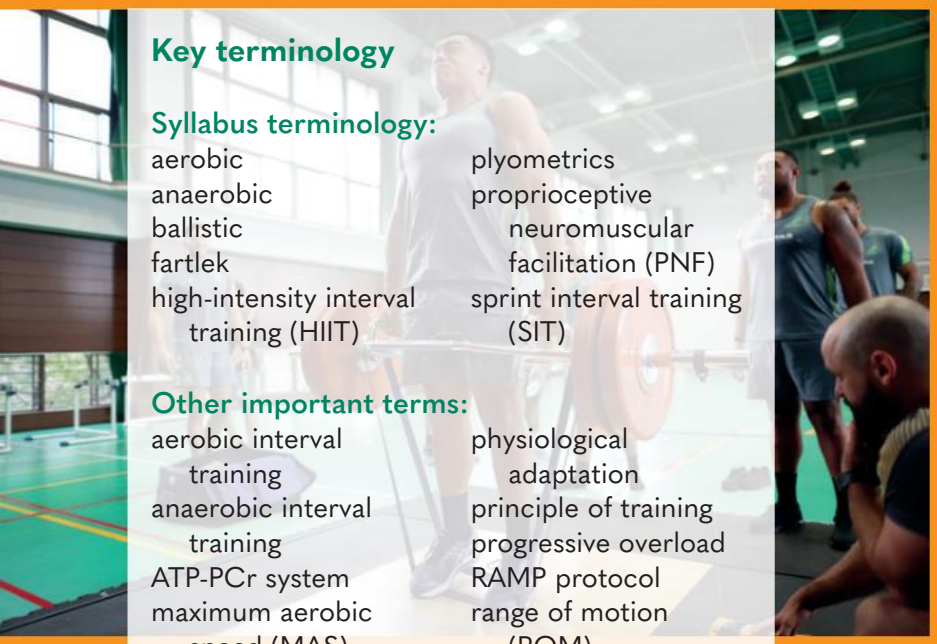
Key terminology

Syllabus terminology:

aerobic
anaerobic
ballistic
fartlek
high-intensity interval training (HIIT)
plyometrics
proprioceptive neuromuscular facilitation (PNF)
sprint interval training (SIT)

Other important terms:

aerobic interval training
anaerobic interval training
ATP-PCr system
maximum aerobic speed (MAS)
maximum heart rate (MHR)
physiological adaptation
principle of training
progressive overload
RAMP protocol
range of motion (ROM)
training threshold
VO_2 max









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Driving questions

What do you think is the hardest sport to prepare for and play?

Select one sport that you believe has the most complicated training and preparation requirements. Prepare FIVE arguments to justify your selection. Consider the components and level of fitness required, the skill and tactical development as well as the broader context of elite success in this sport.





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Introduction

Consider the winning serve in tennis, a 'silky backline' team play in rugby or the elation of finishing first in a triathlon. Highlight reels in elite sport tend to focus on single amazing moments of skill execution and winning glory, but often fail to capture the immense training that goes into preparing athletes and teams to have the greatest chance to showcase these skills in the crucial moments of competitive sport. This chapter explores the physiological adaptations an athlete requires for success in various sports and the way different types and methods of training can develop these adaptations. The chapter will also outline the fundamental guidelines that underpin effective and safe training programs aimed at developing these desired adaptations and performance outcomes. Students are encouraged to watch videos and documentaries that go 'behind the scenes' of training and competitive preparation for a variety of sports to increase their awareness of the nature of this training.

Activity 6.1

Debate: What is the hardest sport to prepare for and play?
Using your FIVE arguments prepared earlier, present, debate and consider with classmates your selection and points of justification as well as theirs.

Skills: collaboration, analysis, communication

6.1 Types of training and training methods

aerobic interval training alternating between periods of high-intensity aerobic activity and periods of low-intensity aerobic and active recovery (typically a work:rest ratio of between 1:0.5 and 1:1)

anaerobic interval training alternating between periods of higher-intensity anaerobic activity and periods of rest and active recovery (typically a work:rest ratio of between 1:2 and 1:8)

Learning objective 6.1
ASSESS the relevance of the types of training and training methods to various sports.

There are five types of training, each with their own specific methods (or sub-types). These are:

- anaerobic training
- aerobic training
- flexibility training
- strength training
- skill training.

Technological developments have increased the ability to profile the physiological requirements of sport and the ability to accurately measure and monitor training adaptations of various types and methods of training. This increased knowledge allows those involved in training athletes (e.g. strength and conditioning coaches) to create highly specialised training programs tailored to maximise physiological adaptations and therefore the ability to execute skills required to perform at the highest level.

Regarding all forms of **aerobic** and **anaerobic interval training** (periods of work and rest), there are many complexities and areas of overlap between specific methods. For the sake of clarity, these will be presented as distinct methods of training. However, it must be recognised that there are many exceptions and variations to the parameters and measurements of each. Some terms and methods are often used interchangeably, such as anaerobic interval and high-intensity interval training. Further, anaerobic training of longer duration leads to the development of aerobic systems; however, aerobic training alone will not develop anaerobic capacity.

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It is important to recognise that these fields of study are complex and ever developing, with most explanations requiring subtle nuance to appreciate the interrelated nature of most human body systems.

This chapter assumes prior understanding of important concepts from Chapter 5 and Chapter 6 of the *Cambridge Health and Movement Science Year 11* textbook, including maximum heart rate (MHR), VO_2 max, onset blood lactate accumulation (OBLA), lactate thresholds (LT1/aerobic threshold, and LT2/anaerobic threshold), aerobic versus anaerobic training and the three human energy systems (ATP-PCr, anaerobic glycolysis, aerobic (oxidative) energy system).

Anaerobic training

Apart from long-distance endurance sports, which require a continuous effort at a moderate intensity, most team and individual sports require the ability to produce maximal and repeated speed, power and force in order to succeed. These sports involve either:

- a singular maximal burst of energy over a very short period of time (primarily relying on the ATP-PCr energy system). Examples include the 100 m sprint, 200 m swim, weightlifting, javelin, long jump, diving and gymnastics vault sprint.

or

- intermittent, varied and repeated periods of high-intensity movement which can be sustained for short periods from 20 seconds to two minutes which are then followed by some level of aerobic recovery (primarily relying on the anaerobic glycolytic energy system). Examples include AFL, basketball, tennis and football.

To prepare for success in these sports, athletes use anaerobic training which primarily relies on energy sources stored within the muscles to fuel activity, which operate in the **absence** of oxygen.

With regard to any form of anaerobic (and aerobic) training, there are many complexities and areas of overlap between specific methods and protocols. For the sake of clarity in this chapter, **anaerobic interval training, high-intensity interval training** and **sprint interval training** are presented as distinct zones; however, there are many exceptions and variations to the parameters and measurements of each, as well as different language used in this field of study.

It is difficult to accurately measure the intensity of effort an athlete is using at any given point. A range of factors also influence output, such as genetics, age, stress, health, current fitness/fatigue level and current training cycle. Understanding intensity of training recognises that athletes train between resting levels and their **maximum heart rate (MHR)**. To establish a baseline to make this measurement easier, athletes often measure an estimate of their anaerobic power (or lactate threshold) using blood lactate testing or some estimation of this. This means the athlete is seeking to measure the intensity of effort where rising blood lactate crosses above LT2 (lactate threshold 2, or anaerobic threshold, which is the second point at which lactate starts to increase more rapidly). At this point, lactate starts to increase sharply for the second time, indicating that they have crossed into the anaerobic training zone, and are unable to meet 100% of their body's demand for oxygen, which correlates with their **VO_2 max**.

maximum heart rate (MHR) the highest level to which an individual is able to raise their heart rate, commonly measured as 220 – age (see Chapter 6 of *Cambridge Health and Movement Science Year 11* textbook)

VO_2 max the maximum (max) volume (V) of oxygen (O_2) the body is able to absorb during exercise, measured in mL/kg/minute

This baseline measurement is then set against a more quantifiable (easy to measure) metric. For example, runners may use heart rate or running speed, cyclists may use watts of power measured at the pedals while rowers may use cadence rate. From this, they can then set the various zones of work intensity to target their training. Another common term and measurement that athletes seek is their functional threshold power, which is the fastest aerobic speed an athlete can sustain for an extended period of 60 minutes. This point sits just below the lactate threshold and gives a good marker to indicate when an athlete enters the anaerobic zone.

Experienced athletes become increasingly aware of their lactate threshold and can subjectively measure their current effort using rate of perceived exertion (RPE) as a convenient way to quickly measure intensity. This is based on perceptions of intramuscular fatigue and cardiorespiratory function (often assessed by the ability to speak fluently or not).

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Table 6.1 Rate of perceived exertion (RPE) zones

RPE zone	Name	Effort intensity	Repetition duration	Maximum duration	Per cent MHR (approximate)	Type of training	Performance benefits and adaptations
10	Sprint	Maximum 'all out'	0–15 secs	10 mins	95–100%	Sprints	↑ neuromuscular power through ↑ size/strength of fast-twitch muscle fibres, ↑ CP stores
9	Sub-sprint	Near maximum	15 secs–2 mins	10–20 mins	90–95%	Short interval	↑ anaerobic capacity and speed endurance, ↑ VO_2 max, ↑ rate of recovery, ↓ perception of fatigue, ↑ lactate tolerance / clearance
8	Fast run VO_2 max	Very difficult	2–10 mins	20–40 mins	85–90%	Moderate – long interval	
7	Lactate threshold	Difficult hard	10–30 mins	30–60 mins	80–85%	Aerobic interval / fartlek	↑ lactate threshold zone, ↑ lactate clearance, ↑ muscle capillarisation, ↑ aerobic capacity, stroke volume, cardiac output, ↑ ventilation
6	Tempo runs	Fast aerobic	30–60 mins	60–120 mins	75–80%	Fast continuous / tempo runs	
5	Aerobic	Moderate aerobic	60–90 mins	90–180 mins	70–75%	Moderate continuous	↑ aerobic capacity, ↑ muscle glycogen stores, ↑ RBC count, ↑ slow-twitch muscle fibre size, ↑ mitochondrial stores
4	Endurance	Light aerobic	60–120 mins	24 hours	60–70%	Light continuous	
3	Recovery	Slow jog	NA	24 hours	50–60%	Recovery interval	NA
2	Easy	Easy fast walking	NA	24 hours	40–50%	Recovery interval	NA
1	Rest	Rest slow walking	NA	24 hours	30–40%	Recovery interval	NA

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Activity 6.2

Measuring lactate threshold and power

Research a training activity that a runner, swimmer or cyclist can undertake to estimate the point at which they cross over into the anaerobic or lactate threshold (the point at which there is a second sharp rise in blood lactate accumulation).

Skills: research





Figure 6.1 Testing of athletes to determine baseline aerobic and anaerobic levels to be used for programming of training and to measure progress

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Anaerobic interval training

Anaerobic interval training utilises periods of work and rest that repeatedly take the athlete *slightly* **above the anaerobic/lactate threshold** for a *moderate* time (30 seconds to 3 minutes) at a high (but not maximal) intensity, before returning to an aerobic level to recover and cycle blood lactate out of the muscle, before repeating. Consider the midfield position of most field and court invasion sports, where the athlete will be constantly moving at varying speeds. This training method develops both aerobic and anaerobic qualities, the ability to recover quickly as well as the ability to perform efforts harder, for longer and more often. This is a distinct advantage in these positions, as this is where an athlete with 'a bigger engine' is able to outperform opponents, particularly in the latter stages of a game.

Table 6.2 Key features of anaerobic interval training

Target heart rate (HR) zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
85–90% MHR 80–85% VO_2 max	1:2	Anaerobic glycolysis (+ aerobic energy system for recovery)	↑ cardiovascular function, ↑ lactate threshold, ↑ VO_2 max, ↑ oxidative capacity and fatigue resistance	400 m tempo run (1 min) / 2 min recovery x 6	Midfielder in AFL, football, 1500 m runner



Figure 6.2 Australian cricketers running anaerobic intervals

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High-intensity interval training (HIIT)

HIIT involves working more intensely at the upper levels of the anaerobic training zone over a shorter period, inducing high levels of fatigue, and therefore requiring longer periods of rest prior to repeating. It is assumed that the athlete is constantly working under increasingly high levels of fatigue. This can be considered the most intense form of training and is intended to develop anaerobic capacity. Similar to anaerobic interval training, this is commonly used in sports of an intermittent nature, where there is more intensity of effort and slightly longer periods of rest. For example, wingers in rugby and forwards in football often have to make more intense runs but have longer periods to recover in between than midfielders. Fitness centres often advertise HIIT sessions, and design interval circuits around these protocols, such as Tabata-style training (over four minutes, work hard for 20 seconds, rest for 10 seconds, repeat eight times and complete four cycles).

Table 6.3 Key features of high-intensity interval training

Target HR zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
90–95% MHR 85–90% VO_2 max	1:3	Anaerobic glycolysis	↑ lactate tolerance, ↑ VO_2 max, ↑ recovery for repeated efforts	50 m fast run (10 sec) / 30 sec recovery x 8	Tennis, football striker, 800 m runner







Figure 6.3 Cycling team performing an HIIT circuit to build their anaerobic capacity

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Sprint interval training (SIT)

ATP-PCr system the anaerobic energy system that is responsible for providing energy in the first 10 seconds of maximal effort

The key feature which distinguishes SIT from other forms of anaerobic training, is the length of effort and recovery between efforts. Because they are typically very short in duration (5–15 seconds), the athlete is primarily using the **ATP-PCr system** and phosphocreatine as the fuel source. Therefore, recovery must allow the full resynthesis of phosphocreatine stores so that it remains the dominant fuel source.

There are unique physiological adaptations from this type of training, which are compromised if the athlete is feeling fatigue from using muscle glucose anaerobically where blood lactate is increasing. Sports that require maximal sprinting speed over any distance from five to 100 metres benefit from SIT, including athletics and gymnastics, as well as many positions in team sports. Metabolically, the athlete increases their phosphocreatine stores and ability to quickly resynthesise ATP. Mechanically, the athlete will increase their potential power and force production through neuromuscular improvements, as seen in faster sprint times.

Table 6.4 Key features of sprint interval training

Target HR zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
95%–100% MHR	1:5+ (up to 1:20)	ATP-PCr	↑ fast-twitch muscle fibre power, ↑ neuromuscular function / contraction speed, ↑ PCr stores, ↑ muscle hypertrophy	50 m sprint (6 seconds) / 2 min recovery x 6	100 m sprint, gymnastics vault, any sprint in sport



Figure 6.4 Rugby players using sprint training to improve their maximal speed

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Plyometric training

Plyometric training involves explosive movements to build power, speed and strength. True plyometric training utilises a rapid cyclical muscle action called the **'stretch-shortening cycle'** (**SSC**). During SSC, the muscle undergoes a **controlled eccentric** (lengthening) contraction as the body comes in contact with an object (such as the ground when landing), a **'split moment' of pause** as the joint absorbs the force and changes direction, immediately followed by a **rapid forceful concentric** (shortening) contraction producing the opposite action. Examples include:

- jumping off a 20 cm box, landing softly but immediately jumping as high as possible
- single-leg broad leaps involving an eccentric landing and a rapid concentric take-off
- push up claps requiring a controlled landing on the hands before immediately pushing straight back up
- lying on your back and catching a medicine ball dropped from above and throwing it straight back up.

In essence, almost all human movement where the agonist and antagonist muscle pair work in unison to quickly change direction involve a plyometric action, such as walking, running and jumping. Plyometric training requires maximal power and fast contact times to produce the unique physiological adaptations that lead to increased power and force capacity.



Video 6.1 Plyometric training

On a more detailed level, a plyometric exercise (e.g. depth jump) involves three phases:

1 **Eccentric component**: the muscle (quadricep) or action (knee flexion) being developed is pre-stretched through the elastic elements of the muscle as the eccentric contraction helps decelerate and absorb the load (controlled landing)
2 **Amortisation component**: the very short time delay between controlling the eccentric load, pausing for a split moment, to then produce the elastic recoil and use the stored elastic energy to move in the opposite direction
3 **Concentric component**: involves unloading and using the elastic energy from the eccentric contraction of the quadricep muscle to produce an even greater concentric contraction and subsequent knee extension during the jumping action.

Different plyometric exercises result in different rates of ground contact time (GCT), which result in slightly different outcomes. GCT is the time period between coming into contact with the ground or object and leaving the ground or object.

- Fast plyometric SSC is considered to be a GCT of 100 ms or less (e.g. sprinting).
- Medium plyometric SSC is considered to be a GCT of 200 ms (e.g. 20 cm depth jump).
- Slow SSC plyometric is considered to be a GCT of 300 ms (e.g. 60 cm depth jump).

A GCT any longer than 500 ms (or 0.5 of a second) is where the training effect of SSC is minimised. This is seen in a counter movement jump, where the athlete performs a vertical jump from a paused half squat position without the eccentric control.

Plyometric training improves the storage and utilisation of elastic energy in the muscle, increased neural reflex and activation and increased coordination of movement. In performance terms, this means the athlete can increase their strength, speed, power, balance, motor control and change of direction speed, allowing them to run, jump, throw, kick, hit and move with greater power and explosive capacity.



Figure 6.5 High-jump athlete using plyometric bounds to increase power

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Plyometric training is very taxing on the body, requires increased recovery time and may lead to delayed-onset muscle soreness (DOMS) due to the eccentric loading. General training suggestions to ensure safety and effectiveness include:

- thoroughly warming up and preparing the muscle, skeletal and nervous system for explosive movements
- maintaining proper form, such as soft landing with no knee valgus (collapse)
- gradual progression, starting with lower impact movements before higher impact movements. A work to rest ratio of 1:5 to 1:10 is suggested to allow the neuromuscular system time to reset between efforts.
- only using plyometric training 1–3 times per week with a minimum of 48 hours recovery
- that beginners might perform 2–3 sets of 6–8 repetitions, whereas elite athletes perform 4–5 sets of 8–12 repetitions
- ensuring the safety of all equipment and surfaces, preferably performing intense movements on a surface that absorbs some force such as rubber mats or grass.

Practical application 6.1

Experiencing plyometric training

Following a good warm-up, students should experience various types of plyometrics, comparing these to non-plyometric jumps. Where possible, use jump pads, force plates, yardsticks or mobile phone applications to measure the height and, where possible, ground contact time.

Skills: collaboration, analysis

Resistance training (for power and speed)

External loads are used to develop greater force production capacity. Athletes use gym-based resistance training to apply a unique stimulus to the body, in order to elicit a greater response and performance outcome. Movements are based on traditional strength training exercises and should target the whole body and focus on the specific joint actions and muscles required for specific sports.



Figure 6.6 Kettlebells can be used as part of a resistance training routine.

In terms of resistance training equipment used for power and speed, there is a variety of tools which athletes may use.

- Barbells, plates, overhead bars and dumbbells are commonly used for foundational movements such as pulling, pressing, squatting and hip hinge variations, such as cleans and deadlifts.
- Elastic bands can add an increasing power stimulus through the range of motion, meaning that the effort is harder at the end of the movement. They can be added onto barbells, such as in banded squats and presses, or can be used as resistance while sprinting.
- Medicine balls and slam balls are useful for moving loads quickly while throwing, especially with rotational movements.
- Kettlebells, landmines, sandbags and water bags can be used to move loads around dynamic and natural arcs similar to human movements, such as swings and landmine presses.
- Heavy sled pushes and drags add resistance to movements that mimic sprinting.

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A typical athletic strength program, tailored to increase power and speed capacity, will often focus on foundational human movements, including:

- vertical push movements such as shoulder press and Viking press
- vertical pull movements such as chin-up and banded pull-up
- horizontal push movements such as bench press and single arm dumbbell press
- horizontal pull movements such as seated row, one arm row and inverted rows
- hip dominant movements such as Romanian deadlift (RDL) and lunge
- knee dominant movements such as Bulgarian split squats, Nordic curls, and heel elevated squats
- rotation movements such as side medicine ball throws, banded twist-lunge-drive and landmine rotations
- core movements (which use deep postural muscles to increase stability of the trunk and body through dynamic power movements). These can be divided into four types:
  - anti-trunk lateral flexion such as side plank and single-arm farmer's carry
  - anti-trunk rotation such as banded Pallof press, bird dog and bear crawl with plate slide
  - anti-trunk extension such as dead bug, plank, body hollow boat hold and reverse crunch
  - anti-trunk flexion such as bird dog, glute bridge and back extension.

Video 6.2 Resistance training



Figure 6.7 Dynamic core training exercises such as plank, bird dogs and glute bridges challenge the body to maintain stability in different planes of motion.

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To increase power using these movements, athletes should apply the following metrics, features and equipment in the training program, which differ from traditional training for strength and hypertrophy.

- A fundamental rule for all resistance training to build power and speed, is to always move with intent, at a velocity which requires effort. The concentric phase should be defined by a 'purposeful drive', while the eccentric phase should be slower and controlled. Typically, this would be one second to 'lift' and two to three seconds to 'lower'.
- Use a load which correlates with the desired outcome of movement. The force-velocity curve (Figure 6.8) shows the relationship between resistance and potential speed of movement. For example:
  - If the athlete requires great strength and ability to hold or move an object slowly (rugby scrum), use 80–100% RM.
  - If the athlete needs to move an object once but quickly (weightlifting/shotput), use 30–80% RM.
  - If the athlete needs to move their body with great velocity repeatedly (sprinting), use 30–60% RM.
- Most athletes in complex sports train all these qualities to develop all-round athletic strength, power and speed, depending on the requirements of the sport.
- Generally, the repetition count should be lower to ensure the athlete can produce maximal force without significant fatigue by the end of the set (it is common to use 1–6 repetitions for strength, 2–8 for power and 6–12 for velocity) but to use more sets (4–5). A total repetition count of 18–30 is enough stimulus to elicit an adaptation and training response.
- Longer rest time between sets (3–5 mins) is used to allow neural and muscular system recovery, ensuring the body is primarily using the ATP-PCr system to produce energy.
- Resistance training for power and speed will often use more complex movements that challenge the body more in more sport-specific ways, often incorporating a combination of dynamic movements which combine single exercises, and also a lot of single-side training to challenge the stability of the body. An example would be a single-arm dumbbell overhead walking lunge into high-knee march with pause.

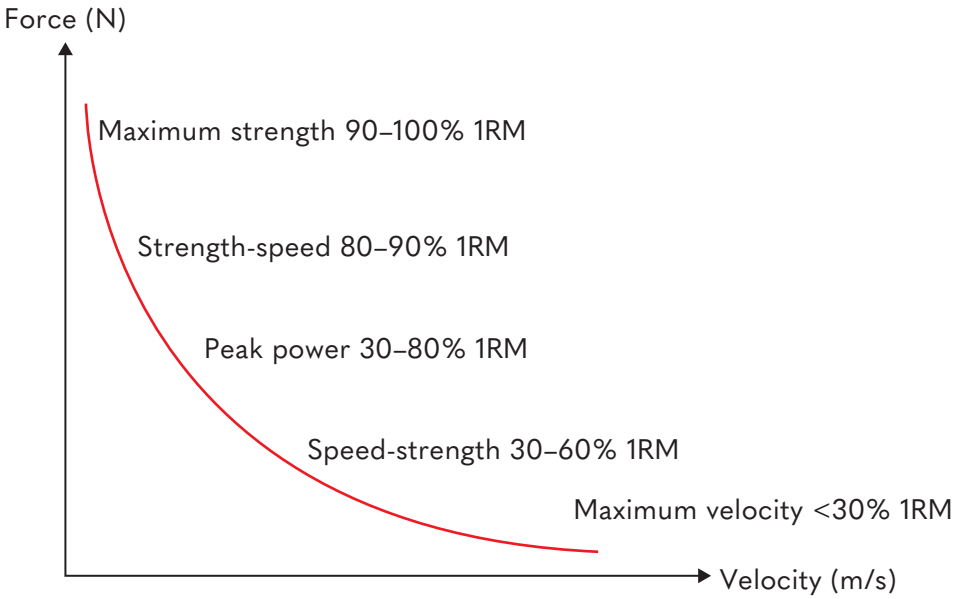


Figure 6.8 The force-velocity curve showing the relationship between the resistance and the speed of movement

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Figure 6.9 Resistance training for power and speed in rugby using complex movements, elastic bands, unilateral (single-side) training and resisted sprinting

Activity 6.3

Sports-specific resistance training for power and speed

For a selected sport, research and watch videos of athletes using resistance training for power and speed, and analyse the exercise for the muscle and joint action used, and how this relates to the requirements of the sport.

Skills: research, analysis

Practical application 6.2

Experiencing resistance training for power and speed

In small groups, design and participate in a resistance training session intended to build power and speed for a selected sport using the equipment available. Use simple and safe movements, ensuring good technique is maintained. The session should consist of:

- a warm-up based on the **RAMP protocol** (see pages 204–206 later in this chapter) (5 minutes)
- explosive movement, e.g. jump, throw or sprint (5 minutes)
- resistance exercises e.g. perform 2–3 sets of 4–6 reps of the following SIX movements using a comfortable weight. Select a familiar exercise for each movement including at least TWO unilateral (single-side) movements: (35 minutes)
  - hip dominant movement
  - upper-body push movement
  - rotation movement
  - knee dominant movement
  - upper-body pull movement
  - core stability movement
- cool-down e.g. stretch (5 minutes).

RAMP protocol a protocol for the phases of a warm-up: raise, activate and mobilise, potentiate/perform

Skills: creative thinking, collaboration, analysis

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Aerobic training

While most dynamic and complex sports require anaerobic power, they also require high degrees of aerobic capacity. Some sports rely heavily on aerobic endurance for success, such as triathlon, but even sports of a very intermittent and anaerobic nature such as tennis, greatly benefit from a strong aerobic base, which supports better functioning of all human body and energy systems.

Aerobic training occurs in the training zone that sits between rest and the lactate or anaerobic threshold. While anaerobic training such as HIIT leads to aerobic conditioning, there are unique physiological adaptations that are more relevant to lower and moderate intensities of training. The phrase 'when you train easy, train easy; and when you train hard, train hard' is commonly used to help athletes recognise the value of training at both aerobic and anerobic intensities. These aerobic processes all involve the mitochondria ('power-houses') of the cell.

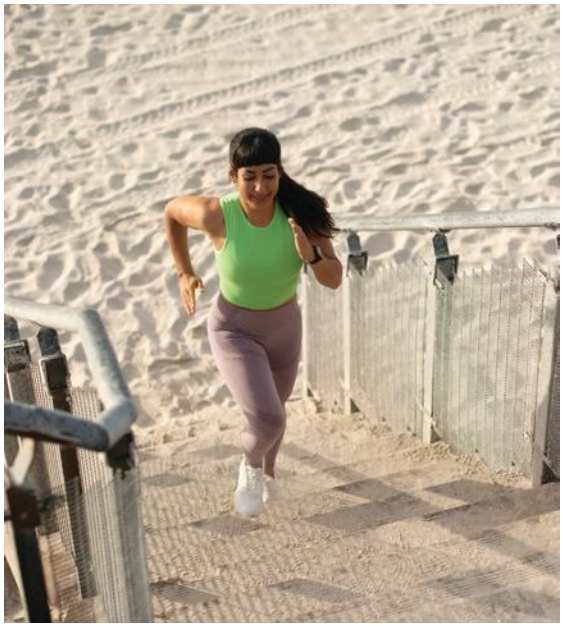


Figure 6.10 Most dynamic sports require high degrees of aerobic capacity.

To investigate aerobic training at a deeper level, it is worth breaking it into two forms:

- **aerobic lipolysis**, the breakdown and use of **fats** for aerobic metabolism, which generally occurs from rest until the lower aerobic intensity of 50–65%. When using **fat** as a fuel source, large amounts of ATP are resynthesised, but in a slower and more involved process that is very oxygen-demanding
- **aerobic glycolysis**, the breakdown and use of **glucose** for aerobic metabolism, which generally increasingly occurs at moderate to higher aerobic intensities of 70–80%. When using **glucose** as fuel, energy is produced faster and more easily at higher intensities, but with a lower overall ATP yield. Both energy pathways share a range of important training effects, but there is a unique training stimulus from using each fuel which provides a distinct benefit for the athlete's aerobic conditioning.

Table 6.5 Using fat as fuel for low-intensity exercise vs. using glucose for moderate-intensity exercise

Aspect	Fat as fuel	Glucose as fuel
Energy pathway	Aerobic lipolysis in mitochondria	Aerobic glycolysis in mitochondria
ATP yield	Higher per molecule of fat (up to 360 ATP)	Lower per glucose molecule (36 ATP)
Oxygen requirement	High (slow, oxygen-intensive process)	Moderate (requires less oxygen than fat)
Mitochondrial activity	Increased density and size	Increased efficiency
Rate of energy production	Slow, sustained energy	Faster, less sustained energy
Fuel source	Free fatty acids (stored as triglycerides)	Glucose (stored as glycogen)
Byproducts	CO_2, H_2O (minimal lactate)	CO_2, H_2O (potential lactate at high intensities)
Efficiency	High, but slower energy production	Lower, but faster energy production

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With regard to aerobic training, there are four methods: **continuous training, fartlek training, aerobic interval training** and **circuit training**.

Continuous training

Continuous training involves a sustained and steady moderate intensity for an extended period. Lower-intensity continuous training at 50–65% MHR utilises fat as the primary fuel source and builds mitochondrial and capillary density due to the higher oxygen demand. This is often described as zone 2 training. At this level, the best indicator is when the athlete can continue to speak in sentences, but with a small disruption from slightly elevated breathing. Longer duration of a minimum of 2–3 hours per week at this level is required to elicit a training effect. This is often used early in pre-season to build an aerobic base, particularly for long-distance endurance sports such as road cycling and marathon running. Training at this level develops the body's ability to use fat as fuel for exercise, resulting in less glycogen being used, making it available for higher intensities, which is an advantage in events lasting over two hours (known as 'glycogen sparing'). Moderate-intensity continuous training 65–80% MHR utilises glucose as the dominant fuel source and correlates with the first rise of lactate (LT1, or aerobic threshold) as the body starts to aerobically metabolise glucose. This is useful for sports requiring a moderate and sustained intensity equating to a fast jog for a moderate length of time, where breathing rates make holding a conversation more difficult. This level of aerobic base increases recovery efficiency from anaerobic intervals as well.

Table 6.6 Key features of continuous training

Target HR zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
50%–65% MHR (fat dominant) 65–80% MHR (glucose dominant)	No rest periods	Aerobic energy system	↑ cardiovascular function and efficiency (↑ left ventricle) / ↑ haemoglobin + myoglobin (O_2 transportation) / ↑ energy pathway efficiency	Moderate and steady pace: Minimum 20 minutes to several hours – run, ride, swim, row, etc.	Marathon, triathlon, road cycling, 1500 m swim



Figure 6.11 Tadej Pogacar training at low intensity and chatting with teammates as they build their aerobic base

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Fartlek training

Fartlek training involves moderate continuous training, interspersed with short efforts of varying high-intensity. These distinct sectors can be somewhat unstructured, often used by athletes to randomly break up continuous training with small challenges that take them briefly into the anaerobic zone. They then return to the dominant aerobic zone, which provides a mental challenge and variation to reduce boredom. More structured fartlek training might involve sprinting for 10 seconds every two minutes, sprinting between two street-lights every five minutes, or using a natural feature such as a short hill to sprint up before slowly returning to repeat. Fartlek develops the body's ability to tolerate work intensities where lactate is elevated, recover quickly and build aerobic capacity. Fartlek suits the sporadic nature of team sports, and elite athletes use more programmed and structured fartlek to accurately track volume, intensity and duration.

Table 6.7 Key features of fartlek training

Target HR zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
70–80% MHR (with short anaerobic efforts)	Varies based on level of structure but is aerobically dominant	Aerobic energy system	↑ cardiovascular function and efficiency / ↑ lactate tolerance and recovery	Structured: sprint 50 m every 350 m x 10 Unstructured: sprint up the short hill on a 1 km road run lap x 5	Midfielder in football, hockey



Figure 6.12 Olympic marathon champion Eliud Kipchoge runs among his pacers during a fartlek session in Kaptagat on 4 May 2024.

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Aerobic interval training

Similar to fartlek training, aerobic interval training also involves periods of aerobic work and rest, but with increased structure and planning to enable more accurate tracking of progress and application of overload. While some work efforts may push slightly into the anaerobic zone, the aerobic energy system is dominant, which may be indicated by the overall average heart rate or average speed at the end of the session being comparable to a relatively fast continuous training level over the same time. This undulating nature between a 'steady moderate pace' and faster 'tempo' effort close to the anaerobic or lactate threshold, or even slightly above LT2 (lactate threshold 2, or anaerobic threshold), builds the ability of the athlete to tolerate the fatigue associated with steady but moderate levels of lactate over longer periods, before recovering using an active aerobic pace. This is also well suited to events between 60–90 minutes, such as a football midfielder who may cover 10–12 km, but at a range of intensities and speeds. Typically, the work periods are longer in nature (2–6 minutes), building the ability of the athlete to maintain pace under moderate levels of fatigue.

A common metric used to more easily program and measure aerobic interval training is to estimate an athlete's **maximum aerobic speed (MAS)**. MAS is slightly above lactate threshold (about 120%), and using a simple calculation of speed, time and distance, strength and conditioning coaches can set intervals as a percentage of MAS. Common tests of MAS include six-minute time trial or 1200 m time trial, with the average running speed calculated in metres per second.

In team sports, this is a great advantage as once the correct length of markers has been set for the interval distances relative to the MAS of each athlete, all athletes can be running at the same intensity and time, receiving the same stimulus, as the MAS has relatively equalised all athletes. The example below is for an aerobic interval session using a work to rest ratio of 1:1, where each athlete runs four laps for 15 seconds at 100% MAS and then four laps for 15 seconds at 120% MAS, with 15 seconds of rest between each repetition. An example for four athletes is shown in Figure 6.13.

Maximum aerobic speed (MAS) the lowest speed an athlete can run where they have reached their maximal oxygen uptake (VO_2 max)

Table 6.8 100% and 120% MAS distances for 15 seconds of running for four different athletes

Athlete #	MAS (from 1.2 km trial)	100% MAS 15 seconds	120% MAS 15 seconds
1	4.87 m/s	73 m	88 m
2	5.06 m/s	76 m	91 m
3	5.22 m/s	79 m	94 m
4	5.47 m/s	82 m	98 m

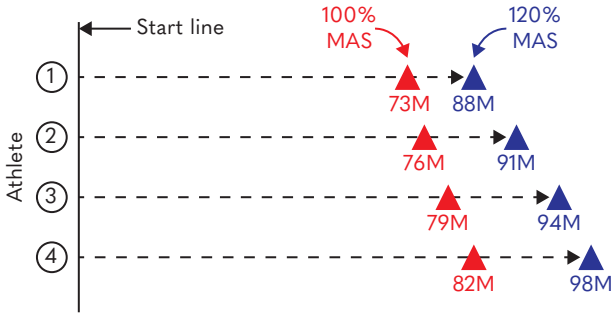


Figure 6.13 Example of how to use MAS for an aerobic interval session for four different athletes

Table 6.9 Key features of aerobic interval training

Target zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
70–90% MHR 100–120% MAS	1:0.5 to 1:1	Aerobic energy system	↑ cardiovascular function and efficiency / ↑ lactate tolerance and recovery / ↑ lactate threshold	800 m tempo pace (fast steady run) with 200 m recovery jog x 5 repeats	Midfielder in football, hockey

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Circuit training

Circuit training involves a series of exercises that can target a range of performance outcomes and generally are intended to keep the heart rate in a zone similar to aerobic interval training, with periods of work and rest. In team sports, circuits can involve sports-specific skills to be executed under fatigue (e.g. sharp shuttle runs with partner passes in football) and they can also be used to build muscular endurance as movements often use body weight with high repetitions (e.g. body-weight jump squats). These can be a fun and energising way to train aerobically, hence their popularity in group fitness sessions. They can also be very challenging mentally and encourage team camaraderie, so are often used in pre-season for team sports.

Table 6.10 Key features of circuit training

Target HR zone	Work to rest ratio	Dominant energy system/s	Targeted purpose / physiological adaptations	Training example	Sporting example
70–85% MHR	1:0.5 to 1:1	Aerobic energy system	↑ cardiovascular function and efficiency / ↑ lactate tolerance / ↑ muscular endurance	Netball: partner 6 station circuit: 30 seconds on + off (shuttles / plank / lateral-jumps / push-ups / piggy-in-middle / squat-lunge-lunge)	All sports



Figure 6.14 Group of people circuit training in a gym

Practical application 6.3

Experiencing aerobic training methods

In small groups, design and participate in a range of activities covering each type of aerobic training method. After each, reflect on the RPE and relevance to different sports.

Skills: creative thinking, collaboration, analysis

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Flexibility training

A key benefit of flexibility training is that it reduces an athlete's risk of injury, However, it can also enhance performance as it enables other components of fitness to be fully expressed, unhindered by muscle tightness or joint restriction. In some sports, performance is directly impacted by flexibility training, particularly those that require aesthetic qualities such as gymnastics, diving and figure skating. Flexibility training is often 'micro-dosed' and built in around the preparation for training sessions and games, such as during the warm-up and cool-down, but most elite athletes also perform isolated flexibility training sessions where they focus on increasing muscle and joint flexibility and **range of motion (ROM)**.

range of motion (ROM) the extent to which a body part can be moved around a joint

During the warm-up, the activation and mobilisation components of the RAMP protocol seek to prepare the muscles for the intensity of activity to come. The neuromuscular stimulation, active joint mobilisation and increase in muscle warmth and suppleness are important injury-prevention measures. The cool-down seeks to use flexibility training to promote recovery and relaxation of fatigued muscles, kick-starting the process of recovery.

More targeted and extensive flexibility training will have specific performance outcomes depending on the specific needs of the sport. For example:

- In AFL, the intensity of long sprints, decelerations, long kicking and frequent bending over challenges the flexibility and range of motion of the hamstrings.
- In swimming, the shoulder joint is vulnerable to overuse shoulder injuries from the repetition of rotation, so having mobile, stable and strong shoulders will lower the risk.
- Diving requires somersaults in the pike position with legs straight and torso tucked to score well, requiring hamstring and lower back flexibility.
- Surfing manoeuvres can be made more impressive with an ability to extend into extreme body positions with legs outstretched through rotation.
- Weightlifters can comfortably squat deeply in the jerk position with bar overhead, and apply great force through the full ROM.

It is important to recognise the broad application and importance of flexibility training for success and longevity in different sports.

Depending on the performance needs, injury risk profile and nature of various sports, there are FOUR methods of flexibility training (or types of stretches): **static, dynamic, ballistic and proprioceptive neuromuscular facilitation (PNF).**

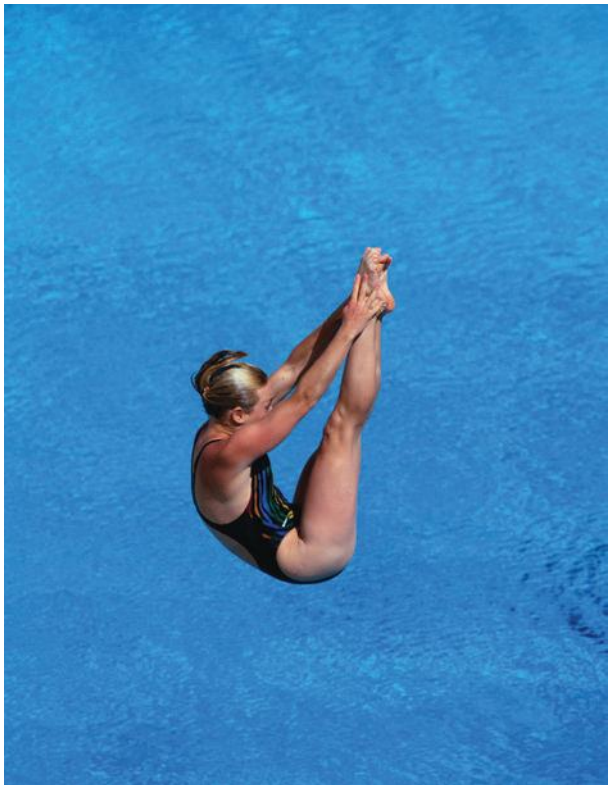


Figure 6.15 Divers require hamstring and lower back flexibility.

Activity 6.4

Targeted flexibility training

For a selected sport, research THREE injuries that occur more frequently. Describe how increased muscle flexibility and joint range of motion can reduce the risk of these injuries.

Skills: research, analysis

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Static flexibility training

Static stretches involve holding a stretched muscle and joint at the limit of its range for an extended time, with a slight feeling of discomfort. It is recommended that each stretch be performed 2–4 times for 30–60 seconds, 2–3 times per week. This will elicit changes by elongating and increasing the elasticity of the muscle and connective tissue, reducing the risk of injury. Most sports have set ideals for the ROM required of specific muscles and joints, and athletes will be measured to ensure they reach these baseline levels. Many sports only require a healthy degree of flexibility, with exceptions where extreme ROM may be of a performance benefit such as in aesthetic sports. For example, footballers are expected to be able to perform a single lying straight leg raise to 90°, which is also advisable for non-athletes. On the other hand, a gymnast should be able to perform deep splits with ease.

During focused flexibility training, athletes use static stretches as a stimulus to increase flexibility, such as 45-minute yoga session. Static stretches are also used during the cool-down as it has the unique advantage of decreasing neuromuscular tension and fatigue following intense activity. This can be shorter in length and may be repeated during the following days of recovery, but this does not lead to increased flexibility as it is not enough stimulus.

Dynamic flexibility training

Dynamic stretches involve gentle rhythmical movements within the normal ROM of a muscle and joint, typically performed prior to intense exercise in training or a game. These movements help synchronise muscle activation and joint mobilisation as can be seen in the example of a deep squat to long lunge with spine rotation. They help increase blood flow, vestibular and neural activation, proprioception and balance, muscle warmth and elasticity, coordination, and they can replicate the specific movements required for sport.

Common examples of dynamic stretches and movements include leg swings, lunges with twist, arm swings, high knees, torso twists, hip circles, walking lunges and toe touches.

Dynamic stretches are particularly useful for sports that require power, speed, balance and agility. As a result, dynamic stretches during a warm-up lead to a significant reduction in injury risk. This has been demonstrated through the highly successful FIFA-approved warm-up protocol, FIFA 11+, which incorporates dynamic movements with strength, balance and agility exercises aimed at reducing the risk of anterior cruciate ligament (ACL) injury and other injuries, especially in female athletes.



Figure 6.16 Elite footballers using hamstring static stretches during a recovery session to promote muscle relaxation and recovery



Figure 6.17 Elite netballers using dynamic leg swings to prepare for a game

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Case study 6.1

The FIFA 11+ Injury Prevention Protocol

The FIFA 11+ Injury Prevention Protocol was developed by FIFA's Medical Assessment and Research Centre in 2006 in response to the alarming rate and increase in injuries in football. This evidence-based program aimed to reduce the risk of lower limb injuries in football, including muscle strains, ligament strains and ACL injuries. Medical professionals, football experts and sports scientists identified suitable and sports-specific mobility, strength and neuromuscular exercises that would best prepare the body for the rigours of competitive football, aimed at reducing the most common and severe injuries. These protocols and activities were intended to be able to be implemented by teams and players at all levels and ages, with progressions for various levels of development. Educational resources were developed to assist coaches and trainers with the regular implementation of the program as part of a team's regular warm-up before training and games. The protocol includes three distinct phases:

Part 1: Dynamic running exercises and locomotor movements to raise body systems, enhance agility and neuromuscular coordination.

Part 2: Strength and plyometric exercises focused on strengthening key muscles (quadriceps, hamstrings, glutes and calf muscles) and improving joint stability (ankles and knees).

Part 3: Flexibility and balance exercises focused on joint mobility, muscle flexibility and balance (proprioceptive awareness).

The FIFA 11+ primarily aims to decrease the risk of football-related injuries, as well as improving injury recovery and enhancing performance. Evidence has shown that regular implementation of the program has reduced the incidence of a range of injuries, particularly ACL injuries (with stronger results in female populations). You can watch a video about the FIFA 11+ Injury Prevention Protocol at redirect https://cambridge.edu.au/redirect/11423.



Figure 6.18 Dynamic running exercises are undertaken in Part 1 of the FIFA 11+ Injury Prevention Protocol.

1 Identify example activities from each phase of the FIFA 11+ Injury Prevention Protocol.
2 Identify an example of an activity that includes progressions from basic to advanced.
3 Demonstrate how THREE specific activities reduce the risk of both hamstring strains, ankle sprain and ACL injuries.
4 Research evidence of the effectiveness of the FIFA 11+ Injury Prevention Protocol.

Skills: analysis, communication, research

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Ballistic flexibility training

Ballistic stretches also involve rhythmical joint actions, but done with more force and intent to move the joint *beyond* its normal ROM (sometimes referred to as 'bounce stretching'). This aims to greatly increase joint ROM and muscle flexibility and is reserved for experienced athletes in specific sports where this is an advantage, such as gymnastics or diving. These are aesthetic sports (judged subjectively on the quality of performance) or those that involve extreme movements performed at a rapid pace such as high kicks in martial arts. Ballistic training should be well supervised, follow a thorough warm-up and ensure good technique. Elastic bands and light resistance may also be used to further increase ROM. The movements are often similar to dynamic stretches but done with some application of force, such as high leg kicks or forced butterfly stretches.





Figure 6.19 Elite gymnasts use ballistic stretching to prepare for the extreme ROM required for performance.

Proprioceptive neuromuscular facilitation (PNF) flexibility training

PNF stretches follow a protocol of a moderate isometric contraction (10 seconds), relax the same muscle (5 seconds) and perform a static stretch (15 seconds), repeating the cycle 3–5 times per muscle. PNF is an effective way to increase muscle length and therefore ROM (when compared to static stretches alone). Skeletal muscles have a special nerve receptor called the muscle spindle which detects sudden changes in muscle length and will signal for a muscle to contract if it is being stretched to a point of potential danger. This is a protective mechanism to prevent injury from overstretching a muscle. However, this will often give a false sense of muscle tightness during static stretches, and relaxing this sensor allows for deeper and longer stretches, leading to increased elongation of muscle fibres and connective tissue. The isometric contraction of the PNF stretch triggers a relaxation of the autogenic inhibition (self-generated tension) which the muscle spindle helps create. PNF stretches are best performed in isolated sessions away from more intense training, and often use partners or bands to create resistance for the isometric contraction.



Figure 6.20 A cricket fast bowler uses a partner PNF stretch during training with an elastic to increase muscle length and shoulder ROM.

Practical application 6.4

Experiencing flexibility training methods

Following a good warm-up, students should experience the various methods of flexibility training, taking particular care to not over-exert during the ballistic stretches. Reflect on any changes in feelings of muscle tightness and joint inhibition before and after each method.

Skills: analysis

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Strength training

Strength training is vital for health as well as sporting performance. It comes in many forms for different purposes but is essential for every athlete to use in some form. Strength training primarily seeks to increase the maximum force a muscle can produce regardless of speed (whereas power requires rapid force production). For this reason, it is foundational for the expression of power and speed, and there is an overlap between strength training and resistance training for power and speed. The main differences between these are in the resistance and speed of movement. Another misconception is that strength training equates to increased muscle size (hypertrophy). While this may be a valuable performance goal for some, athletes can increase strength while maintaining their level of muscle mass. This is useful for sports which rely on athletes being lean, such as road cyclists and high jumpers. Strength training can also be used to develop muscular endurance, which is important for sports requiring high repetition of a moderate contraction force, such as rowing and middle-distance running. There are a wide variety of positive effects from strength training, with adaptations and responses in the muscular, skeletal, neural and endocrine system.

General rules for strength training are below:

- Always have good form and safe technique.
- Use supervision and spotters for heavy weights.
- Have a thorough warm-up and movement preparation.
- Follow a well-structured program of gradual overload, avoiding overexertion and injury risk.

There are many parameters to effectively programming for strength training, and athletes often follow a similar program structure to the one outlined in anaerobic training (resistance training for power and speed), whereby athletes train movements, as opposed to muscle groups. There are three methods of strength training based on the equipment used: **free and fixed weights, body weight** and **elastics**.



Figure 6.21 Comparing the legs of road and track cyclists who both require high levels of strength but with different levels of hypertrophy

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Free and fixed weights

Strength training, using free and fixed weights, applies an external resistance to the body which acts as a unique stimulus to elicit a training effect of either increasing muscular strength, hypertrophy or muscular endurance. Exercises can be highly sports-specific, directly relating to the movement requirements of the sport. There are two forms of equipment which offer unique advantages.

Free weights include equipment such as dumbbells, kettlebells, barbells, trap bars and plates. They are highly versatile and countless exercises can be performed along natural paths of human movement. Exercises may be isolated single joint exercises, such as calf raises, or complex compound movements involving several joints such as deadlifts. Resistance can be incrementally increased as strength develops, allowing accurate tracking of progress. Strength training requires strict form and technique to reduce injury risk, particularly in heavy compound exercises such as back squats and bench press. Many adaptations can be made to these movements to increase safety without compromising effectiveness. Free weights also promote the development of stabilising muscles during movements, and therefore offer holistic development relevant to sports. For example, unilateral (using a single side of the body) training such as single leg box squats challenges core stability throughout the movement, as the athlete maintains balance with an 'unbalanced' load. Interestingly, for athletes working unilaterally, the 1RM (one repetition maximum – refers to the maximum load that can be lifted for one repetition) is close to 70–80% of their capacity for bilateral (using both sides of the body) lifts. An obvious point to note is that free weights are affected by gravity, and therefore there is some limit to possible movements with free weights.

Fixed weights use pin-loaded cable machines with a set path of movement to target specific muscles, such as seated row, shoulder press or leg extension machine. These offer some unique benefits that free weights are not able to provide, such as increased safety for heavy loads, as seen with the leg press. They can also help less experienced athletes learn the patterns of key movements such as Smith machine squats before moving to free weights. A key drawback is that they offer less challenge for stabilising muscles. A key advantage of a weighted cable machine is the adjustable angle of pull, where the cable and pulleys can be changed to allow any range of angle to be used, such as a cable chest press from a high, medium and low height to hit the fan-shaped pectoral muscle fibres from different angles.

Table 6.11 shows the thresholds used in strength training to develop the distinct qualities of increased muscle strength, hypertrophy and endurance.

For heavier weights over 80%, the speed of the exercise should be close to as fast as possible on the concentric phase, often described as 'lifting with drive and intent'. The load will not actually be moving fast given the heavy weight, but this technique is important for recruiting maximum muscle fibre units and increasing strength and size. Breathing should be controlled, breathing in during the eccentric and holding and bracing during the concentric phase before releasing at the end of the movement. This helps stabilise the torso to maintain stability during heavy lifts. During the eccentric phase, the weight should be slowly 'lowered' and controlled. Generally, sets should finish with the 'last rep as good as the first' with no breakdown in technique. Lifting to the point of fatigue should generally be held for the last set, and here athletes may use overload techniques to recruit maximum muscle fibres, such as assisted reps or slow eccentrics.

Table 6.11 Key features of strength training

Training goal	Repetitions	Sets	Intensity %1RM	Rest
Muscular strength	1–6	3–6	80–100%	2–5 minutes
Muscular hypertrophy	6–12	3–5	60–80%	30–90 seconds
Muscular endurance	12–20+	2–4	40–60%	30–60 seconds

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Figure 6.22 Members of the Australian Dolphins swim team using free weights to increase strength using deadlifts and weighted pull-ups





Figure 6.23 Fixed weights being used for sports-specific strength training by a rower with seated rows and an AFL player with leg press

The eccentric phase is more likely to lead to delayed-onset muscle soreness and fatigue, due to the microtrauma of muscle fibres. While this stimulus will result in a positive adaptation, it can lead to increased recovery time. Some athletes train movements which minimise the eccentric phase, such as power cleans, dropping the weight at the top. Trained muscle groups should be given at least 48 hours to recover between sessions, but training can be done on consecutive days, as long as different body parts are trained, using either an upper-lower split, or a push-pull split.

For lighter weights and higher reps training muscular endurance, the speed should be smooth and controlled, maintaining strict form on every set. These sets can last for up to a minute and cause a sharp rise in heart rate, making it important to keep breathing naturally throughout. These exercises are often done in a circuit fashion, so the athlete can quickly move to train different muscle groups, and benefit from the associated aerobic training.

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Body-weight exercises

Body-weight exercises, sometimes called calisthenics, are convenient, require minimal equipment and can be used for a wide range of strength outcomes. For some, these exercises may lead to strength and hypertrophy, or for stronger athletes, they can be used to build muscular endurance. Exercises such as pull-ups, push-ups, squats, glute bridges and lunges may be used for light cardio circuits or can be made more challenging (for example, single leg box squats, Nordic hamstring curls or handstand push ups). They are excellent for challenging the core and developing postural stability (for example, slow bear crawls with only two points of contact while moving). They are also useful for priming and activating the neuromuscular system prior to using resistance.

Elastics

Elastics and bands were formerly reserved for older populations and rehabilitation settings but are now widely used in athletic strength programs. They can be used in isolation as a form of resistance, such as banded rows; however, the variable resistance can limit the stimulus on the muscle, so this may be less effective for large muscle groups. They are, however, excellent for challenging smaller muscle groups, and light bands wrapped around a handle can be used to add light resistance for movements such as shoulder external rotation for a swimmer's rotator cuff, or for challenging the small muscles of the foot and ankle to decrease risk of injury for basketballers. Other advantages and uses for elastics include:

- to assist challenging movements such as banded pull ups, where the athlete is unable to perform reps without assistance
- to recreate sport-specific actions, which free weights are less able to do, such as horizontal banded one arm rows which replicate a swimmer's pulling action through the water
- can be used in combination with free weights to add extra challenge, such as banded squats, requiring a more forceful contraction towards the end of the ROM, where the resistance is often easiest to move, such as at the very top of the squat
- they are very light and convenient to use, making them common on training grounds
- can be used as part of a mobility and joint stability program, where the athlete develops strong and stable joints through the full ROM of a joint.



Figure 6.24 An AFL player uses elastics and free weights creatively to challenge whole body postural stability, focusing on strengthening the small muscles of the shoulders as they react to the unpredictable movement of the plate and band.

Practical application 6.5

Experiencing strength training

In small groups, design and participate in a strength training session intended to build muscular hypertrophy and endurance for a selected sport using available equipment. Use simple and safe movements, ensuring good technique. The session should consist of:

- warm-up based on the RAMP protocol (5 minutes)
- strength exercises: perform 2–3 sets of 8–15 reps using a comfortable weight. Select one familiar exercise per movement, including at least one free-weight exercise, one body-weight exercise and an elastic exercise in the session (35 minutes)
  - hip dominant movement
  - upper body push movement
  - rotation movement
  - knee dominant movement
  - upper body pull movement
  - core stability movement
- cool-down: stretch (5 minutes).

Skills: creative thinking, collaboration, analysis

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Skill and tactical development

All sports rely on a degree of skilfulness and strategy for success. The four types of training covered are foundational to enabling the athlete to express and use these skills in the pursuit of success. For example, a cricketer who is strong and powerful can apply more force to their already highly refined batting technique, leading to more success. It is rare for an athlete to forego fitness requirements and rely on skill alone. Specific fitness requirements allow athletes to express their technical coordination and skills more effectively, accurately and repeatedly.

Some sports are more fitness dominant, with less skill development and technical challenge. Endurance running has no equipment and only requires an efficient gait pattern to increase running economy, energy efficiency and reduce injury risk. Shotput is a sport requiring immense power and strength, but only requires a single highly refined motor pattern to execute maximal throws. The focus of training is placed on anaerobic, strength and flexibility training.

Other sports are highly technical and skill dominant, and the fitness requirements provide more of a foundation. For example, golf is highly technical; it still requires a strong and mobile body, but not to the degree of endurance sports. Table tennis needs incredible hand–eye coordination, but less emphasis is required on the four other types of fitness.

However, many sports require a diverse range of skills, able to be executed in unpredictable and varying competitive environments that demand a great deal of the athlete's fitness levels. Consider the wide range of precise motor skills of basketball, tennis and football. These players all need 'big engines' to perform, but they are generally judged on their skill execution and game play. Decades of practice and refinement go into developing the remarkable levels of accuracy, proprioception and kinaesthetic sense that almost make the athlete seem like they have grown up 'with a ball in their hands or at their feet'. The use of expert technical coaching and feedback using video technology plays an important role in perfecting technique to the point where it can be executed under the most intense of competitive contexts, such as a winning serve for a tennis grand slam, or conversion after the whistle to win. Athletes should practise these skills under pressure in training to ensure they are prepared for the mental challenge of performance. Sports psychology offers helpful tools to develop the skills of concentration and resilience needed to become a 'mentality monster' in sport. Skills also need to be practised in game-like situations where the unpredictability of competition is recreated, especially for elite athletes in the autonomous stage of skill development.



Figure 6.25 This athlete is serving for championship point at Wimbledon, displaying remarkable skill, tactical awareness and elite levels of endurance, power, balance and coordination.

Complex sports also require a high degree of cognitive awareness of the game, knowing the right time to move and execute certain skills. This tactical awareness is developed over many years, and excellent coaches help younger athletes learn the intricacies and tactical nuance needed for success. This involves knowing your own individual and team strengths and weaknesses, as well as those of the opposition. The goal is to capitalise on your strengths, while minimising the effect of your weaknesses, and also seeking to nullify the opposition's strengths and target their weaknesses.

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Drills

Athletes who rely on highly refined skills as seen in golf, tennis and hockey, use practice drills to constantly sharpen their ability to perform these skills accurately under pressure. While many team training sessions focus on team tactics and game play, assuming the players are already highly skilled, committed players continue to find time to further refine their skills. Golfers constantly try to find incremental improvements they can make to their swing or particular shots they struggle with. Rugby league kickers will practise their skills after training in order to keep improving, as do the greatest shooters in basketball. Thousands of hours of drill practice can mean the difference between gold and silver.



Figure 6.26 Hitting a 'clutch buzzer beater' shot under immense pressure to seal Olympic gold is the result of tireless hours of shooting practice.

Modified games

Sporting teams will only marginally improve by playing the sport in its traditional form during training. For example, 18 vs. 18 AFL only provides a relatively small number of touches for all players compared to a 5 vs. 5 possession-based game. There are endless modifications that can be made to the rules, game objectives, constraints and equipment used. Games may bring together sub-groups from a team to work on their own tactical development, such as a forward pack in rugby or a defensive unit in football. While these provide variations that can increase motivation and interest, they are primarily aimed at increasing the cognitive ability of the athlete to better read the game, make better in-game decisions and emphasise specific skills or tactics. A simple 'rondo', with a circle of passing footballers and two chasing in the middle can be played with either 'one touch' or 'two touch', with each requiring unique skills and teamwork to be successful. Effective modified games often include targeted reflective questions from the coach which develop a deeper understanding of the game. Coaches pause activities mid-play to assess movements and decisions of players with, and without the ball, and show the effect of making different decisions. Video analysis can be used to assist, as players assess their performance and watch replays in slow motion.



Figure 6.27 Playing on a short, modified field, the England defence practises their tactics of 'playing out from the back' to retain possession, while at the same time the attack practises pressing together as a unit, trying to force a turnover.

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Games for specific outcomes

Modified games can be used to develop isolated and targeted aspects of games, to either overcome weaknesses or develop strengths. Consider a football team playing 5 vs. 5 on a smaller narrow pitch with four small goals. Players are encouraged to play longer 'through passes' and to work the ball closer to goal before shooting. Likewise, in basketball, consider a team playing a possession game with an offensive overload of 5 vs. 3, with the requirement to bounce pass the ball through two hoops outside the key prior to shooting, encouraging the players to pass into space, and to patiently wait for pass channels to open through complex team movements. These games can also be used to practise different playing formations, so that players understand their specific role when there is a change of shape and style of play. For example, basketball teams learn to play both zone defence, player on player or a combination of both depending on the opposition's strength. A football team may elect to play with a 4–3–2–1 formation while in possession, but then change to a 4–4–2 shape in defence. Good teams and players can also change mid-game if required to play 4–3–3 in attack. These games are designed to help players understand their roles in various team tactics and be able to make better decisions in the game.



Figure 6.28 Elite footballers use small-sided modified games to develop specific tactical strategies.

Activity 6.5

Analysing training sessions

Many team sports post 'inside training' videos on social media, which provide a behind-the-scenes insight into the training and preparation of teams during different phases of the training year and week. In small groups, watch a variety of these videos and identify examples of the types of training and training methods covered and relate these to the specific requirements of the sport.

Skills: research, analysis, collaboration

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Practical application 6.6

Experiencing skill and tactical training

In small groups, design and participate in a skill and tactical training session intended to develop the fundamental skills and basic tactical awareness for a selected sport. This should be able to be played by the majority of the class. The session should consist of:

- warm-up based on the RAMP protocol (5 minutes)
- skill development exercises that also develop a component of fitness required for that sport
- TWO small-sided modified games that have a targeted outcome to develop. Prepare three reflection questions to be asked afterwards that help players reflect on the tactic being developed.

Skills: creative thinking, collaboration, analysis

Quiz

Revise and summarise 6.1

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Create a table summarising the types of training and training methods.

Depth Study

Think critically and apply 6.1

1 Rank the relative importance of type and method of training for each of these three very distinct sports. Provide a reason for the higher-ranking training methods.
   a diving
   b tennis
   c netball.
2 Select a sport and research how each type of training can be used to improve performance.
3 Select the top five most important methods and create and deliver a presentation to demonstrate your understanding of how these training methods are applied in this sport.

Skills: research, analysis, communication



Figure 6.29 A Japan training session during the 2023 FIFA Women's World Cup.

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6.2 Applying the principles of training

Learning objective 6.2
EVALUATE the importance of the principles of training for both aerobic and strength training.

There are fundamental guidelines or rules that training programs must adhere to in order to maximise success. These **principles of training** are relevant to all levels of athletic performance, including:

- progressive overload
- training thresholds
- reversibility
- specificity
- variety
- warm-up and cool-down.

Progressive overload

In order to improve fitness capacity and output, athletes must gradually increase the training stimulus above the current level of adaptation. This is known as **progressive overload**. In simple terms, the body will not improve if it is not pushed further than its current level or capacity. The increased stimulus leads human body systems and tissues to adapt, change and grow as they recover so they can 'cope' with the increased demand. This response to 'build and improve' is referred to as supercompensation. As this principle is consistently applied over time, athletes can develop remarkable fitness levels depending on their genetic capacity, body health quality of training program and environment. Analyse Figure 6.29 and Figure 6.30 for a visual representation of this principle in action on the macro (long-term) and micro (short-term) level.

principle of training a fundamental guideline applied to ensure training programs are safe, effective and tailored to meet the specific requirements of a sport

progressive overload the gradual increase in training stimulus above the current level of adaptation in order to improve components of fitness

Athletes seek continual improvement in the potential output of their body, such as aerobic endurance, anaerobic capacity, muscular strength, power, balance, agility, reaction time or speed. Different sports require varying degrees of each, and the goal of training is to develop the body systems capable of producing these outcomes either as high as possible (in the case of aerobic endurance for a marathon runner), or to a level required for that sport (such as having moderate flexibility in football). Once a sport and individual athlete have been profiled, strength and conditioning coaches design tailored training programs to meet the needs of the

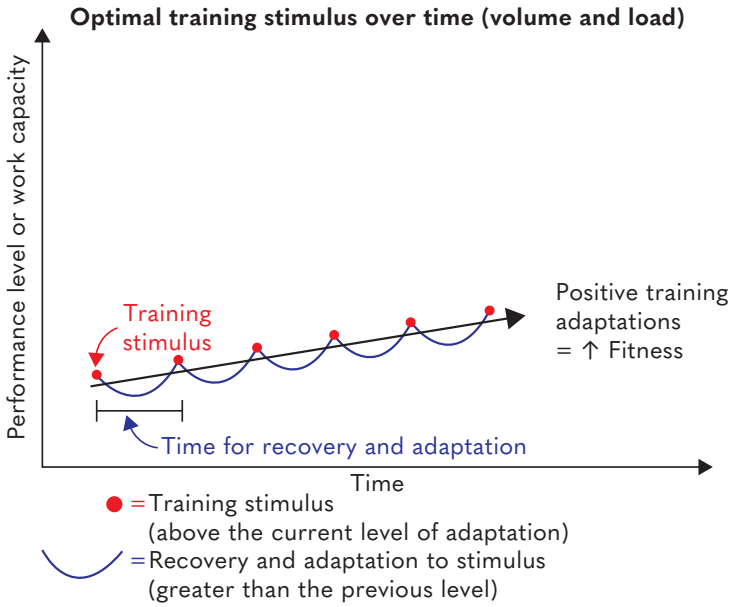


Figure 6.30 Progressive overload applied over time will lead to improved performance.

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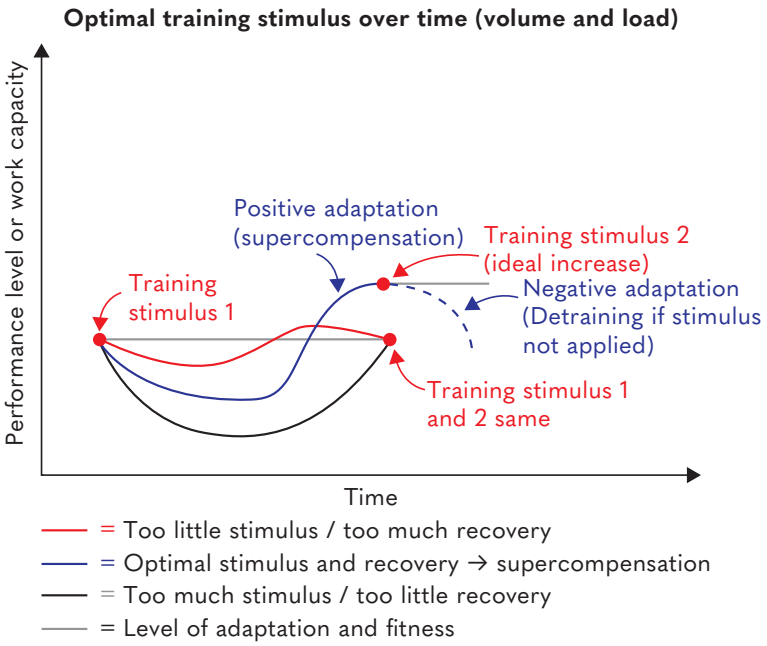


Figure 6.31 Optimal training stimulus and recovery (in terms of timing, intensity and volume) will lead to positive adaptations, as well as the effects of sub-optimal (too little or too much) training stimulus and/or recovery.

athlete for that sport. Data-driven training programs set realistic performance benchmarks, and apply the principle of progressive overload to help the athlete reach their performance and fitness goals.

training threshold the minimum level of intensity or effort that a person must reach during exercise to achieve specific fitness improvements (when an upper limit is set, this is called a training zone)

For aerobic training, the common guide is to increase the duration, distance or intensity of the run by **10% per week** (e.g. increase total weekly running distance from 10 km to 11 km). It should be noted that this is a general rule, but if the athlete overloads faster than 10%, they risk overuse injuries as they are pushing their body tissue beyond what it can tolerate, recover and adapt to. Athletes need to 'carefully listen' to their body, and to taper their training and overload if they are feeling excessive fatigue or mild pain.

For strength training, as the athlete can do more reps than the prescribed total for their specific goal (e.g. more than 15 reps for hypertrophy at a given weight), weight should be increased so they are only able to complete 8–10 reps per set.

A developing area of research and application within training programs, is to factor in a lighter training week (microcycle) every 6–8 weeks (which is known as a mesocycle or training block). This recovery week involves a 'de-load' or reduction in training stimulus to a lighter level. This has been shown to promote further supercompensation and deeper recovery of human body systems from intense training loads, ultimately leading to greater improvement over time.

Training thresholds

In order to improve fitness, athletes must train above the **training threshold**, which refers to the minimum volume, load or intensity of stimulus to elicit the desired response. When an upper limit is set, this is called a training zone. This is closely linked with progressive overload, as data-driven programs look to increase the volume, intensity, duration and load over time, but within the correct training threshold.

Specific examples of these training thresholds have been extensively discussed in relation to the types of training earlier in this chapter, but a summary of these broad guidelines include:

- **For aerobic training**, maintaining working heart rate between 60–85% will develop aerobic endurance, while training with intervals above 85% will develop anaerobic capacity.
- **For strength training**, the general training threshold of heavier weights (70–90%) and lower reps per set (1–12) will develop strength and hypertrophy, whereas training with lighter weights (40–60%) and higher reps per set (15+) will increase muscular endurance.

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Reversibility

An insufficient training stimulus will result in some level of **detraining** or loss of fitness level. Reversibility can occur for a number of reasons, and athletes put measures in place to minimise the loss of training effect, such as a maintenance program or alternative activities. Some common causes and alternatives include:

- **Injury**: A basketballer with a rolled ankle will be unable to run for a time, leading to a loss of lower limb strength and conditioning. They may safely still perform upper body strength training while wearing a moon boot and could use water-based activities for aerobic conditioning.
- **Off-season**: At the end of the season, athletes are given a break of a few weeks to mentally and physically recuperate. In this time, they are advised to maintain a light level of activity to maintain their current levels of fitness, or at least to ensure they don't decrease too much prior to starting the off-season.
- **Bench players**: A player who is to be used as a substitute on the bench may receive less game time, which is a significant loss of stimulus to the body. After the game, these athletes often perform some interval training to apply a stimulus to the body to ensure they do not suffer for less game time.
- **Overtraining**: Excessive training stimulus or inadequate recovery over time can cause plateaus in development, and even loss of training effect. Careful application of progressive overload can reduce the risk of this occurring. Athletes should carefully monitor their physical and mental wellbeing for signs of chronic overreaching and pushing the body too far, which precedes the state of overtraining.

For aerobic training, there are many low-impact options that injured athletes can use to reduce the effects of reversibility, such as air bikes, arm bikes or water exercises. Two to three sessions of 30 minutes of moderate aerobic activity is generally sufficient to maintain current levels of conditioning.

For strength training, injured muscles are unable to be trained intensely. Sometimes, isometric contractions are possible within pain limits to engage muscle fibres. Athletes may also use body weight and elastics as a lighter form of resistance to minimise the loss of strength while they are unable to train. Other movements are often still able to be trained so strength training can be modified.



Figure 6.32 Injury is the most common cause of reversibility.

Specificity

All training activities should be relevant and tailored towards the demands of the sport. Specificity can be applied to the energy systems, movement skills, fitness components and physiological requirements of the sport. Designing effective annual training plans, called **periodisation**, involves planning what, how and when to train these specific requirements for a sport.

For aerobic training, considerations should focus on the nature of the sport (whether participants run, swim, ride, row, etc.) and whether there is a continuous or more undulating effort required. This will determine the volume, duration and intensity of aerobic and anaerobic conditioning, and the specific training method most suitable. For example, a centre in netball would primarily use short aerobic interval training and HIIT training, whereas the goalkeeper would use more HIIT and SIT training.

For strength training, assessment of the relative value of muscular strength, size, endurance, power or speed will influence the design of training sessions. Movement analysis will also show the muscles and joint actions to target, such as upper body push exercises using the deltoids, triceps and pectorals for shotput.

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Variety

Programming a range of varied training activities is crucial for athletic success. Novel activities and games provide mental stimulation and a break from more structured and monotonous training, such as on-land training for swimmers. A more diverse stimulus through varied training will also increase the adaptations of the body, as it is being more challenged through different activities.

For aerobic training, athletes could incorporate a variety of training methods such as continuous, fartlek and anaerobic interval training, which would all be effective variations for triathletes. It can also be good to use different types of aerobic training. For example, a rower could use running to offer a different challenge. Even changing the location of training can help overcome the monotony of aerobic training at times, and running in a scenic location with hill repeats can be a welcome alternative for a track athlete.

For strength training, muscles are very good at adapting to movements and can plateau their rate of development even with increases in the load. Instead, subtle changes to exercises can stimulate the muscle fibres in unique ways to overcome plateaus and stimulate new growth. For example, changing to incline dumbbell presses, using heels wedges for squats or changing pull-up grip positions are easy ways to vary training.



Figure 6.33 Para Powerlifter Garrison Redd doing strength training in Robert E. Venable Park, New York. Changing the location of training, from a gym to an outdoor area, can offer variety.

Warm-up and cool-down

Using a thorough warm-up to prepare for the types and intensity of movement to come is essential to enhance performance as well as decrease injury risk. Likewise, cool-downs reduce muscle soreness and fatigue, promoting faster recovery and therefore allowing for faster return to training.

Warm-up

Warm-ups generally include three distinct phases, and many athletes use the RAMP protocol to guide these stages: raise, activate and mobilise, potentiate (or perform). The following RAMP warm-up is suited to a team training session or game.

The RAMP protocol

Phase 1: Raise

The aim of this phase is to:

- increase body temperature
- increase heart rate
- increase respiration rate
- increase blood flow
- increase joint viscosity.

Essentially, it should raise body systems to a working level and prepare for the intensity of the activity to come. Cognitively, the neural system is starting to be prepared for physical activity.

This should not be just a 'lap of the oval' or the equivalent. It could utilise exercises or simplified sport-specific movements. This is where light aerobic exercise takes place.

Example: Start with deep breathing, head nods and quadricep rocking to fire up the vestibular system. Then run and move with variations at low intensity (jog, gallop, skip, carioca, side skips, etc.) to increase cardiorespiratory function, muscle warmth and move the body systems into a working state.

Phase 2: Activate and mobilise

The aim of this phase of the warm-up is two-fold:

- activate key muscle groups
- mobilise key joints and ranges of motion used in the sport or activity.

During this phase of the warm-up, dynamic flexibility exercises tend to be the norm for both individual and group sports.

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- **Activate** muscles with body-weight movements such as:
  - squats
  - lunges
  - rotations
  - RDLs
  - ground sweeps
  - push-ups
  - bear crab walks
  - glute bridges.
- These all fire up the neuromuscular connections of the working muscles and rehearse movement patterns to follow.
- **Mobilise** muscles and joints with dynamic ROM movements to decrease muscle and connective tissue tightness and prepare for intense movements. Common choices include:
  - leg swings
  - open-close gates
  - shoulder rotations
  - long lunge with reach-through and rotation
  - slow segmental rolling
  - deep squats
  - lying leg cross-overs.

These exercises would often be completed by all athletes. However, once these movements are complete, individuals may choose to complete their own extra exercises depending upon their position on the field, injury history or other needs. The movements chosen for this component of the warm-up should be sport-specific to the needs of the athlete.

Athletes with particular tightness or previous injury should perform extra movements as necessary. Rollers, bands and yoga balls are used to decrease muscle tension and engage muscles.

Phase 3: Potentiate (or perform)
Now the body is physically warm, activated and tension is released, the final stage is to increase intensity of the movement to the maximal level required, and thus 'prime' the athlete for the session or performance.

This phase will involve exercises that will directly lead to performance enhancement and therefore focuses on sport-specific movements. It should be comparable in intensity to the actual session or performance.

For example, the performance phase of a sprint session may include sprint-specific drills such as 5–10 m accelerations, rolling 30–40 m sprint and plyometrics.

In team-based sports such as football, this phase may include the use of agility drills, sprints and plyometrics, along with ball-based movements. Skill practice and small-sided possession games are used to increase mental focus and tactical awareness for the game to come. Body contact is performed, such as tackling drills for rugby league.

Duration of the warm-up

For aerobic training, less time is needed for the warm-up due to the lower intensity of training. Gradually increase the intensity of movement for five minutes and include activation and mobilisation exercises to reduce risk of injury and improve performance.

For strength training, the above protocols are recommended, as well as possible light warm-up sets before heavier work sets.



Figure 6.34 Members of the Queensland Firebirds warm up at Netball SA Stadium.

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Figure 6.35 Here, a Tour de France rider is rehydrating and cooling down and 'flushing lactate from leg muscles' on a stationary bike trainer after a five-hour stage of intense racing.

Cool-down

Cool-downs are less involved but still important. Spend a few minutes to return body systems and functions to resting levels of homeostasis (including heart rate, ventilation rate, body temperature, sweating, hormone levels, muscle lactate, energy stores, fluid and electrolyte balance). Keeping the body moving helps cycle metabolic waste products away from the muscles and decreases muscle soreness. Gradually decrease movement from a moderate intensity (jogging) to a low level (walking). Include light dynamic movements and static stretches to relax muscles, by restoring muscle length and elasticity. Hydration and nutrition are also key at this time, as the body is better able to absorb these nutrients whilst it is still in a working state. These cool-down steps apply to both **aerobic and strength training**.

Practical application 6.7

Experiencing a RAMP warm-up

In small groups, design and participate in a full warm-up for a chosen sport following the RAMP protocol.

Skills: creative thinking, collaboration, analysis

Quiz

Revise and summarise 6.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Define the SIX principles of training.
2 Demonstrate how the SIX principles of training can be applied to aerobic and strength training for sports.

Think critically and apply 6.2

Research and source training sessions and programs for an elite level athlete or sport. Identify examples of the principles of training in action and explain how they will contribute towards success.

Skills: research, analysis

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6.3 Principles of training, physiological adaptations and improved performance

Learning objective 6.3
INVESTIGATE how the principles of training are used to develop physiological adaptations and improved performance.

All training activities seek to stimulate positive changes and **physiological adaptations** in the chemical, cellular, tissue and system levels of the human body. These changes are intended to enable increased performance potential. The application of each principle of training intends to ensure the efficient and effective development of these adaptations, ultimately seeking to contribute towards improved performance and success.

Students are encouraged to actively learn and seek a deep understanding of the changes that happen on the inside of the body. Rather than simply knowing that strength training makes you stronger, students should be able to explain **how** and **why** this occurs, using the anatomical and physiological concepts of the *Cambridge Health and Movement Science Year 11* textbook, and the scientific and technical language, especially at the biochemical level of the human body. The following content provides a foundational understanding of some of these physiological adaptations. Student depth studies are encouraged to develop a deeper understanding of how each adaptation can improve performance, as well as an understanding of how the principles of training are applied to achieve these.

physiological adaptation
a training stimulus causes stress on human body systems, signalling biochemical changes leading to an improved ability to tolerate the stress of exercise







Figure 6.36 Rugby, sprinting and judo are all training activities which stimulate physiological adaptations in the chemical, cellular, tissue and system levels of the human body.

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Heart rate

Aerobic and anaerobic training stimulates positive changes in heart rate at different intensities, such as:

- lower resting heart rate (healthy resting heart rate is less than 60 bpm, down to 30 bpm for elite endurance athletes)
- over time, a lower sub-maximal working heart rate at the same intensity (so the athlete can move faster at a similar level of heart rate and fatigue)
- faster heart rate recovery to resting levels (important for interval-based sports with repeated efforts)
- increased ability to sustain intensity at very high levels of heart rate (an advantage in sports where athletes regularly push into the 'red zone' and need to keep focused).

The physiological adaptations that lead to these changes are primarily:

- increase in heart muscle size and strength, due to thicker ventricle walls, particularly in the left ventricle as it pumps blood to the body
- larger chambers in the heart, allowing more blood to be pumped each beat
- more efficient neural control of the heart through the sympathetic and parasympathetic nervous system
- blood vessels less restricted from plaque as well as being more elastic and better able to absorb the pressure of arterial blood flow.

Stroke volume and cardiac output

The physiological adaptations related to heart rate coincide with positive changes in stroke volume and cardiac output. This content is extensively covered in Chapter 6 of the *Cambridge Health and Movement Science Year 11* textbook, and students should review as required. In short, cardiac output (CO = volume in litres of blood pumped through the heart per minute) is the combined measure of stroke volume (SV = volume in millilitres of blood pumped per beat) multiplied by heart rate (HR = beats per minute) → CO = **SV × HR**. (This calculation gives CO in millilitres per minute, which is then converted to litres.)

Table 6.12 Demonstrating the relationships between heart rate, stroke volume and cardiac output

% of MHR	Heart rate zone descriptions
50–60%	**Basic aerobic training zone:** this zone is typical for older or untrained individuals starting an exercise program. For most young healthy adults, a brisk walk would raise their heart rate into this zone. This is also the zone that is optimal for a cool-down or recovery interval. While in this zone, the body is working aerobically using more fat as an energy source, with the oxygen needs of the muscles being easily satisfied.
60–70%	**Health-based aerobic training zone:** this is a comfortable pace that can be sustained for an extended period. It is still a predominantly aerobic pace where oxygen demand is easily supplied for most healthy people. It is suitable for people aiming to increase cardiovascular health or for people new to training, who may be looking to develop a base level of fitness or are trying to lose weight. New research is finding the significant and unique improvement athletes can experience by training in this zone, commonly known as zone 2 aerobic training. This is at a level where they are still able to hold a conversation, and the body adapts in powerful ways such as increased mitochondrial density, which increases aerobic capacity.
70–85%	**Performance-based aerobic training zone:** in this zone, the body is working at a more stressful level where cardiovascular and aerobic development will be more effectively achieved. At the lower end of this zone, kilojoules are optimally burned, using both fat and glycogen stores. As the athlete pushes towards the top end of the zone, fatigue levels will increase and there is a greater reliance on glycogen stores as oxygen needs are becoming more difficult to meet. Working consistently above 80% MHR for an extended period is very challenging, but leads to the greatest aerobic development.
85% +	**Anaerobic training zone**: as athletes begin to work above 85% MHR, they will experience a greater degree of fatigue, due to localised neuromuscular fatigue (a feeling of heaviness within the muscles), as well as an increase in metabolic byproducts such as lactate. Athletes generally have to intersperse this intensity of training with a rest period at a lower intensity, which is known as interval training. This is also a very effective way to develop aerobic fitness.

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Training stimulates improvements in stroke volume, primarily the result of thickening of the muscle in the left ventricle, meaning more blood can be pumped per beat. A simple analogy for cardiovascular adaptations uses the concept of trains. Trains carry passengers, much like the cardiovascular system carries blood. If more trains can run on the tracks, then more passengers can be transported (and the place where passengers get on and off equates to capillaries with their semi-permeable membranes). The same is true for the heart, blood vessels and blood. An increase in cardiac output means an increase in the volume of blood transportation and therefore the ability to transport more oxygen to working muscles and waste removal.

Oxygen uptake and lung capacity

Training also stimulates adaptations related to the increased uptake of oxygen into muscle cells which coincides with the increase in blood flow around the body. Oxygen uptake is measured in millilitres of oxygen absorbed into the body per kilogram per minute. VO_2 max is an important metric of aerobic fitness and improves with aerobic and anaerobic training. Common tests to estimate this include six-minute time trial, 1200 m time trial, multistage fitness test or yo-yo test. A significant physiological adaptation that contributes to this is the increased capillary density in the alveoli and muscle cells, allowing increased diffusion of oxygen across the pressure gradient.

Lung capacity also increases with training and a greater volume of air can be moved through ventilation (breathing). A common misconception is that lungs increase in size in a similar way to the heart. This is not accurate. However, training does lead to an increase in tidal volume (amount of air that can be moved) as well as the rate and depth of each breath. This is caused through stronger respiratory muscles (diaphragm and intercostal muscles) creating a larger space to draw air into, as well as improved neural drive and control of ventilation.



Figure 6.37 Lung capacity increases with training and a greater volume of air can be moved through ventilation.

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Haemoglobin level

To further complement both the cardiovascular and respiratory adaptations of aerobic and anaerobic training, there is an increase in haemoglobin level from aerobic training. Contained within red blood cells and formed from iron, haemoglobin carries oxygen in red blood cells, transporting it from the capillaries in the lungs to the capillaries in body tissue. There is an increase in a similar protein called myoglobin found in skeletal muscle which transports oxygen from capillaries into the mitochondria in muscle cells. Ultimately these adaptations all contribute to increased oxygen-carrying capacity and aerobic endurance, which has a number of performance outcomes.

Muscle hypertrophy

Anaerobic training (HIIT, SIT, plyometrics and resistance training for power and speed) and strength training (for strength and hypertrophy) stimulate an increase in the cross-sectional size of muscle cells. Mechanical tension from intense training methods strains muscle fibres, leading to micro-damage of muscle cells. This stimulus elicits a response of short-term inflammation which signals cellular changes, and the process of anabolic protein synthesis commences as the body repairs the micro-damage and grows new tissue in order to cope with the increased demand. As a result, the muscle cells have increased contractile elements (actin and myosin) and increased neural control, allowing the muscle to produce more contraction and force capacity, which is an advantage in sport. Athletes may aim to increase strength without similar increases in size through training for strength, rather than hypertrophy (using heavier weights and fewer repetitions).



Figure 6.38 Athletes may aim to increase strength without similar increases in size through training for strength, rather than hypertrophy.

Fast- and slow-twitch muscle fibres

There are different types of skeletal muscle fibres, as different muscles perform different roles. Tonic (postural) muscles (e.g. transverse abdominus of the core and soleus in the calf) help hold the body upright and stable, resisting the pull of gravity, as can be seen when standing on one leg. These muscles tend to be constantly in a state of excitement and contraction, providing enduring but low force contractions, often isometrically. Conversely, phasic (movement) muscles are used more for on-demand and active movements, suited to isotonic contractions of higher force, but are less able to endure these for longer periods. These differences have been observed for decades, and our understanding of muscle fibre types is developing.

Muscle fibre types are therefore categorised according to their contraction speed, metabolic properties and level of fatigue resistance, commonly referred to as either slow- or fast-twitch muscle fibres. Different types of training result in different physiological adaptations in each fibre type, leading to different performance outcomes.

Slow-twitch fibres: commonly referred to as **type I oxidative fibres**, they are observed as being reddish in colour due to their increased capillarisation. They are more exclusively suited to aerobic endurance, being more fatigue resistant, with higher amounts of mitochondria, and can use fats and glucose as fuel for aerobic metabolism. However, they have fewer contractile units and are therefore smaller in diameter, producing less force. Aerobic and sub-maximal efforts target the specific qualities of these fibres, leading to the physiological adaptations that increase aerobic capacity already discussed. For this reason, aerobic activities do not lead to much hypertrophy.

Fast-twitch fibres: commonly referred to as **type II glycolytic fibres**, they are observed as being whitish in colour due to their decreased capillarisation and lower blood supply.

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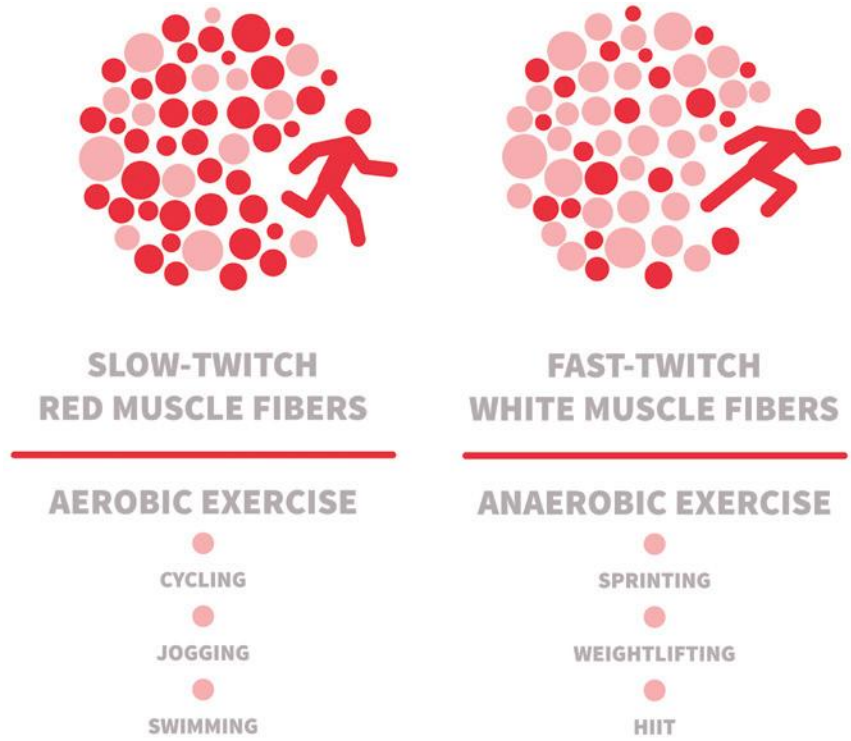


Figure 6.39 Slow-twitch muscle fibres are reddish in colour and suited to aerobic endurance. Fast-twitch muscle fibres are whitish in colour and better suited to higher-intensity movements.

They are better suited to higher-intensity movements, and therefore fatigue more easily. They can, however, produce greater force. Maximal anaerobic power and speed training target the specific qualities of these fibres. An area of developing understanding is in a greater number of sub-categories being observed. For clarity's sake, the following information presents two sub-types of fast-twitch fibres, but it should be recognised that there could be up to six distinct fibres, which can be placed on a continuum from slow to fast.

- **Type IIa or oxidative/glycolytic fibres** are an **intermediate** fibre type with qualities of both fast and slow twitch. They have oxidative properties (such as increased capillaries, mitochondria and myoglobin) but also increased anaerobic glycolytic capacity. These versatile fibres respond well to both aerobic training and anaerobic training and can adapt based on the stimulus applied. For this reason, the composition of muscle fibre types can be changed in the sense that these intermediate fibres can develop qualities of either fast- or slow-twitch fibres, or both.
- **Type IIx or glycolytic fibres** (sometimes referred to as type IIb, although type IIx is now considered more accurate) are exclusively suited to fast and powerful contractions. They have far less capillarisation, mitochondria or myoglobin, and are larger in diameter with increased contractile units (actin and myosin) as well as increased stores of glycogen and creatine phosphate for anaerobic energy pathways. They are only stimulated by explosive movements and suffer most from atrophy through ageing and inactivity.

Factors which influence the development of muscle fibre types include:

- **Genetics:** there is a hereditary component, where some people have a tendency to be more aerobically or anaerobically capable, or a combination of each (however, people are not exclusively one or the other).
- **Age:** as people age, fast-twitch fibres atrophy more quickly, especially if they are not stimulated or used. Slow-twitch muscles which are used in daily activities such as walking and day-to-day chores, atrophy much more slowly.
- **Training stimulus:** type IIa fibres respond to varied training types and will adapt based on the relative aerobic (endurance) versus anaerobic (power and speed) training stimulus. Type I (aerobic) and Type IIx (anaerobic) require more specific and targeted training to improve.

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Table 6.13 Summary table of the characteristics of muscle fibre types

Characteristic	Type I slow-twitch oxidative	Type IIa fast-twitch oxidative/glycolytic	Type IIx fast-twitch glycolytic
Mitochondria + capillaries	High	Moderate – High	Low
Myoglobin	High	Moderate	Low
Fuel stores	Glucose + Fats	Glucose + Fats	Glucose
Fatigue resistance	High	Moderate – High	Low
Dominant energy system	Aerobic	Combination	Anaerobic
Contraction speed/power	Slow	Fast	Fastest
Strength	Moderate	High	High
Typical distribution	40–55%	25–40%	10–15%
Muscles with increased %	Diaphragm, soleus, transverse abdominus	Quadriceps, deltoids, gastrocnemius	Hamstrings, biceps, pectoralis major
Example activities	Support long-distance endurance activities (run, swim, ride, row)	Support combined endurance and power – aerobic team sports, middle-distance racing, boxing, tennis	Maximal effort sports – sprints, jumps, throws, weightlifting

Quiz

Revise and summarise 6.3

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Identify three positive changes in heart rate brought about by training, and why they are important for athletes.
2 Explain the primary physiological cause of improvement in stroke volume brought about by training, and the effect of an increase in cardiac output.
3 Describe the effects of training on lung capacity.
4 Explain what is meant by 'muscle hypertrophy'.
5 Muscle fibre types are categorised according to their contraction speed, metabolic properties and level of fatigue resistance. Name and describe the three different types.

Depth Study

Think critically and apply 6.3

1 For each physiological adaptation, demonstrate how TWO relevant principles of training (refer to each principle at least twice) are used within training programs to cause each change.
2 Select a complex sport and describe how the SIX physiological adaptations provide a distinct advantage within the performance requirements of this sport.

Skills: research, analysis

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Chapter summary

TYPES OF TRAINING

- There are five **types of training** (anaerobic, aerobic, flexibility, strength and skill), each with its own methods, which athletes use in order to improve performance.
- **Anaerobic training**
  - Many sports require maximal or repeated bursts of speed, power and force, which are fueled by the anaerobic energy systems (ATP-PCr and anaerobic glycolysis), depending on the intensity and duration of efforts.
  - Measuring anaerobic training intensity is challenging. Athletes estimate their baseline lactate threshold and set easier to measure metrics against this (e.g. heart rate, running speed, power output or RPE).
  - **Anaerobic interval training** alternates between high-intensity work (85–90% MHR) and aerobic recovery (60–70%), improving aerobic and anaerobic capacity, recovery speed and endurance for repeated efforts in sports such as AFL.
  - **High-intensity interval training** (HIIT) involves short, intense bursts of effort in the anaerobic zone (90–95%), inducing high fatigue with longer rest periods, aimed at developing anaerobic capacity. This is commonly used in fast intermittent sports such as basketball.
  - **Sprint interval training** (SIT) involves short, maximal efforts (5–15 seconds) using the ATP-PCr system with longer recovery periods (1–3 minutes). This is used for power and sprinting sports such as athletics or by a winger in rugby.
  - **Plyometric** training enhances power, speed and strength through explosive movements utilising the stretch-shortening cycle (SSC), involving three phases: eccentric (controlled landing), amortisation (brief pause) and concentric (rapid take-off). It is useful for sports requiring explosiveness, such as sprinting, volleyball or basketball with maximal jumping.
  - **Resistance training for power and speed** uses external loads (barbells, plates, dumbbells) to increase force production through strength exercises targeting the whole body and movements relevant to the sport. Exercises are moderate in load (40–80%) and performed explosively.
- **Aerobic training**
  - Dynamic sports require anaerobic and aerobic capacity. Aerobic training enhances overall body and energy system functioning, with unique adaptations arising from both aerobic lipolysis (fat as fuel) and aerobic glycolysis (glucose as fuel) occurring at different intensity levels.
  - **Continuous** training involves sustained low- to moderate-intensity exercise (60–80% MHR) for extended periods. Lower intensities using fat build mitochondrial density and endurance. Moderate intensities using glucose improve aerobic metabolism and recovery efficiency from anaerobic efforts. Endurance sports rely on this, such as triathlon and marathon running.
  - **Fartlek** training combines moderate continuous exercise with intermittent bursts of high intensity, allowing athletes to briefly enter the anaerobic zone before returning to aerobic activity. This enhances lactate tolerance, recovery and aerobic capacity, while providing mental variation and enjoyment.
  - **Aerobic interval** training features structured periods of aerobic work and rest (1:1), primarily engaging the aerobic energy system, which enhances an athlete's ability to tolerate moderate lactate levels over longer durations, making it ideal for events lasting 60 to 90 minutes. Maximum aerobic speed (MAS) is used to accurately program aerobic intervals to build aerobic capacity.
  - **Circuit** training involves a series of exercises targeting various performance outcomes, maintaining heart rate in an aerobic interval training zone, and often incorporating sport-specific skills or body-weight movements to build muscular endurance.

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- **Flexibility training**
  - Enhances performance by reducing injury risk and enabling the full expression of other fitness components. Leads to improved range of motion, critical for sports requiring specific movements (e.g. AFL hamstring flexibility for kicking) or for aesthetic sports (e.g. diving). Flexibility training is integrated into warm-ups, cool-downs and for isolated sessions to target improvement.
  - **Static** stretching involves holding a muscle and joint at its limit for 30–60 seconds to increase flexibility, elasticity, and reduce injury risk. It is used to increase muscle length and during cool-downs to reduce neuromuscular tension.
  - **Dynamic** stretches involve rhythmic movements within normal range of motion to increase blood flow, muscle warmth and elasticity. Performed during warm-ups to reduce injury risk and prepare for intense activity, especially in sports requiring power, speed and agility (e.g. leg swings).
  - **Ballistic** stretches involve forceful, rhythmical movements to push joints beyond their normal range of motion and are aimed at increasing flexibility for experienced athletes in sports requiring extreme movements (e.g. gymnastics or martial arts). They should be done with caution, following a thorough warm-up and proper supervision.
  - **Proprioceptive neuromuscular facilitation (PNF)** stretches involve a cycle of isometric contraction, relaxation and static stretching to increase muscle length and range of motion, utilising nerve receptors to relax muscle tension. They are the most effective form of flexibility training to increase muscle length.
- **Strength training**
  - Strength training is essential for both health and sporting performance, aiming to increase maximal muscle strength, size and endurance, and is foundational for power development. There are benefits across the muscular, skeletal, neural and endocrine systems.
  - Strength training uses **free weights** (dumbbells, barbells) and **fixed weights** (pin-loaded machines) to develop muscular strength, hypertrophy or endurance, with free weights promoting stabilising muscles and versatility, while fixed weights offer increased safety and ease for beginners. Free weights enable a wide range of exercises with progressive resistance, enhancing core stability and balance, while fixed weights such as cable machines allow adjustable angles of movement to target muscles from different angles, especially useful for sports-specific exercises.
  - **Body-weight** exercises (calisthenics) are versatile, requiring minimal equipment, and can be used for strength, hypertrophy or muscular endurance (e.g. push-ups, squats, pull-ups) for cardio circuits or advanced variations for greater challenge, while also improving core stability and neuromuscular activation.
  - **Elastics** and bands, once primarily used for rehabilitation, are now popular in athletic strength programs for their versatility in targeting smaller muscle groups, assisting challenging movements, recreating sport-specific actions, adding resistance to free weights, and enhancing mobility and joint stability.
- **Skill and tactical development**
  - Success in many sports relies on a blend of skill, strategy and fitness. Many require the ability to accurately and consistently execute technical skills; while also being aware of the tactical complexities of a game, requiring accurate decision making to find success.
  - Athletes in sports like golf, tennis and hockey continually engage in practice **drills** to refine their skills and perform accurately under pressure, such as an elite basketballer practising their shooting.
  - **Modified games** (such as 5 vs. 5 possession) increase player involvement, cognitive abilities and tactical decision making, with variations in rules and objectives used to foster skills and team tactics.
  - Games can help athletes **develop specific outcomes**, such as playing through passes in a 5 vs. 5 football match or strategic passing in a basketball possession game, while also allowing teams to practise different formations and understand their roles during changes in play.

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PRINCIPLES OF TRAINING

- Training programs must follow fundamental guidelines, including progressive overload, training thresholds, reversibility, specificity, variety, and warm-up and cool-down principles.
- To improve fitness, use **progressive overload** to gradually increase training stimuli beyond the current adaptation levels, triggering the body's supercompensation response of adaptation and growth, leading to increased potential output.
- To improve fitness, athletes must train above specific **training thresholds**, which is the minimum volume, load or intensity needed to elicit the desired response and adaptation.
- An insufficient training stimulus can lead to detraining or loss of fitness, known as **reversibility**, which athletes combat through maintenance programs or alternative activities.
- **Specificity** requires all training activities to be relevant and tailored towards the demands of the sport. This can be applied to energy systems, skills, fitness components and physiological requirements of the sport.
- Incorporating a **variety** of training activities is essential for athletic success, as it offers mental stimulation, breaks the monotony of structured training and enhances physical adaptations by challenging the body in diverse ways.
- A thorough **warm-up** is essential for enhancing performance and reducing injury risk, while **cool-downs** return body systems to rest, decrease muscle soreness and promote faster recovery. The RAMP warm-up protocol consists of three phases: raise, activate and mobilise, and potentiate or perform, which prepares the body for training or competition.

PHYSIOLOGICAL ADAPTATIONS

- Training activities aim to stimulate positive physiological changes at the chemical, cellular, tissue and system levels to enhance performance potential.
- Aerobic and anaerobic training leads to significant cardiovascular improvements, including a lower resting **heart rate**, decreased sub-maximal working heart rates, faster heart rate recovery, and an increased capacity to sustain high-intensity efforts, primarily due to increased heart muscle size and enhanced neural control.
- Related to heart rate, **stroke volume** and **cardiac output** also increase with training (CO = SV x HR). Training increases stroke volume by thickening the left ventricle, allowing more blood to be pumped per minute.
- Training increases **oxygen uptake** and **lung capacity**, increasing the oxygen supply to working muscles.
- Aerobic training increases **haemoglobin levels** in red blood cells and myoglobin in skeletal muscle, which improves oxygen transport from the lungs to body tissues and into muscle mitochondria.
- Anaerobic and strength training promote **muscle hypertrophy** (growth) by causing micro-damage to muscle fibres, leading to an increase in muscle size and ultimately enhancing contraction force capacity.
- Skeletal muscle fibres are broadly classified into **slow twitch** (type I) or **fast twitch** (type II), with slow-twitch fibres being more suited for aerobic endurance due to their fatigue resistance and high mitochondrial content, while fast-twitch fibres are better for high-intensity activities, producing greater force but fatiguing more quickly.
- Fast-twitch fibres are further classified into type IIa intermediate, which have characteristics of both fast- and slow-twitch fibres and can adapt to both aerobic and anaerobic training, and type IIx for explosive movements but which have less endurance.

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Multiple-choice questions

1 Which type of training primarily focuses on enhancing maximal bursts of speed and power?
- A aerobic training
- B flexibility training
- C anaerobic training
- D skill training

2 What is the primary energy system used during sprint interval training (SIT)?
- A aerobic glycolysis
- B ATP-PCr system
- C anaerobic glycolysis
- D fat oxidation

3 In aerobic training, what does continuous training typically involve?
- A short bursts of high intensity followed by longer rest periods
- B sustained low- to moderate-intensity exercise for extended periods
- C alternating high- and low-intensity exercises
- D flexibility exercises performed at a slow pace

4 Which type of stretching involves holding a muscle towards its limit for 30–60 seconds?
- A dynamic stretching
- B ballistic stretching
- C static stretching
- D PNF stretching

5 What is the purpose of strength training?
- A to increase flexibility and reduce injury risk
- B to enhance maximal muscle strength, size and endurance
- C to improve skill and tactical development
- D to promote aerobic endurance

6 Which principle of training involves gradually increasing training stimuli beyond current adaptation levels?
- A specificity
- B reversibility
- C variety
- D progressive overload

7 What does maximum aerobic speed (MAS) primarily measure?
- A the maximum amount of weight an athlete can lift
- B the highest speed an athlete can maintain while primarily using aerobic metabolism
- C the total distance an athlete can run in a set time
- D the speed at which an athlete transitions from aerobic to anaerobic metabolism

8 Which type of muscle fibres are better suited for aerobic endurance and have a higher fatigue resistance?
- A type IIa fibres
- B type IIx fibres
- C type I (slow-twitch) fibres
- D type III fibres

9 What physiological adaptation results from anaerobic and strength training?
- A increased lung capacity
- B increased haemoglobin levels
- C muscle hypertrophy
- D lower resting heart rate

10 What is the goal of flexibility training?
- A to enhance aerobic endurance
- B to develop strength and power
- C to improve range of motion and reduce injury risk
- D to increase anaerobic capacity

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Exam practice

How to answer an exam question

Example question

Justify why the coach of a basketball team would include several all-team circuit sessions in the weekly training program. In your answer, include examples of activities that might be included in the circuit. (6 marks)

What is the question asking?

The key verb in this question is **justify**, which means you need to provide support for the coach's decision to include circuit sessions.

Note that the circuit sessions are specified as **'all-team'**, so your answer should recognise why this is relevant (as compared to individual circuit sessions).

You also need to include **examples** of activities included in the circuit.

Marking criteria

Criteria	Marks
• Demonstrates a comprehensive understanding of circuit training • Makes well-informed judgements about the extent to which circuit training benefits a basketball team • Provides relevant examples	6
• Demonstrates a sound understanding of circuit training • Makes a judgement about the extent to which circuit training benefits a basketball team • Provides relevant examples	5
• Describes how circuit training could benefit basketball players • Provides some link(s) between circuit training and the performance of a basketball team • Provides example(s)	4
• Outlines circuit training AND/OR team training sessions	2–3
• Provides some relevant information	1

Sample response

Circuit training exercises are generally intended to keep the heart rate in a zone similar to aerobic interval training, with periods of work and rest. This suits the sporadic nature of team sports. This coach would probably include basketball-specific skills to be executed under fatigue, such as sharp shuttle runs with partner passes. They would probably also have exercises to build muscular endurance, such as body-weight jump squats. The circuit training sessions will offer a fun and energising way to train aerobically, and can also be mentally challenging. By doing the circuits as an all-team session, they will encourage team bonding, and also build awareness of individual team members' skills.



Video 6.3 Answering the exam question

Exam-style questions

1. Evaluate the role of flexibility training in injury prevention and performance enhancement. (3 marks)
2. Examine TWO principles of training and their application in aerobic training programs. (4 marks)
3. Analyse the physiological adaptations resulting from strength training and their impact on performance. (6 marks)
4. Discuss the relationship between the principles of training and physiological adaptations related to heart rate and muscle fibre types. (8 marks)
5. Assess the relevance of anaerobic training methods for athletes in team sports. (8 marks)

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Chapter 7
Training for individual and group sports



After completing this chapter, you will be able to demonstrate knowledge of:

- factors for consideration when planning a training session for individual versus team sports
- annual training plans for individual and team sports
- how psychological techniques are used in both individual and team sports
- the elements that affect the implementation of strategies and tactics in both individual and team sports.

Key terminology

Syllabus terminology:

anxiety
arousal
conditioning
cool-down
strategy
stress
tactic
warm-up

Other important terms:

mental rehearsal
periodisation
pre-hab
RAMP
state anxiety
strategy
tactic
trait anxiety
visualisation

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Driving questions

1 Discuss your experiences of coaches that delivered highly planned, flexible, diverse and focused training sessions as well as coaches who made little effort in the preparation of their training sessions.
   - How did the players and team respond to each of these?
   - Why do you think this was the case?

2 'Make sure your worst enemy doesn't live between your two ears.' (Laird Hamilton – American surfer)
   - How important do you think a player's psychological state is in determining success?
   - Identify examples of when mental strength won or lost a game. Do you think you can ever win without being mentally strong?

3 Consider some recent sporting victories or losses.
   - What role did the team's strategies or tactics contribute?

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Introduction

Training for sports, whether individual or group-based, is essential for achieving peak performance and overall athletic development.

Individual sports, such as tennis, swimming and track and field, require athletes to focus on personal skill development, technique and mental fortitude. Training programs for individual sports are often highly personalised, targeting specific strengths and weaknesses. Athletes work closely with coaches to refine their techniques, improve their physical conditioning and develop strategies tailored to their unique needs. Mental training is also crucial, as individual athletes must cultivate self-discipline, motivation and resilience to perform at their best.

Group sports, such as soccer, basketball and rugby, emphasise teamwork, communication and collective strategy. Training for group sports involves not only developing individual skills but also fostering team cohesion and understanding. Athletes participate in drills that enhance their ability to work together, anticipate teammates' actions and execute complex plays. Effective communication and trust among team members are vital components of successful group sports training. Additionally, group dynamics and leadership play significant roles in creating a positive and productive training environment.

In both individual and group sports, a well-rounded training program includes physical conditioning, technical skill development, mental preparation and recovery strategies. By addressing these elements, athletes can enhance their performance, prevent injuries and achieve their athletic goals.



Figure 7.1 Skill practice in a Matildas training session, 2024

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7.1 Aspects to consider when designing a training session

Learning objective 7.1
COMPARE aspects for consideration in the design of individual and group sport training sessions.

Generally, individual sports will tend to have competition points of specific meets that may be a week apart to months apart and can be of varying importance. Group sports will generally be weekly and culminate in a final series. Therefore, the nature of competition of the sport needs to be considered, along with the individual or group nature.

Health and safety considerations

Considering the health and safety of the athlete (group or individual) is an integral component of effective planning and preparation. Coaches and officials must consider the following health and safety recommendations.

Environmental factors

Extreme heat, cold, wind, humidity and rain can all have a significant impact on the performance of the athlete. During hot, humid conditions, a failure to appropriately hydrate or wear suitable protective clothing and equipment can result in injury and illness. Likewise, playing and training during extremes of cold without considering appropriate insulation can result in hypothermia. Extreme weather conditions may require rescheduling, particularly during lightning storms.

Appropriate clothing can help counteract the effects of extreme weather conditions. Sunscreen, sunglasses, hats and protective apparel help counteract the extreme effects of heat. Wet-weather clothing, beanies, warm clothing and insulation such as wetsuits help counteract the effects of cold, rain and wind. For example, the triathlon, which involves swimming, cycling, and running, can often occur in varying weather conditions.

1. **Heat**: during the cycling and running segments, athletes wear lightweight, moisture-wicking clothing to stay cool. They also use **sunscreen**, **sunglasses** and **hats** to protect against the sun's rays.
2. **Cold and rain**: for the swimming segment, athletes wear **wetsuits** to insulate against cold water. If the weather is rainy or windy during the cycling and running segments, they might wear **waterproof jackets**, **beanies** and **thermal layers** to stay warm and dry.



Figure 7.2 Triathlete completing a swimming session

Protective equipment

Appropriate protective equipment, such as mouthguards, shin pads, shoulder pads, helmets, protective footwear, gloves, wrist guards, elbow guards, wetsuits and protective eyewear, all minimise the risk of injury. The protective equipment needs to be specific to the sport.

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Training ground and sporting facilities

Regular checks of the playing surface should be made for glass, holes, trip hazards such as exposed sprinkler heads and dangerous worn areas. In addition, the dressing rooms should be kept clean and hygienic and free from clutter and litter. Additional protective padding to goal posts, adequate lighting and protective fencing should be checked regularly to avoid the risk of injury. Indoor facilities also need to be checked to ensure the surface is suitable for the sport and that the fixtures/posts are secure and have the correct padding.



Figure 7.3 Goalpost with safety padding around it

Injury protection

Effective warm-ups and cool-downs are integral to minimising the risk of injury. Individualised player medical and physiotherapy screening can help expose muscle imbalances, mobility and stability issues, and enable the implementation of personalised **pre-hab** and strength training programs for injury prevention. The correct lifting technique and proper use of equipment help reduce injury risk, while appropriate supervision and the monitoring of players' training loads all help minimise injury risk.

pre-hab actions taken to proactively avoid injury

Both individual and group sports require a strong focus on proper training, conditioning and adherence to safety protocols to minimise the risk of injuries and ensure a safe sporting experience.



Figure 7.4 Individualised player medical and physiotherapy screening can help expose muscle imbalances, mobility and stability issues.

Activity 7.1

Health and safety

Choose one individual sport and one group sport.

1 What health and safety considerations would be similar?
2 What health and safety considerations would be different?

Skills: analysis, research

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Overview/aim of the session

Great coaches are effective communicators and collaborators. They provide a clear explanation of the goals and expectations of the season, ensure that the athlete takes ownership of the goals and expectations, and that the long-, medium- and short-term goals are regularly planned and evaluated. At the conclusion of the season, coaches review the performances through group and individual meetings, assess the strengths and weaknesses of the team and individuals and use that information to set team and individual goals and put plans in place to address weaknesses and improve strengths.

An individual sport overview or aim of the session may specifically include:

- **Personalised focus:** training sessions are tailored to the specific needs, strengths, and weaknesses of the individual athlete.
- **Flexibility:** the schedule and intensity can be adjusted based on the athlete's progress and goals.
- **One-on-one coaching:** direct interaction with the coach allows for detailed feedback and personalised instruction.
- **Skill development:** focus on improving specific techniques and skills relevant to the sport.
- **Physical fitness:** enhance overall physical condition, including strength, endurance and flexibility.
- **Mental preparation:** develop mental toughness, focus and strategies for competition.
- **Performance optimisation:** aim to achieve peak performance in competitions.

A group sport overview or aim of the session may specifically include:

- **Team dynamics:** emphasis on building teamwork, communication and cohesion among players.
- **Structured environment:** sessions are planned to accommodate the needs of the entire team, often with a set schedule and routine.
- **Varied activities:** incorporates drills, scrimmages and exercises that involve multiple players.
- **Team coordination:** improve the ability to work together effectively, understanding each player's role and responsibilities.
- **Tactical training:** develop and practise strategies and game plans.
- **Physical conditioning:** enhance the team's overall fitness level, ensuring all players are in peak condition.
- **Skill enhancement:** focus on both individual skills and how they integrate into team play.

Both types of training sessions aim to improve performance, but individual sports focus more on personal development, while group sports emphasise teamwork and collective success.

Warm-up and cool-down

Warm-up

Warm-up comprises the processes associated with elevating core temperature and preparing the body, both physiologically and psychologically, for training or competition. It serves four primary purposes: mental readiness, physical readiness, injury prevention and performance enhancement. The warm-up is the first part of any training session or preparation for competition and should involve active motion activities that progress from low to moderate and eventually reach sport-specific intensity. A thorough warm-up should cover all muscles and movements specific to the chosen sport.

Effective warm-ups:

- increase core temperature
- increase respiratory and heart rate
- increase range of motion and ease of movement
- increase metabolic rate
- practise/prepare the nervous system for high-powered activities
- practise already learned skills with high frequency
- prepare further for skill and tactical performance.

The RAMP (raise, activate and mobilise, potentiate/perform) protocol is widely used to develop warm-up procedures. This was covered in detail in Chapter 6.

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Figure 7.5 Elite footballers following the RAMP warm-up protocol to prepare for a game

Cool-down

The cool-down refers to the gradual processes associated with decreasing core temperature and reducing the neural and physiological state of the body after training or competition.

Cool-downs comprise low-intensity activity such as jogging, followed by static stretching. They help remove lactate and speed up the recovery process, promote muscle relaxation, reduce soreness and help relax the athlete.

An effective cool-down consists of three to four minutes of light activity to help reduce core temperature. It could incorporate jogging, walking, functional mobility exercises such as lunges, lateral lunges, knees to chest, walking hamstring stretches and/or very light basic skills with the ball, followed by whole-body static stretching.

Activity 7.2

Warm-up and cool-down

In pairs

1 Design a warm-up for an individual sport of your choice.
2 Design a warm-up for a group sport of your choice.
3 Design an effective cool-down for a sport of your choice.

Skills: collaboration, creative thinking, research

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Skill instruction and practice

The purpose of practice is to prepare athletes for competition. Effective coaches must ensure that skill instruction and practice are designed to ensure this purpose is being met.

Effective skill instruction and practice require considerable planning, organisation and communication. Coaches are responsible for providing clear instruction regarding sport skills, teaching teamwork and cooperation, providing appropriate feedback, helping to improve skills and evaluating the success of the sessions.

Guidelines for effective skill instruction

- Instruction should be brief, simple and clear.
- Ensure the language is appropriate to the age and level of the athletes.
- Be positive and enthusiastic when providing instruction.
- Ensure feedback is immediate and positive.
- Keep instruction time for a specific skill short, so athletes can maximise practice time.
- Use demonstrations to support the instruction, so players can see, hear and then feel the movement through practice.

Guidelines for effective practice

- Ensure skill practice is appropriate to the age and level of the athletes.
- Vary practice between individual, partner and group practice.
- Increase the complexity of the skill practice as athletes progress in skill level.
- Move from simple to more complex skill practice.
- Practise skills in short three-to five-minute blocks during the session.
- Practise skills under similar conditions to competition requirements.

Conditioning

To effectively integrate conditioning training within a training session, it is imperative that the coach determines the training units to be completed within the training session (– for example, warm-ups, skill drills, speed and agility, match preparedness, aerobic conditioning and cool-down). The coach then assigns the appropriate training units in the correct order within the timeframe of the session.

When designing conditioning programs within a training session, the correct sequence of the integration of conditioning components within the training session is as follows:

- Warm-up is the priority within the session.
- Strength/power, speed/agility and skill/tactical training components should be completed next.
- Aerobic conditioning training is implemented after high-intensity training.
- Cool-down, incorporating flexibility training, is completed last.

It is not uncommon for coaches to incorporate skill/tactical training in-between components of conditioning, as this provides an opportunity for players to challenge skills and decision making under fatigue conditions.

The length of the training session and the volume of conditioning work performed during the in-season period are shorter in the competition phase of the season, compared with the preparation phase of training.

For recreational participants, shorter sessions are required, as they do not have access to the same recovery modalities as those available to full-time athletes. For part-time athletes, the total session length may be around 70–90 minutes.



Figure 7.6 Children practising skills at an ice hockey club in Canada

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Strategies and tactics

Strategies and **tactics** are critical for the athlete's success in a competitive environment.

strategy a plan of action developed before beginning a task or activity to successfully achieve a goal or outcome; a long-term objective to achieve

tactic a short-term move or combination of moves to achieve a short-term objective

While athletes may demonstrate proficiency at a skill during practice, they must also be able to apply it during competition. In addition to building the skill, the coach must develop performance elements like decision making and strategic and tactical awareness. While skill development is fundamental to any training session, as the athlete progresses, the coach should use techniques that develop skills through competitive games. This is referred to as the game-centred approach.

A football coach who gets their players to practise passing through small-sided games is applying this principle. In this scenario, football players enhance their passing game while in an open environment in which they must balance all the uncontrolled environmental factors like surface and defence.

Decision making

Decision making is a skill that is primarily learned through experience. Knowing when to pass the ball or draw a player, or which opposition weakness to target, is a crucial performance element that needs to be developed. Presenting athletes with scenarios that are both theoretical and practical is a good way to develop decision-making skills. Decision making can be developed through:

- Direct coaching: coaches use demonstrations, whiteboard/coaching boards and video analysis to show and discuss various decision-making moments with the sport.
- Questioning: this is a very powerful tool, asking athletes the right question at the right time can develop the decision-making skills of an athlete. Asking 'In this scenario, when should you pass, kick or run the ball' and 'What indicators are you looking for to make that decision?' can develop the athlete's thinking.
- Specific drills: setting up on-field scenarios can develop the thinking of the athlete as well as being able to add thinking to their skill set.

Taking time out after training and competition to debrief specific decisions and their level of success can ensure continuous improvement.

Strategic and tactical development

The athlete who can manipulate a game to their advantage is said to have strategic and tactical awareness. The knowledge and confidence to take leadership of a situation to ensure the best possible result for the athlete and the team, is immensely powerful in sport. Often, opponents can possess similar skills and ability: it is strategy alone that makes the difference between winning and losing. In football, coaches and players implement formations targeted at guaranteeing their team's strengths and exposing the opposition's weaknesses.



Figure 7.7 Daria Saville and Ellen Perez of Team Australia talk tactics during a tennis training session ahead of the 2024 Paris Olympic Games.

Activity 7.3

Strategies and tactics

Consider your own sporting experiences.

1 How do you analyse your opponent's strengths and weaknesses before a game?
2 How do you develop a game plan that leverages your personal or team's strengths?
3 How do you adjust your tactics during a game if your initial plan isn't working?

Skills: analysis

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Athlete reflection and coach evaluation

Reflecting on and evaluating training allows both the athlete and the coach to monitor the effectiveness of training and to determine whether the goals, aims and objectives of training are being met.

Athlete reflection

Athletes can reflect on their performance during a training session through several methods, each aimed at enhancing their self-awareness and improving future performance. Here are some effective reflection tools:

- **Journaling**: athletes can keep a training journal where they note down thoughts, feelings and observations about their performance. This helps in tracking progress over time and identifying patterns.
- **Video analysis**: recording training sessions and reviewing the footage allows athletes to see their performance from an external perspective, helping them identify areas for improvement.
- **Feedback sessions**: regular discussions with coaches and teammates can provide valuable insights and different perspectives on performance.
- **Self-assessment**: athletes can use structured self-assessment tools or questionnaires to evaluate their performance against specific criteria.
- **Mental rehearsal**: reflecting through visualisation techniques can help athletes mentally practise and improve their skills.

Through reflection, athletes can:

- Identify strengths and weaknesses: reflection helps athletes recognise what they did well and what needs improvement, allowing them to focus their training efforts more effectively.
- Enhance decision making: by reflecting on past decisions and their outcomes, athletes can improve their decision-making skills in future situations.
- Boost confidence: acknowledging successes and progress can build an athlete's confidence and motivation.
- Develop self-awareness: understanding their own performance helps athletes become more self-aware, which is crucial for personal growth and development.
- Show continuous improvement: regular reflection ensures that athletes are constantly learning and adapting, leading to continuous improvement in their performance.

By incorporating these reflection methods into their routine, athletes can gain valuable insights and make informed adjustments to their training, ultimately enhancing their overall performance.

Coach evaluation

Following training sessions and at the conclusions of blocks of training, coaches use evaluation to:

- collect input from the players to determine the level of training enjoyment and satisfaction
- determine whether training session goals have been achieved
- monitor the success of specific training blocks
- monitor the athlete's understanding of the training aims and objectives
- monitor player training loads
- access the effectiveness of training programs with fellow coaches and support staff
- make decisions in relation to future training guidelines
- gather information regarding athletes' welfare issues and general training enjoyment
- ensure all players, coaches, parents and guardians clearly understand session times, game venues, playing times and travel arrangements
- identify player and team technical and tactical strengths and weaknesses
- assess the physical fitness strengths and weaknesses of the team
- evaluate their own coaching performance.

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Activity 7.4

Comparing individual and group sports

Complete the table below, considering the aspects for designing a training session.

	Individual sport	Group sport
Health and safety considerations		
Overview/aim of the session		
Warm-up and cool-down		
Skill instruction and practice		
Conditioning		
Strategies and tactics		
Athlete reflection and/or coach evaluation		

Skills: analysis, research


Quiz

Revise and summarise 7.1

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Why must protective equipment be specific to the sport?
2 Why is it important for coaches to clearly explain the goals and expectations of the season?
3 Explain the importance of warm-ups and cool-downs in injury prevention.
4 List at least three physiological benefits of an effective warm-up.
5 How does a cool-down help in removing lactate from the muscles?
6 Why is it important to increase the complexity of skill practice as athletes progress?
7 How does the length and volume of conditioning work differ between the in-season and preparation phases of training?
8 Why do recreational athletes require shorter training sessions than full-time athletes?
9 What is the game-centred approach and how does it help in skill development?
10 What are some effective methods for athletes to reflect on their performance during a training session?

Think critically and apply 7.1

1 How can presenting athletes with theoretical and practical scenarios help develop their decision-making skills?
2 Why is strategy often the deciding factor between winning and losing when opponents have similar skills and abilities?
3 How can coaches balance the need for structured training sessions with the flexibility required to address individual athlete needs and unexpected challenges?
4 In what ways can athletes use their reflections on past performances to innovate new strategies and tactics for future competitions?
5 How might the integration of technology, such as wearable fitness trackers and video analysis software, enhance the evaluation of training effectiveness and athlete reflection?
6 What are some creative methods that coaches can use to make the evaluation process more engaging and meaningful for athletes?

Skills: analysis, creative thinking, problem solving

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7.2 Yearly training programs

Learning objective 7.2
COMPARE a yearly training program for an individual and a group sport.

Planning a training year requires a great deal of preparation. It can be a difficult and time-consuming task, so to make the process easier, coaches use a method called **periodisation**.

Periodisation is the division of the training year into smaller and more manageable intervals with the goal of managing and coordinating all aspects of training to bring an athlete to peak performance at the most important competition, or for managing performance across a long in-season.

Effective periodisation requires planning, organisation, implementation and evaluation, and must take into consideration both individual and team strengths and weaknesses, and the physical, technical, tactical and psychological aspects of the sport.

Phases of competition

There are three distinct phases of the competition season.

periodisation the manipulation of training loads over time in order to bring about optimal gains in performance

Pre-season (preparation phase)

The length of the preparation period is generally around eight to 12 weeks; however, this may vary, depending on:

- the type of sport – for example, team sports (footballers) generally have shorter preparation periods, while individual sports (swimmers) have longer preparation periods
- the length of the competition period – for example, team sports (basketballers) have a long competition period while individual sports (cyclists) have a shorter competitive period
- the age and experience of the athletes – professional athletes tend to have far longer preparation periods than amateur players (A or W League vs. weekend players).

During the pre-season, the predominant energy systems relevant to the sport are developed to their maximum capabilities, and the technical and tactical skills are refined as the competition period approaches.



Figure 7.8 Pre-season for elite athletes commences months before competition.

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The pre-season can be divided further into two distinct phases:

- General preparation period: the objective of this phase is the development of fitness and general technical skill development.
- Specific preparation period: the objective of this phase is to maximise the specific fitness qualities relevant to the sport. The specific preparation phase generally concludes with a pre-competition phase of training, allowing an athlete to replicate performance for the in-season. For example, NRL teams will play trial games prior to the season starting.

Table 7.1 An example of the general and specific preparation phase training objectives for a contact sport athlete

General preparation phase	Specific preparation phase
General physical fitness development	Training specific to the demands of the sport
Base aerobic conditioning development	Aerobic running maximised
General speed and agility technique	Game-specific fitness maximised
General hypertrophy and strength development	Strength and power maximised
General wrestling technique developed	Game-specific speed and agility maximised
Flexibility and mobility development	Game-specific wrestling fitness maximised
General skill development	Repeat sprint ability maximised
	Advanced technical and tactical development

Annual training plan for a winter team sport						
Macrocycle	**Pre-season**			**In-season**		**Transition**
Mesocycle	General preparation	Transition	Specific preparation	Pre-comp	Competition	Transition
Microcycle	Weeks 1, 2, 3, 4, 5, 6	1 week	Weeks 8, 9, 10, 11, 12	Weeks 13–16	26 weeks + four-week final series	Six weeks

Figure 7.9 Annual training plan for a winter team sport



Figure 7.10 AFLW players warm up before a Collingwood Magpies men's and women's joint AFL pre-season training session in December 2017.

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In-season (competition phase)

The in-season, or competition phase is structured around the specific competition calendar and varies significantly between different sports. Regardless of the sport, the goal of competition period is to maintain the fitness qualities developed during the pre-season and allow the minor competitions to bring the athlete to peak performance during the main competition.

The in-season period requires considerable collaboration between coaches, medical staff and the athletes to avoid injury and achieve peak performance. Coaches and support staff spend considerable time assessing the athlete's performance level, tactics, equipment changes, nutritional plans, travel arrangements, training loads, weekly schedules, muscle soreness and fatigue levels. Data collected allows the coaches to adjust weekly training loads. During higher priority competitions (such as the final series and grand final common to group sports, or national championships, world championships and Olympic Games for many individual sports), there is a definite taper stage or freshening up period during peaking periods, while lower priority competitions might simply be integrated into a normal training week.

Off-season (transition phase)

The off-season or transition phase of the yearly training plan varies depending on the requirements of the sport, and the age and experience of the athlete. While the transition period generally lasts for three to five weeks for professional athletes, part-time athletes may take three months or more off at the completion of the season.

The off-season allows the athlete sufficient time to recover physically from the rigors of training and competition, in addition to providing an opportunity to relax psychologically as well as overcome any niggling injuries or muscle soreness accumulated during the season. This is the perfect time of the year for athletes to take a break, enjoy themselves and go away on holiday. It can be divided into two distinct periods.

The first phase, commonly one or two weeks in duration, involves complete rest and rejuvenation. The second phase, defined as the active rest phase, provides an opportunity for athletes to commence general cross-training at a low intensity and volume. The active rest phase, while still providing athletes with a physical and psychological break from the usual training and competition demands of the sport, allows them to maintain an acceptable level of fitness through cross-training.

When conducted successfully, the transition period should ensure that athletes return to training fully regenerated and ready to recommence the more structured sport-specific pre-season of training.

Sub-phases

The macrocycle

The macrocycle or annual plan refers to the long-term annual plan for the entire season that works towards peaking for the main competitive goal of the season. The macrocycle comprises the phases of competition (pre-, in- and off-season).

The mesocycle

A mesocycle of training generally represents a two-to-six-week phase of training during the annual plan. However, this can vary depending on the sport, age and experience of the athletes. While a mesocycle may last two to six weeks during a preparation period, it may be as short as two to four weeks during the competition period, depending on the competition calendar.

The microcycle

A microcycle refers to the smallest block of training, and typically comprises a week of training. Multiple microcycles are joined to form a mesocycle. The microcycle is then broken down into individual daily session plans.

<table>
<tr><th colspan="24">Macrocycle</th></tr>
<tr><th colspan="8">Preparatory period</th><th colspan="8">Competitive period</th><th colspan="8">Transition period</th></tr>
<tr><td colspan="4">General preparation phase</td><td colspan="4">Specific preparation phase</td><td colspan="4">Pre-competition phase</td><td colspan="4">Main competition phase</td><td colspan="8">Transition phase</td></tr>
<tr><td colspan="4">Mesocycle 1</td><td colspan="4">Mesocycle 2</td><td colspan="4">Mesocycle 3</td><td colspan="4">Mesocycle 4</td><td colspan="4">Mesocycle 5</td><td colspan="4">Mesocycle 6</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td></tr>
</table>

Figure 7.11 Basic overview of the sub-phases

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Figure 7.12 Sprinters at the 2025 Australian Athletics Championships (left) and an NRL training session (right)

Four-week mesocycle for a sprinter				
Weeks	**1**	**2**	**3**	**4**
General preparation weekly load			x	
		x	x	
	x	x	x	x
	x	x	x	x
	x	x	x	x

Figure 7.13 Example of a mesocycle for a sprinter

General preparation weekly microcycle for a professional National Rugby League player						
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Mobility	Mobility	Rest	Mobility	Mobility	Mobility	Rest
Speed and agility	Team skills		Speed and agility	Team skills	Aerobic conditioning Skill games	
	Aerobic capacity			Aerobic capacity		
Group skills	Wrestle		Group skills	Wrestle		
Gym	Gym		Gym	Gym		
Stretch	Massage		Stretch	Massage		

Figure 7.14 An example of a one-week microcycle for a professional National Rugby League player during the general preparation phase

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Following is the training plan of pentathlete Genevieve Janse van Rensburg. The Modern Pentathlon involves five different sports, with very different requirements.

Training plan of Olympic pentathlete Genevieve Janse van Rensburg		
Day	**Time**	**Training**
Monday	5 am – 7 am	Swimming (long session paddles and pull buoy usually over 6 km)
	7.30 am – 9 am	Sprint and Shoot session
	3 pm	Riding lesson
	6 pm – 8.15 pm	Fencing
Tuesday	5.30 am – 7 am	Running (high reps middle distance running but lower effort – usually 8 km on the track 1 km, 800 m, 600 m, 400 m × 2–3)
	5 pm – 7 pm	Swimming (depending on weekly cycle)
Wednesday	5.30 am – 7 am	Laser running (main session with shooting at the end or in the middle of distances, e.g. 10 × 800 m with minute 30 rest first five under 3 minutes then 3 minutes rest followed by the last ones having to be 3:15 or under).
	3 pm	Riding lesson
	6 pm – 9 pm	Fencing session with 45 minute 1 on 1 fencing lesson
Thursday	5.30 am	Running (easy 8 km run with no pressure on the pace)
	5 pm – 7 pm	Swim (depending on cycle but usually 25 m pool with a focus on 50 m efforts at 200 pace)
	7.15 pm – 9 pm	Fencing
Friday	6 am	Running (tempo at distance with continuous running, e.g. 3 × 10 minutes at 4:15 pace with 5 minutes continous jogging)
	8.30 am	Shooting
	10 am	Riding (without instructor working on basics and getting hours on the horse)
	5 pm – 7 pm	Swimming (focus on sprints with dives)
Saturday	6 am – 8 am	Swimming (depending on cycle progression)
	Anytime	Long run 10 km to 16 km easy with no pressure
Sunday		Rest Day or Competition Day

Figure 7.15 Training plan of pentathlete Genevieve Janse van Rensburg



Figure 7.16 Genevieve Janse van Rensburg at the 2024 Olympics. The Modern Pentathlon consists of five events: swimming (not shown), fencing, horse riding, running and pistol shooting.

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Peaking and tapering

Peaking

Training for peak performance is a complex process that requires considerable planning, preparation and evaluation. To achieve peak performance, the athlete must be able to adapt to the volume and intensity of the various training components and methods of training.

Thorough athletic preparation that balances both the volume and intensity of training results in athletes who display multiple positive attributes. These include an improved work capacity, physical fitness, technical and tactical proficiency, neuromuscular coordination, physical health and a psychological state of readiness, confidence, excitement, enjoyment and anticipation in preparation for competition.

Athletes often describe themselves as being in 'great shape' during the competition phase of training.

Peaking is achieved when the athlete has reached a state of optimal physical, psychological, emotional and spiritual health and wellbeing. The athlete has adapted to the work and recovery demands, and super compensation has been achieved.

Generally, prior to the main competition, an unloading phase of training is implemented, and this is critical to achieving peak performance. During this period, the volume and intensity of training are reduced, and the athlete is unloaded (tapering). Proper tapering results in a heightened state of readiness. A short-term peaking period is achieved through super compensation.

Tapering

Critical to peak performance is the taper period of training. It is during this period that the coach's and the athlete's periodised training program is tested, as the athlete prepares for the major competition of the season.

Tapering for sports performance refers to a period of reduced training load in the days and weeks leading up to the main competition, to promote 'peak' performance at the most vital time.

Tapering allows for the replenishment of muscle glycogen, neuromuscular and metabolic system regeneration and an elevation of hormone levels – all of which are depleted during intense training periods. Adequate taper allows for a decrease in training stress and an optimal state of recovery and regeneration. During this period, the body is rested for an appropriate period while fitness is maintained. The drop in fatigue while maintaining fitness results in increased performance.

Performance = fitness – fatigue

Taper periods are common in all sports. The sport and competition window will determine the size of the taper. It can last for several days and up to a week or more for some sports.

Taper guidelines

General guidelines for a successful taper include:

- dropping the total training volume by 50% to 70%
- keeping high-intensity training levels high but volume low during the taper
- reducing the difficulty of training
- increasing recovery periods during training
- reducing the frequency of training sessions by up to 20%
- keeping the taper between four and 21 days, depending on the individual and the sport's requirements
- keeping the activities performed during the taper specific to the competitive demands of the sport.

Activity 7.5

Taper types

1 Research the following tapers available to athletes:
   - linear taper
   - step taper
   - exponential taper.
2 Is one of the above tapers suited to any particular sports or settings, or could all be utilised by any athletes/sports?

Skills: analysis, research

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Sport-specific attributes: fitness components, skill requirement

Sub-phases can be geared specifically to the time of the season, and particularly the needs of the athlete in that phase of the season. Various sports will have different needs for skills and fitness at different times of the year. Therefore, the sub-phases will need to be specific to the demands of the sport and the athlete. Sports that do not require large muscle mass will not focus on this area, while sports that are dominant in the areas of cardiovascular endurance will have more sport-specific sub-phases built around developing and maintaining this.



Figure 7.17 Cricket training at the nets

Activity 7.6

Comparison of individual and group sport

Consider the example below of a sprinter and footballer.

Individual sport: running

Fitness components:

- **Cardiovascular endurance:** essential for long-distance runners. Training includes long runs, tempo runs, and interval training.
- **Muscular endurance:** important for maintaining form over long distances. Strength training focuses on lower body and core.
- **Speed:** interval training and sprints to improve overall pace.
- **Flexibility:** regular stretching and mobility exercises to prevent injuries.

Skill requirements:

- **Running technique:** focus on stride efficiency, breathing techniques and posture.
- **Pacing:** learning to manage energy over different distances.
- **Mental toughness:** developing strategies to handle the psychological demands of long-distance running.

Group sport: football

Fitness components:

- **Cardiovascular endurance:** necessary for maintaining high-intensity effort throughout the game. Training includes continuous running and high-intensity interval training.
- **Muscular strength and power:** important for sprinting, jumping and tackling. Strength training includes both upper and lower body exercises.
- **Agility and speed:** drills that improve quick changes in direction and acceleration.
- **Flexibility:** regular stretching to maintain range of motion and prevent injuries.

Skill requirements:

- **Ball control:** dribbling, passing and receiving under pressure.
- **Tactical awareness:** understanding team strategies and positioning.
- **Communication:** effective verbal and non-verbal communication with teammates.
- **Coordination:** synchronising movements with the ball and other players.

1 Compare the two sports in terms of training structure, skill development and fitness components.
2 Choose another individual and group sport and compare.

Depth Study

Skills: analysis, research

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Quiz

Revise and summarise 7.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Briefly outline the three phases of competition and what occurs during each phase.
2 Describe macrocycles, mesocycles and microcycles. Provide examples.
3 What is peaking and how do athletes and teams plan to peak?
4 What is tapering and what are the key elements of a 'good' taper?

Think critically and apply 7.2

1 Develop a periodisation chart for the fitness or skill-specific requirements of a sport of your choice.
2 Justify the periodisation of the various requirements of that sport.

Skills: analysis, problem solving

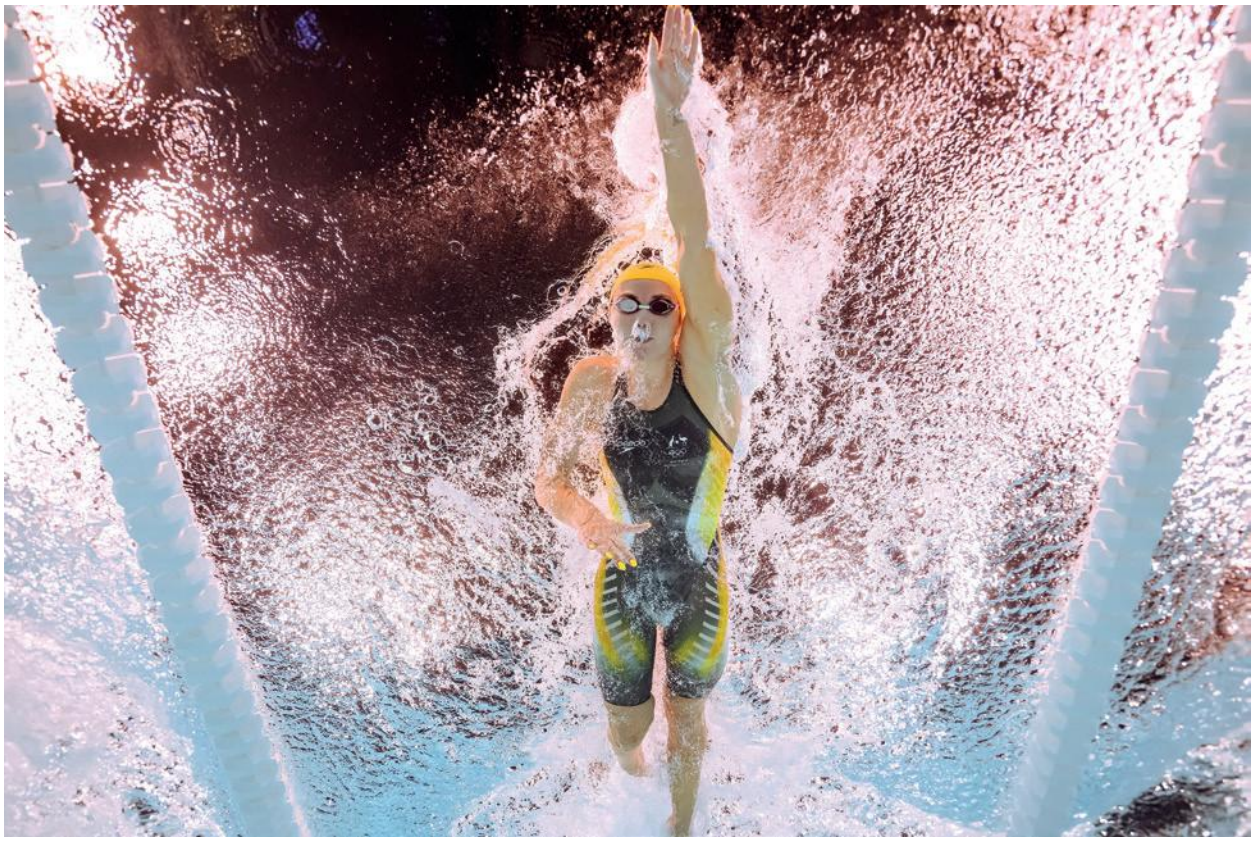


Figure 7.18 Various sports will have different needs for skills and fitness at different times of the year.

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7.3 Psychological strategies to improve participation and performance

Learning objective 7.3
INVESTIGATE how psychological strategies, arousal optimisation and stress/anxiety management are used in individual and group sports in order to improve participation and performance.

The importance of a strong and focused mind in sport is now widely recognised. Many professional coaches and athletes believe that the awareness of one's state of mind, as well as a range of effective strategies to mentally prepare for competition and maintain self-belief, can be the difference between winning and losing. This is most clearly evident when the world's best sportspeople are in the heat of battle, where the physical characteristics and skill levels are evenly matched. Consider a play-off in golf between the world's number one and number two ranked players at a major tournament such as the US Open, or a penalty shootout at soccer's World Cup.

To ensure athletes are adequately prepared for elite competition, coaches and managers will employ the expertise of a sports psychologist, to develop a close relationship with athletes and to help individual athletes recognise potential problems with their current level of motivation, arousal levels, anxiety and stress, especially while competing. Once these are identified, a range of psychological skills can be developed and practised, to help achieve even greater performances in competition. By helping the athlete enhance their motivation and manage anxiety, they increase the likelihood of improved performance.

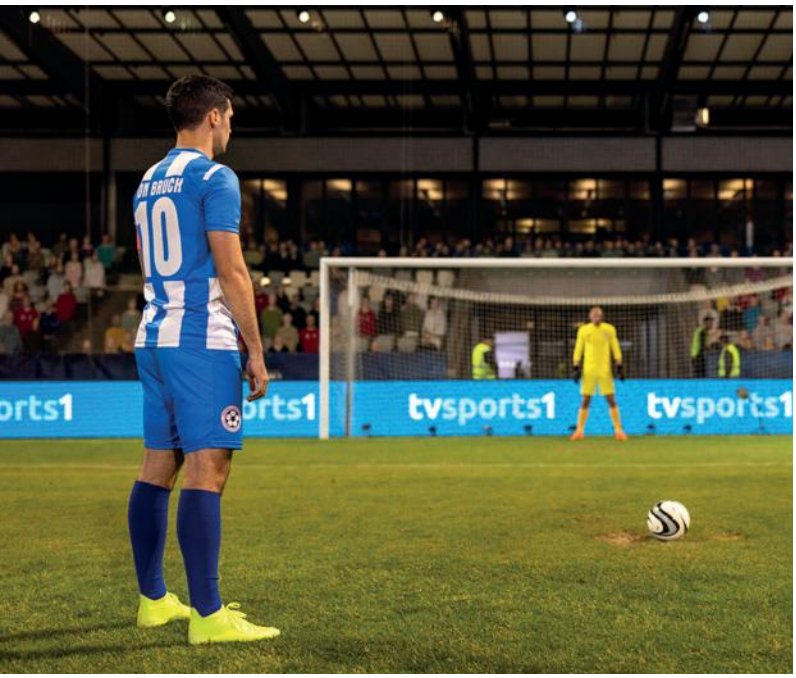


Figure 7.19 Focus is required at key moments in sport.

Concentration/attention skills (focusing)

The ability to maintain concentration for an extended period can be challenging. A range of external and internal factors can distract someone from the task on which they are currently focusing. All physical skills require cognitive processing. This could be to:

- read and filter cues received through the five senses into relevant and irrelevant categories
- read and interpret the movement and tactics of opposing players
- be able to make correct decisions that complement the execution of a particular game plan.

Athletes can execute many routine skills automatically, with minimal concentration and specific thought. This is achieved through years of training to practise and refine motor patterns. However, the basketballer who executes a technically correct pass that is intercepted because of a poor read of the opposition's movements has failed to accurately focus on the relevant cues and make a correct decision. Athletes must maintain their concentration and attention on relevant cues and be able to ignore cues that are largely irrelevant. All sporting scenarios present a unique challenge to the athlete when it comes to maintaining the correct focus.

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Generally, athletes have to be able to achieve three things when maintaining their focus:

- select the important and relevant cues on which to focus and ignore the rest
- manage their concentration and attention when their focus is either voluntarily or involuntarily shifted
- focus on a number of relevant cues simultaneously if required.

Generally, successful athletes can focus more on the process and actual movement skill or team tactic to be executed and ignore factors that do not have a direct impact or relevance to the actual execution. This is particularly important prior to executing skills performed in a more stable and static environment, such as a penalty shot, free throw or conversion. However, in these moments the athletes will be more acutely aware of their thought processes and are more likely to have to combat thoughts of doubt, fear and anxiety. The athlete must be able to stay confident and positive, focus only on the relevant cues and information and be able to block and ignore factors that are irrelevant to the impending skill to be performed.

Another aspect of concentration and attention is the unique situation where an athlete enters a state of total immersion and focus on the play around them. This is a very satisfying experience that is unique to experienced athletes, where the skill execution itself is second nature. While analysing and moving in a very dynamic and competitive environment, they make decisions and execute skills with little conscious thought. This is evident in football, when a team makes a number of quick and successive passes through opponents to score. Players involved are reading the movements of both opponents and teammates and making instantaneous and complex decisions on their next move, then executing them with amazing timing and accuracy.

Activity 7.7

Concentration

Reflect upon your level of concentration right now in class.

- Is it adequate to enable learning?
- How does it compare with your concentration during another lesson from today?
- What are some factors that help you to concentrate?
- What are some barriers to you staying focused?
- How much responsibility do you take for your attention level in class?

Skills: analysis, problem solving

Mental rehearsal and visualisation

Most professional athletes and coaches recognise the value and power of being mentally strong, even in sports that primarily seem to be physically based, such as weightlifting. Being able to control doubt, fear and anxiety while remaining centred and focused can provide the edge required for victory. Both real and fictitious imagery created in the mind can help athletes achieve both these goals. Athletes can use their imagination and visual memory to improve performance. Two major types of imagery used are mental rehearsal and visualisation.

mental rehearsal practising a skill in the mind

Mental rehearsal

Mental rehearsal is a cognitive technique where individuals visualise themselves performing tasks or achieving specific outcomes. This process involves mentally practising and experiencing an event without physically performing it. By doing so, individuals can prepare and improve their performance in various domains, such as sports, public speaking, or even daily activities.

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If practised and properly performed, mental rehearsal is a powerful psychological skill and phenomenon that can be used to a player's advantage, increasing the likelihood of success. It allows the athlete to experience the skill before it has actually occurred. It is most useful for self-paced skills that are under the total control of the athlete. Such sports include golf, archery, long jump, shot put, diving and gymnastics vault. These opportunities also exist within dynamic sports such as a free throw in basketball or a conversion kick in rugby league.

Athletes should practise this skill in training, to ensure they are able to effectively execute it in the competitive environment. Some key guidelines are:

- The skill should be performed from the athlete's point of view, as in the first person.
- They should always be successful.
- The skill should be visualised in real time, from start to finish.
- Once rehearsed, the athlete should attempt the skill without delay for maximum effect.

Athletes who routinely use mental rehearsal report decreased anxiety and greater confidence. It also assists them to focus on the skill while ignoring distractions such as their own negative thoughts and heckling from the crowd. One of the greatest benefits of mental rehearsal is the effect it has on the neuromuscular system. Elite athletes have highly refined motor patterns, which helps account for their incredible consistency in skill execution. Effective mental rehearsal stimulates this precise motor pattern, without resulting in the actual movement being rehearsed. Athletes report being able to almost 'feel' this sensation throughout their bodies as they prepare to perform.



Figure 7.20 The majority of NRL goal kickers use mental rehearsal before a conversion.

Practical application 7.1

Mental rehearsal

In groups of three, students will spend 10 minutes practising a regular sporting skill (e.g. basketball free throw).

- Each student will attempt the skill five times and record their results.
- Student 1 will spend 10 minutes physically practising the skill.
- Student 2 will spend 10 minutes mentally rehearsing the skill.
- Student 3 will spend five minutes mentally rehearsing the skill followed by five minutes physically practising the skill.
- At the completion of the 10 minutes, students will attempt the skill five more times and record their results.
- Discuss the three methods in terms of their advantages and disadvantages.

Skills: communication, collaboration, analysis

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Visualisation

While also involving role-play and imagining specific mental scenarios, **visualisation** differs from mental rehearsal primarily through the lack of reality that can exist in the mental image. This depends upon the desired psychological outcome the athlete desires in preparation for competition.

visualisation creating and focusing on a range of positive mental images and experiences to achieve specific psychological benefits

If an athlete were trying to relax, decrease anxiety or arousal levels and not think too much about the impending intensity or stress of competition, they could focus on an image or scenario that calmed them down and allowed them to focus on something unrelated – for example, imagining relaxing on a secluded island in the warm sun. Anything that promotes feelings of calm and relaxation could be used for this.

However, if the athlete were seeking to increase confidence and arousal levels, a more stimulating visualisation would achieve this – for example, imagining performing incredible feats such as winning gold, scoring a miracle goal or making a 'crunching' tackle would allow an athlete to feel almost invincible. While this may seem to lead to an 'inflated ego', a positive impact can be found in the increased confidence and arousal for intense and combative competition.

A unique feature of visualisation is that it can be used while actually performing or training to increase the intensity of effort. An athlete running on a treadmill could imagine that they are running in front of their home spectators in an Olympic Games final. By creating a scenario and role-playing it to ensure incredible success, the athlete can push their body to greater heights as they ignore feelings of pain and fatigue. Some key guidelines for visualisation include:

- It should be practised and rehearsed away from actual competition, prior to being used before or during competition.
- Most images should be from the perspective of a spectator – that is, in the third person.
- Success should always be evident in sporting visualisations.

Athletes should become aware of the specific physiological impact of certain visualisation techniques, and ensure that they do not over-compensate for the desired effect. For example, relaxing too much could lead to feelings of tiredness or lack of focus, whereas an athlete may become over-aroused, leading to decreased performance. Athletes need to be aware of anxiety levels, emotional levels, heart and breathing rates as well as feelings of nervousness, sweating, or tiredness and lethargy.



Figure 7.21 Visualisation can be used while training to increase the intensity of effort.

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Relaxation techniques

The ongoing and intense stress of elite competition can lead to decreased performance, burn-out and the loss of desire to compete. It could possibly even contribute to the development of a mental health condition, such as depression, if left unchecked. Specific relaxation techniques play a major role both in and away from the competitive environment. Generally, methods of relaxation are used while the athlete is sensing increased feelings of stress, anxiety and arousal prior to or during competition.

The use of calming and relaxing music can take the athlete's mental attention away from distracting and negative thoughts that could be flooding their mind. Music can also help them to zone away from outside distractions and noise, allowing them to focus their thoughts on the upcoming performance. The chosen music should lead to feelings of relaxation and focus. If music is used while an athlete is training, such as on a long training ride, the athlete should not develop an over-reliance on this mental distraction, as it is most likely not permitted during actual competition, where the athlete will not be able to use music to distract them from feelings of fatigue.

The conscious use of controlled and rhythmic breathing is an effective way of calming an anxious athlete, especially if they are physically reacting to high levels of state anxiety. It can provide a single point of focus and concentration. An athlete could be mindful of the feelings of the cool air rushing in and warm air being exhaled through the nose and mouth. When coupled with visualisation, the athlete is able to directly affect their levels of anxiety and arousal. Some athletes may even use a specific aromatic smell, such as the menthol in a warm muscle rub, to increase arousal and alertness, by stimulating the limbic system of the brain. Alternatively, smelling certain essential oils such as lavender can help calm and relax an athlete.

Meditation based on Eastern practices such as yoga and tai chi, or more sensory-based meditations focused on the feelings of warmth and heaviness of the body, can help athletes relax and escape from the stressors of training and competition. These can be done privately be listening to a podcast or in a group led by a trained instructor. These are often accompanied by music and aromatherapy, and some athletes describe these sessions as essential for helping them maintain good mental health and wellbeing.



Figure 7.22 Yoga can be a form of relaxation for many.

A popular method of relaxing both the mind and body is Jacobson's progressive muscle relaxation technique (PMR), first devised in the 1920s. This is a proven method to decrease an athlete's perceived levels of anxiety, and has even been reported to help decrease the effects of certain physical ailments. Biofeedback research demonstrates the positive effect of PMR in decreasing heart and ventilation rate, as well as brain activity and stress. Similar to meditation, it helps provide a narrow focus point, concentrating on feelings of relaxation. In a quiet environment, the athlete closes their eyes and follows a two-step process:

1 Increase the tension of a specific muscle by performing a gentle isometric contraction.
2 After a few seconds, release the tension and contraction and focus on the feeling of relaxation in the muscle.

This is repeated throughout the body on different muscles. PMR can be performed both in and outside of competition.

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Goal setting

Elite athletes are highly driven individuals, who aim to be the absolute best that they can be. The commitment and efforts made during training to fully prepare themselves for competition are arduous and highly taxing, both physically and mentally. Only the most dedicated and self-disciplined of athletes generally go on to achieve greatness.

Consider the following example of a typical training day for an ultra-triathlete:

- Wake up at 4.30 am every morning.
- Each Monday, Wednesday and Friday, swim from 5 am until 7 am.
- On Tuesdays, Thursdays and Saturdays, bike ride instead.
- Each week, swim around 30 kilometres, ride about 800 kilometres and run about 120 kilometres.
- Have a midday sleep before going for an hour's run in the afternoon.
- Go to sleep by 9.30 pm.

An athlete's drive, motivation and enthusiasm for training naturally vary; however, it is evident that such training requires the strictest self-discipline and commitment. To assist with this, effective goal setting can be invaluable in helping athletes stick to strict training regimes and continue to produce the physical effort required to achieve success and improved performances. Goals are important to help keep athletes accountable to a previously established expectation or standard, and the athlete may have several goals in place at any one time in relation to a range of lifestyle, training and performance factors. These could include the following:

- nutritional goal – adhering to a set nutritional plan as established by a dietician
- lifestyle goal – avoiding alcohol or ensuring that the athlete is asleep by a set time on most nights
- training goal – completing a set volume of training in a set time, such as 40 kilometres of swimming per week
- performance goal – winning gold or finishing the season in the top four.

A number of people should be aware of an athlete's particular goals, such as their sports psychologist, coach and family. This increases the accountability and likelihood of success. Also, goals should be kept visible, to act as a constant reminder of the intended aim. For example, a poster on a wall, an image as a screen-saver on a phone or writing something on a piece of tape wrapped around the wrist can all serve as such reminders.



Figure 7.23 A triathlete's training needs to include running, riding and swimming.

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A common acronym to help establish effective goals is to use the principles of SMART:

- **S:** Is the goal **specific**? Goals should be explicit and clearly defined. There should be no doubt about the standard that the athlete is aiming to achieve. An athlete who says 'I aim to do well' is not establishing a definitive level of performance or achievement.
- **M:** Is the goal **measurable**? Generally, goals that are quantifiable (able to be measured in numbers) are more effective in setting a clear expectation of success – for example, decreasing an athlete's personal best in the 400-metre sprint to below 45 seconds or their weight to 85 kilograms. Performance-based goals are not always able to be expressed using statistics; however, honest reflections from either the athlete or an educated observer such as a coach can still track progress and improvement.
- **A:** Is the plan able to **achieve** the goal? Athletes generally set longer-term goals (anywhere from three months to four years in the case of the Olympics). It is hard to connect such distant goals to the short-term demands of today's arduous training program. Therefore, a range of related short-term and mid-term goals need to be identified and established that will help track the athlete towards their ultimate long-term goal. Often these goals are more training- and behaviour-based, as the long-term goal is likely to be performance-based, such as winning the grand final. Short-term goals could include:
  - increasing training intensity by decreasing a weekly 5-kilometre test run by 15 seconds per week
  - for this week's rugby league game, aiming for a completion rate of 75%
  - sticking to an established nutritional plan
  - sleeping at least eight hours per night.
- **R:** Is the goal **relevant?** Goals need to be something for which to strive. If the set goal is too easily achieved, then the athlete is not driven to work harder and push themselves. However, goals can be too hard and somewhat unlikely to be achieved because they are outside the athlete's current level of potential achievement or improvement. When setting a performance goal, athletes must be honest with their current level of development and the level that they could see themselves achieving in a set time. Goals that find this delicate balance between being too easy or difficult to achieve are most effective in helping the athlete reach their potential without disheartening them.
- **T:** What is the **timeframe** of the goal? All goals, whether they are short-term (days to weeks), mid-term (weeks to months) or long-term (months to years), should have a defined timeframe within which the athlete intends to achieve the goal. This imposes finality on the athlete and will increase the chances of success. Goals should be routinely evaluated using a suitable tool or test. This could be a questionnaire, training log or statistical data from a GPS device. This process should occur at regular intervals throughout the timeframe (such as fortnightly), and should involve the athlete and a coach or trainer who can provide independent assessment. This can allow progressive modifications to the goal to be made if the athlete is either tracking below or above the expected progress level. This ensures the goal stays realistic and achievable.

When establishing a goal, the athlete should identify potential or set rewards that will be realised if the goal is achieved. These could be the inherent effect of a particular goal, such as personal glory and satisfaction, prize money or achieving a number one ranking. However, it could be a personal reward put in place by the athlete, coach or even their family for a particular goal that may not relate to a competitive performance outcome. This could be a holiday, contract extension or monetary reward for a specific achievement. Extrinsic and material rewards are less effective. Athletes being driven by internal factors generally show more resilience, perseverance and commitment. At this point, athletes must be very aware of their self-talk (the internal self-conversation and thoughts). This can lead to further anxiety if uncontrolled and unhelpful, whereas positive self-talk can be beneficial in helping to control feelings of anxiety and in increasing motivation.

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Optimising arousal

All sports require athletes to be in a certain mental state and condition prior to competing. This differs between sports, and athletes also present with individual differences in their mental state during the final moments prior to competing. Research has found that different tasks require different levels of arousal for optimal performance. For example, difficult or intellectually demanding tasks may require a lower level of arousal (to facilitate concentration), whereas tasks demanding stamina or persistence may be performed better with higher levels of arousal (to increase motivation).

The arousal level of an athlete can play a significant role in determining success. Adequate preparation of the athlete for the impending event involves physically preparing the athlete, as well as achieving this specific level of arousal. This relationship is demonstrated in the theory commonly known as the 'inverted U hypothesis'. Yerkes and Dodson (1908) originally considered the relationship between arousal and performance. This suggested a specific point of arousal where performance was optimised. Later developments of the theory in relation to sport suggested that rather than a precise point of optimum arousal, a broader zone exists that takes into account individual differences and natural fluctuations of this optimal arousal to suit the task ahead.

When an athlete who is about to compete is suffering from arousal levels that are either too high or too low, they are less likely to be able to reach their full potential. They must be able to assess and adjust their arousal levels both leading up to an event and during the event. Specific psychological skills can be employed at this point to either increase or decrease arousal.

High levels of arousal are suitable for sports that are either very physical or combative in nature, such as rugby union, boxing and weightlifting.

Sports that generally demand lower levels of arousal, such as shooting and archery, require greater levels of control and concentration.

It is also recognised that athletes actively learning the basic skills and tactics of a sport require lower levels of arousal. Being over-aroused in this situation can lead to decreased concentration and attention. As the athlete develops towards being elite, they are able to effectively use higher levels of arousal to their advantage.

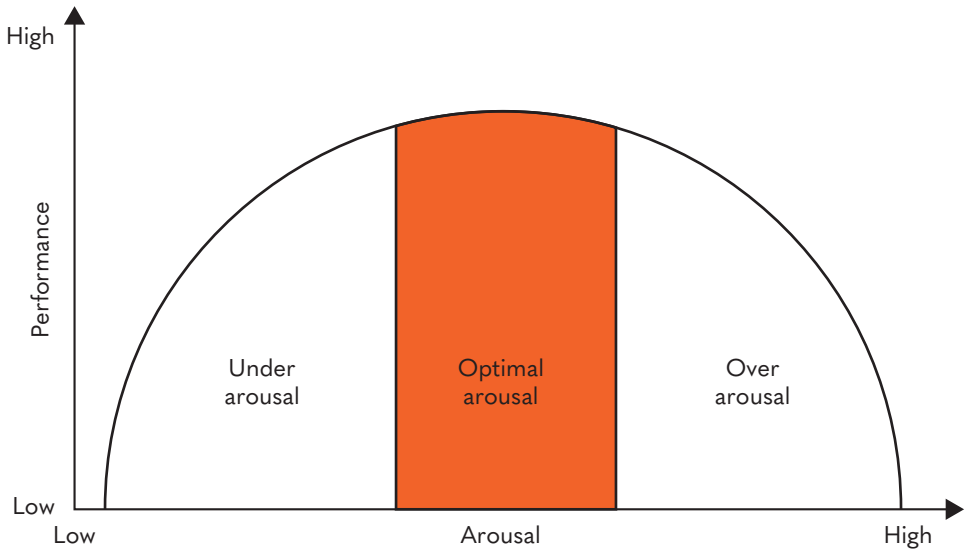


Figure 7.24 The 'inverted U hypothesis'

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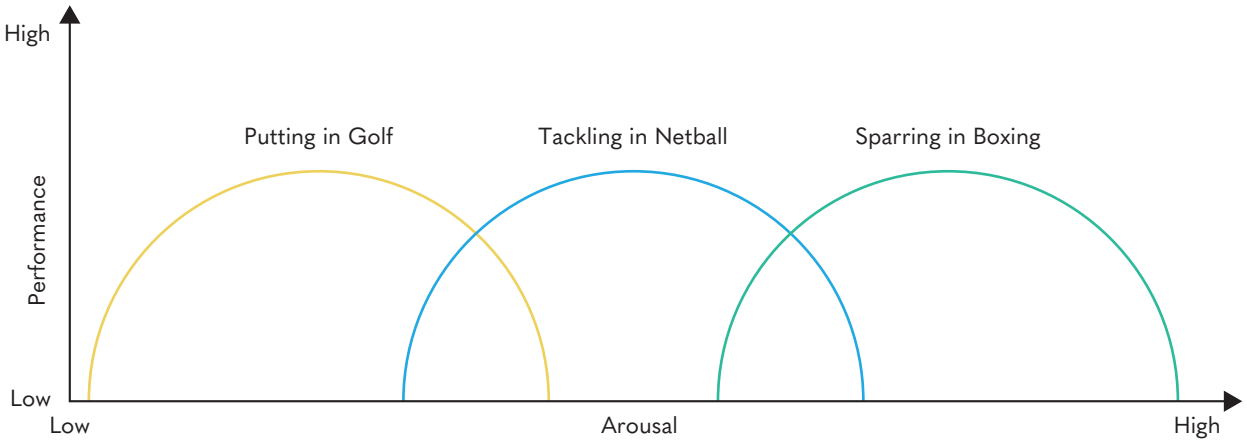


Figure 7.25 Arousal levels required for different skills.

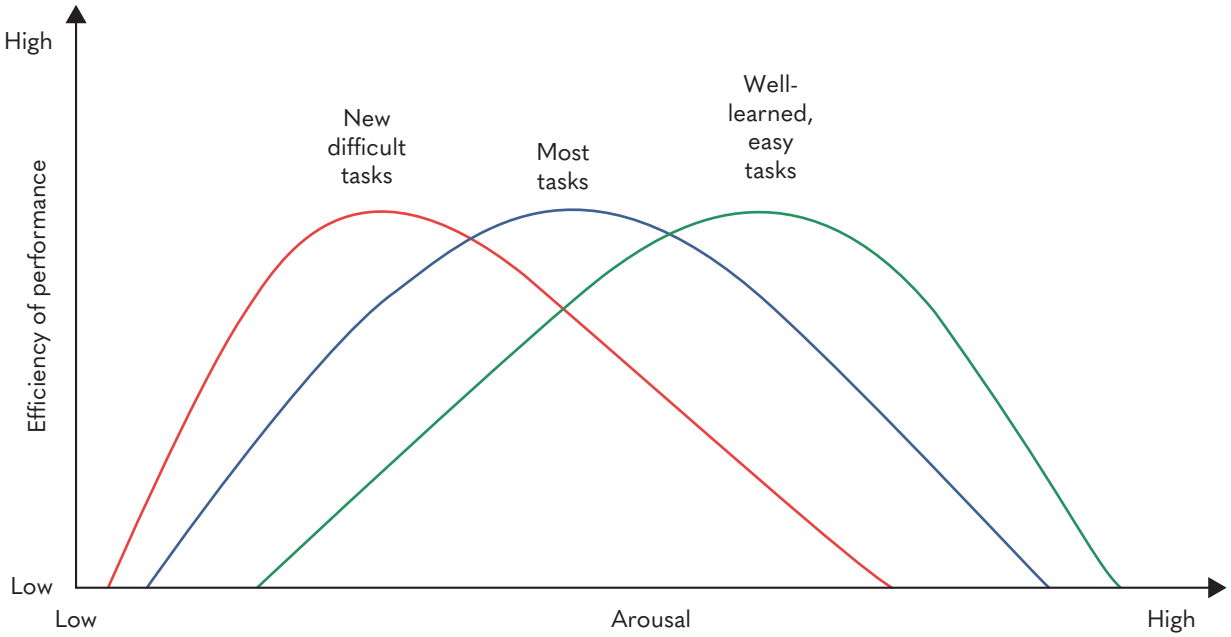


Figure 7.26 Arousal always needs to be optimal.

Activity 7.8

Optimal arousal

Reflect and share personal anecdotes of when you have experienced being 'in the zone'.

Skills: communication

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Managing stress and anxiety

Trait and state anxiety

The immense pressure an athlete faces during elite competition can challenge the athlete's mind almost as much as the physical demands of the sport. Even spectators and fans can feel the pressure as they watch their favourite athletes and teams compete, with increased feelings of anxiety and nervousness, as well as increased heart rate, breathing and body temperature. However, these challenges can extend beyond the game, as the athlete may have to deal with feelings of anxiety outside of competition. If dealing with anxiety becomes a daily struggle, then athletes are exposed to mental health disorders, such as anxiety and depression, just as any other person may be. Increased anxiety levels can be detrimental to the performance of all athletes. There are two categories of anxiety that athletes will need to learn to handle: **trait anxiety** and **state anxiety**.

trait anxiety the genetic predisposition and proclivity an athlete has towards increased anxiety and nervousness

state anxiety feelings of anxiety related to a specific game or event

All people have unique and individual personality characteristics. Some people may carry greater levels of anxiety throughout life, over any number of daily events. For athletes with higher levels of trait anxiety, the increased pressure of elite competition can present an even greater mental obstacle to success.

The nature of competition inherently leads to increased pressure on the athlete to perform to the best of their ability. Some sports place a great deal of pressure on an athlete to perform very precise movements with only a small degree of error allowed, such as shooting and archery. In other sports, there are certain situations where the pressure on an athlete increases, such as during a free throw in basketball. Success is entirely reliant on the athlete being able to control their nerves and execute the skill accurately. In all sports, state anxiety will increase as the level of competition rises, eventually culminating in either a grand final or a gold medal match. In a situation where an athlete has to execute a single skill that they may have practised for four years leading up to the Olympics, only the most controlled and focused athletes will be able to prevent state anxiety from impacting upon their performance.



Figure 7.27 The pressure of taking a free throw in basketball can increase state anxiety.

Both state and trait anxiety can negatively impact upon performance. Some of the signs that athletes report when suffering from increased anxiety include:

- feelings of 'stomach butterflies', even to the point of vomiting prior to competition
- constant feelings of tension and being unable to relax, which can lead to increased feelings of fatigue
- prior to a game, feeling very twitchy – their legs may seem uncontrollably shaky or they may pace around the room
- muscles becoming tense, leading to increased errors. This can happen during the match as the competition increases. This is particularly evident in tennis, as a player struggles to serve out a match, or during a penalty shootout in soccer
- having more negative thoughts and doubts about their own ability, leading to decreased confidence and self-belief.

All athletes – particularly those who suffer more from trait anxiety – identify factors that lead to increased anxiety, become skilled in recognising the signs and feelings of increased anxiety (both in and out of competition) and develop strategies and techniques to help manage these.

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Sources of stress

Stress is a natural part of human existence and is closely linked to the pressures associated with the competitive sporting environment. All athletes respond to stressful situations in unique and individual ways, which are associated with their level of trait anxiety. Positive stress caused by exciting circumstances, such as bungy jumping, is called eustress. However, stress caused by undesirable threats is called distress. Excessively elevated levels of cortisol, the hormone released in response to stress, are linked with a range of health conditions such as heart disease. Yet, often people will say that they perform best when there is a small amount of stress, as it compels them to action. An example of this is an upcoming exam, which will motivate a student to study. There are many internal and external sources of stress.

Handling stress is a normal part of everyday life. However, experiencing excessive and long-term stress can have many negative personal and performance effects on an athlete. Because of the nature of the competitive environment and professional sport, athletes must develop skills in recognising and dealing with stress. Internal sources of stress relate to a person's personality. Some people tend to stress and worry more about everyday events, whereas others are more relaxed and calm. Feeling threatened – such as the fear of being dropped from a team – can increase stress. External sources of stress could include threats by coaches about the negative consequences of a poor performance, losing sponsorship, or not having a contract renewed. The fear of losing and performing in front of large crowds is another source of stress with which athletes must be able to deal. There are many strategies and techniques that an athlete can practise and utilise to help them handle the stress of a situation. These skills empower an athlete to take more control during high-pressure events. These are discussed in the next section.





Figure 7.28 High-pressure events, such as the Olympics or Paralympics, can increase an athlete's stress levels.

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Activity 7.9

Psychological strategies

1 Watch video footage of elite athletes executing set skills in key moments of their chosen sport and investigate the following questions.
   - What psychological strategies can you identify?
   - What are the relevant cues for the athlete to focus on?
   - What distractions do they need to manage?

2 Reflect on the current goals you have in your life.
   - If you do have a current goal, what influence does it have on your behaviours and attitude?
   - If you don't have a current goal, what influence is this having on your current behaviours and attitude?

Skills: problem solving


Quiz

Revise and summarise 7.3

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What are trait anxiety and state anxiety?
2 What are some sources of stress for athletes?
3 What is the optimal arousal zone?
4 What are indicators of:
   a under-arousal?
   b over-arousal?
5 What are focusing skills?
6 Distinguish between mental rehearsal and visualisation.
7 Outline a range of relaxation techniques.
8 Explain the difference between anxiety and arousal. How does this affect participation and performance?


Depth Study

Think critically and apply 7.3

1 Interview a current or former elite athlete, or research the case study of a particular athlete, to find out:
   a the strategies they use to optimise arousal
   b the strategies they use to manage stress and anxiety
   c any other psychological strategies they use.
2 You could repeat this for one individual and one team sport.

Skills: analysis, research

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7.4 Application of strategies and tactics

Learning objective 7.4
DISCUSS factors that influence the application of strategies and tactics in both individual and group sports.

Strategies are the plans or approaches designed to achieve a long-term goal. In sports, this could involve planning for an entire season, focusing on player development, or setting objectives for winning championships.

Tactics are the specific actions or steps taken to implement the strategy. They are more immediate and focused on short-term goals.

For example, the Penrith Panthers side that have dominated the 2022–24 NRL seasons have utilised the strategy of having possession of the ball in good field position. They have achieved this through a high completion rate and support play while in possession and limiting the speed of the play of the ball, superior defensive line speed and effective tackles of the opposition in defence.

There are several factors that influence how strategies and tactics are applied to individual and group sports. Each of these factors can interact in complex ways, making the application of strategies and tactics in individual and group sports a dynamic and multifaceted process.

Athlete's physical attributes

A player's physical attributes, whether for an individual or group sport, are critical to influencing skills and tactics. For example:

- Strength and endurance: athletes with greater strength and endurance might adopt more aggressive or sustained strategies.
- Speed and agility: faster athletes may use tactics that capitalise on quick movements and rapid changes in direction.

Skill level and technique

The skill level and technique of the athlete will influence the technical nature of the strategies and tactics utilised. Elite sports have far more advanced strategies and tactics when compared to recreational or beginner athletes. Autonomous athletes have the capacity to direct attention to strategies and tactics.

- Technical proficiency: higher skill levels allow for more complex and varied tactics.
- Experience: experienced athletes can adapt strategies based on past performances and knowledge of opponents.



Figure 7.29 Skill and technique allow athletes to consider their tactics.

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Figure 7.30 Injury can impact on strategies and tactics.

Health and fitness

The capacity to deliver the strategy and tactics is greatly influenced by the ability of the individual or group to be able to sustain it.

- Injury status: current health and injury status can dictate more conservative or aggressive strategies.
- Fitness levels: peak fitness allows for the execution of more demanding tactics.
- Player fitness: injuries and overall fitness levels can dictate how a team approaches a game. A team with key players injured might adopt a more cautious strategy.

Psychological factors

The psychological capacity of the athlete also needs to be considered when adding strategies and tactics to their training, preparation and performance.

- Mental toughness: athletes with strong mental resilience can maintain focus and execute strategies under pressure.
- Confidence: confidence levels can influence decision making and risk-taking during competition.

Environmental conditions

Environmental conditions can change, and often this requires individuals and groups to change their strategies and tactics.

- Weather: conditions like wind, rain or heat can affect how strategies are applied, especially in outdoor sports.
- Venue: the characteristics of the venue, such as the type of surface or altitude, can also play a role.



Figure 7.31 A change in the environment can require a vastly different tactical approach.



Figure 7.32 Home ground advantage

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Opponent's strengths and weaknesses

The opponent's strengths and weaknesses are a major influence in determining the strategies and tactics that are used in sport. Elite teams and individuals will spend a lot of preparation time examining video of their opponents to determine their best chances of success. Information about opponents can also come from scouting reports, and past matches against the same opponent can provide insights into effective strategies and tactics.

Understanding the opponent's strengths and weaknesses allows a team to tailor their strategies and tactics to exploit vulnerabilities and counter strengths. Football teams will consider formations, key players and playing styles – tailoring tactics to exploit specific matchups can be crucial. Similarly, individual players on the team may focus on their likely opponent and consider their preferred kicking foot. Tennis players will examine their opponent's forehand versus backhand and preferred style of play. These strategies and tactics can be fluid and can change depending upon what is happening at the time.

Rules and regulations

In some sports, there are rule changes in the off-season to improve the quality of the games being played. Whether rules change or remain the same, being able to utilise the existing rules and any changes can give an individual or group an advantage.

- Sport-specific rules: different sports have unique rules that can influence strategic choices. For example, the offside rule in soccer influences how teams position their players.
- Changes in rules: updates or changes to rules can necessitate adjustments in tactics. For example, the NRL has changed the interchange rule. Initially, unlimited interchange rules were in place but these have been reduced to eight per game to bring a fatigue factor into the game to ideally increase the excitement of the sport. This change meant that coaches and teams needed to train and prepare in a very different way, requiring a reconsideration of their strategies and tactics.
- Refereeing style: the way a game is officiated can also impact on tactics. Some referees might allow more physical play, while others might call more fouls, affecting how aggressively teams play. At the FIFA World Cup and FIFA Women's World Cup, teams need to adapt to a range of referees who referee in their home country competitions and who may have language differences and interpret rules very differently. Being successful at this tournament can often mean adapting to this component.



Figure 7.33 Matchups can be critical to success.

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Coaching and support staff

Coaching staff can have a strong influence on the strategies and tactics used by athletes.

- Coaching philosophy: the coach's approach and philosophy can significantly impact on strategy.
- Support team: input from trainers, nutritionists and psychologists can refine and enhance strategic planning.
- Offensive vs. defensive mindset: coaches with a more offensive mindset might focus on aggressive tactics, while defensive-minded coaches might prioritise solid defence.
- Adaptability: some coaches prefer to stick to a set game plan, while others are more flexible and adjust tactics on the fly.



Figure 7.34 A coach is often the first to be blamed for poor results.

Technological advancements

Sport is always evolving in many ways. Technology is at the forefront of many of these changes.

- Equipment: advances in equipment can open new strategic possibilities. Developments in tennis racquets have changed the game of tennis immensely. Increased speed and power are now much more of a focus.
- Data analysis: modern sports heavily rely on data analytics to inform strategies. This includes player performance metrics, opponent analysis and situational statistics.
- Video analysis: reviewing game footage helps in understanding both one's own performance and the opponent's tendencies and patterns.

Game situation

Despite all the best planning in the world, sport is unpredictable. Therefore, strategies and tactics need to be flexible. Individuals and groups will often practise deliberate game scenarios, so they are prepared for those moments.

- Score and time: the current score and remaining time can influence whether an athlete adopts a more defensive or offensive approach. In many sports, the teams or individuals practise game scenarios to be prepared for these situations when they arise. For example, rugby union sides will prastice various plays for when they need to score a try in the final minutes to win a game, so that the players know their role and are not overwhelmed by the situation.
- Momentum: the flow of the game and momentum shifts can also impact strategic decisions.
- Stage of the competition: strategies might differ depending on whether it's a regular-season game, a play-off or a final.

Team composition

In group sports, the extra factor of multiple players can impact on the strategies and tactics employed.

- Player skills and roles: the individual skills and roles of players significantly impact the strategies employed. For instance, a team with strong defenders might focus on a defensive strategy.
- Team chemistry: how well players work together can influence tactical decisions. Teams with high chemistry might use more complex plays that require precise coordination.



Figure 7.35 The individual skills and roles of players significantly impact the strategies employed.

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Revise and summarise 7.4


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Identify five factors that influence how strategies and tactics are applied to individual and group sports.
2 How does an athlete's physical fitness level impact their strategic approach in individual sports?
3 Why is it important for athletes to study their opponents' strengths and weaknesses in individual sports?
4 How do weather and playing conditions influence the strategic choices in sports like tennis or golf?
5 How do team cohesion and communication impact the effectiveness of strategies in team sports?
6 How do different game scenarios (e.g. leading, trailing, tied) influence the tactical decisions made by a team?
7 How does understanding the opposing team's strategy help in formulating effective counter-tactics?

Think critically and apply 7.4

Consider at least one individual and one group sport from the following:

- weightlifting
- fencing
- 1500 m sprint
- high jump
- hockey
- softball
- AFL
- basketball.

Describe how the athletes might implement various strategies and tactics.

Skills: problem solving, research

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Chapter summary

INDIVIDUAL SPORTS

- **Training sessions** focus on personalised drills and exercises tailored to the athlete's specific needs. Emphasis is on technique, endurance and personal goals.
- **Yearly training programs** are highly customised, with cycles of preparation, competition and recovery tailored to the athlete's competition schedule. Emphasis is on peaking at the right times.
- **Psychological strategies** mean athletes often work on mental toughness, focus and self-motivation. Techniques like visualisation, goal setting and relaxation are common.
- **Strategies and tactics** are centred around the athlete's strengths and weaknesses, with a focus on optimising performance in specific events or matches.

GROUP SPORTS

- **Training sessions** involve team drills, coordination exercises and strategies that enhance team dynamics. Sessions often include small-sided games and group activities to build teamwork.
- **Yearly training programs** are structured around the team's competitive season, with phases for pre-season conditioning, in-season performance and off-season recovery. Focus is on maintaining team cohesion and collective performance.
- **Psychological strategies** place an emphasis on building team morale, communication and collective resilience. Strategies include team-building activities, group goal setting and fostering a positive team culture.
- **Strategies and tactics** involve coordinated plays, formations and strategies that leverage the strengths of the team. Emphasis is on teamwork, communication and adapting to opponents' strategies.

Multiple-choice questions

1 When designing a training session for a 100 m/200 m sprinter, which aspect is most important to focus on?
A team coordination
B personalised drills and exercises
C small-sided games
D team-building activities

2 Which aspect is crucial when designing a training session for a rugby league side?
A individual technique improvement
B personalised recovery plans
C team drills and coordination exercises
D self-motivation techniques

3 How is the yearly training program for individual sports typically structured?
A around the team's competitive season
B with cycles of preparation, competition and recovery tailored to the athlete's schedule
C focused on maintaining team cohesion throughout the year
D based on group activities and team-building exercises

4 What is a key focus in the yearly training program for group sports?
A personalised drills and exercises
B individual competition schedules
C pre-season conditioning, in-season performance and off-season recovery
D self-motivation and mental toughness

5 Which psychological strategy is commonly used in individual sports to manage stress and anxiety?
A team-building activities
B visualisation and relaxation techniques
C group goal setting
D coordinated team plays

6 How do group sports typically optimise arousal and manage stress during competitions?
A focusing solely on individual performance
B using team morale-building exercises and communication strategies
C emphasising personal goals and self-motivation
D practising individual drills and exercises

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7 Which factor primarily influences the strategies and tactics used in marathon running?
   A team dynamics and communication
   B the athlete's personal strengths and weaknesses
   C group coordination and teamwork
   D team morale and collective resilience

8 What is a key factor that influences the strategies and tactics in rugby union?
   A individual performance optimisation
   B personalised recovery plans
   C coordinated plays and formations
   D self-motivation techniques

Exam practice

How to answer an exam question

Example question

Describe TWO aspects to consider when designing a training session. (4 marks)

What is the question asking?

The key verb in this question is **describe**, which means you need to present the features and characteristics of the aspects you are talking about.

Note that the question asks you to write about **two** aspects to consider. While you may have knowledge of a range of aspects, you should choose just two to write about.

Marking criteria

Criteria	Marks
• Provides a description of TWO aspects to consider when designing a training session	4
• Outlines TWO aspects to consider when designing a training session	3
• Outlines ONE aspect to consider when designing a training session OR • Identifies TWO aspects to consider when designing a training session	2
• Provides some relevant information	1

Sample response

A training session should include skill practice (and instruction where necessary) to prepare athletes for competition. This includes sport-specific skills, and also teamwork and cooperation. The coach must be prepared to offer appropriate feedback.
The training session should include time for a three to four minute cool-down of light activity (e.g. walking, jogging) and whole-body static stretching. This will help reduce core temperature.



Video 7.1 Answering the exam question

Exam-style questions

1 Explain the difference between anxiety and arousal in terms of sporting performance. (4 marks)
2 Compare psychological strategies that an archer and a netballer would employ to improve participation and performance. (5 marks)
3 Explain the key differences in the structure of a yearly training program for individual and group sports. (4 marks)
4 Discuss the psychological strategies used in individual and group sports to manage stress and optimise performance. (8 marks)
5 Analyse how strategies and tactics are developed and implemented in individual and group sports. (8 marks)

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Chapter 8
Impact of sleep, nutrition and supplementation on movement and performance



After completing this chapter, you will be able to demonstrate knowledge of:

- the dietary and fluid intake requirements for athletes from various sports, focusing on their needs before, during and after performance
- how adequate sleep, proper nutrition and sufficient hydration can help minimise fatigue, enhance movement and prevent injuries
- how supplements, micronutrients, protein, caffeine and creatine products improve performance.

Key terminology

Syllabus terminology:
micronutrients

Other important terms:
osteopenia
osteoporosis
QQRT

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Driving questions

1 What specific changes do you make to your dietary intake to account for increased physical activity?
2 What are the specific reasons for each of these changes?
3 If an elite athlete were to regularly neglect their diet, in what ways would this be detrimental to their performance?

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Introduction

In addition to training and skill development, for an athlete to be able to move and perform at peak effectiveness, their body must also be in good condition. Nutrition is a key element of this, as is sleep. If there are any shortfalls, the athlete may be able to address these through the use of supplements.



Figure 8.1 Nutrition and sleep are key elements of ensuring the body is in good condition.

8.1 Dietary requirements of athletes

Learning objective 8.1
USE research to analyse the dietary and fluid requirements of athletes across a range of sports, before, during and after performance.

The dietary and fluid intake requirements of athletes are crucial components of their overall performance and recovery. Athletes from different sports have unique nutritional needs that vary based on the intensity, duration and type of activity they engage in. Understanding these requirements is essential for optimising performance, preventing injuries and ensuring quick recovery.

Before performance, athletes need to fuel their bodies with the right balance of carbohydrates, proteins and fats to provide sustained energy and enhance endurance. During performance, maintaining hydration and replenishing electrolytes are critical to prevent dehydration and maintain peak performance levels. Post-performance, the focus shifts to recovery, where the intake of proteins and carbohydrates helps repair muscle tissues and restore glycogen levels.

By analysing the specific dietary and fluid needs of athletes from various sports, we can develop tailored nutrition plans that support their training and competitive goals. This holistic approach ensures that athletes are well-prepared, perform at their best and recover efficiently, ultimately contributing to their long-term success and wellbeing.

The Australian Institute of Sport (AIS) offers an e-learning platform for further information around sports nutrition and supplements. The nutrition modules are available at Performance Nutrition HQ Modules | Australian Institute of Sport, and include: Nutrition Fundamentals, Training and Competition Nutrition, Hydration, Building Your Nutrition Plan, Supplements and Understanding Food Labels. It is estimated that each module takes approximately 20 minutes.

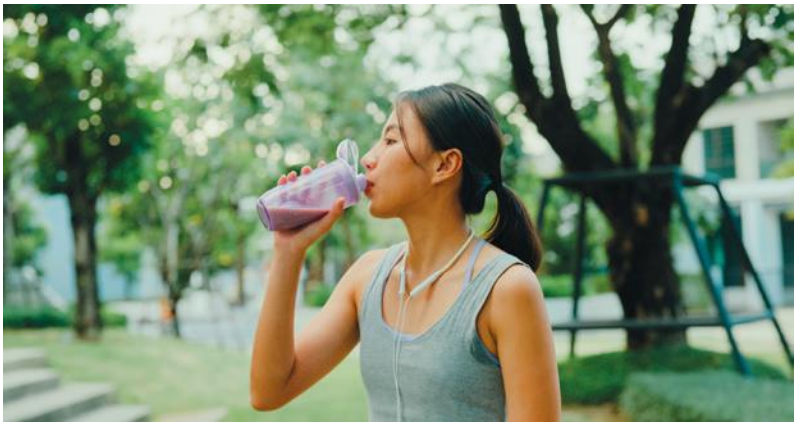


Figure 8.2 Runner drinking a protein shake after exercise workout

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Figure 8.3 Energy availability

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Figure 8.4 Factors that can make fuelling challenging

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Case study 8.1

Jemima Montag's nutritional journey

Jemima Montag is an Australian racewalker. She is a two-time Commonwealth Games champion, and at the 2024 Olympics, she won bronze medals in the 20 km walk and the marathon walk relay. Scan the QR code to see her talk about the importance of nutrition and challenges as a female athlete.



Video 8.1 Jemima Montag talks about her nutritional journey as a female athlete. (01:38)

Video 8.1 Jemima Montag talks about her nutritional journey as a female athlete. Scan the QR code to watch the video.

1 What was the first difference or challenge that Jemima mentioned?
2 What were the issues that Jemima had to consider in organising her nutrition for training and competition?
3 Why did her training plan involve three weeks with higher intensity followed by a 'deload' week?
4 What impact would the menstrual cycle have on a female athlete when competing or training and how could nutrition assist?

Skills: analysis

Pre-performance

Regardless of whether an athlete is eating to train or perform, there are several reasons why what the athlete eats and drinks is important. The aim of the training diet is to achieve nutritional adequacy (providing the body with the recommended intake of vitamins and minerals) and provide appropriate amounts of energy to support training and body composition goals. It is important that nutritional targets for athletes (such as total energy, protein and carbohydrate requirements) are based on an individual athlete's goal body weight and muscle mass, as this provides more specific targets. Essentially the pre-event meals aim to:

- fuel and hydrate the body for the exercise session or performance
- maximise the training session – quality and quantity of effort
- avoid stomach discomfort and unwanted toilet breaks
- meet body composition goals
- avoid hunger issues during the session or performance.

Carbohydrate intake

Carbohydrates (starches and sugars) are a key fuel source for exercise, especially during prolonged and high-intensity exercise. The body stores carbohydrate as glycogen in the skeletal muscles and liver; however, its storage capacity is limited. If athletes are not able to consistently provide adequate energy and carbohydrates in their training diet, this can lead to fatigue, inability to improve

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Figure 8.5 Carbohydrates are a key fuel source for exercise.

in training, poor concentration during training sessions, reduced immune system functioning and increased susceptibility to injury.

The amount of carbohydrate needed depends on the fuel needs of the athlete's training program, including the frequency, duration and intensity of the training. Training sessions and activity levels change from day to day, and carbohydrate intake needs to be adjusted to reflect this. On high-activity days, carbohydrate intake should be increased to provide the required fuel for the extra activity and promote recovery between sessions. Alternatively, on low- or no-training days, carbohydrate intake should be reduced to reflect the decreased training load.

- **light-intensity exercise (30 mins/day)**: 3 to 5 g/kg/day
- **moderate-intensity exercise (60 mins/day)**: 5 to 7 g/kg/day
- **endurance exercise (1 to 3 hrs/day)**: 6 to 10 g/kg/day
- **extreme endurance exercise (more than 4 hrs/day)**: 8 to 12 g/kg/day.

Carbohydrate loading

Carbohydrate loading refers to strategies that aim to maximise muscle glycogen stores prior to a competitive event (high carbohydrate intake combined with light training or rest). For events lasting for less than 60 minutes, there is no performance benefit associated with carbohydrate loading, and it may have a negative effect on performance in short-duration events at high intensity. Provided the athlete has only engaged in light exercise or rested for the 24–36 hours prior to the event, adequate glycogen stores will be achieved with an intake of around 5 grams of carbohydrate per kilogram of body weight over this period.

For endurance events lasting more than 90 minutes, such as marathons, triathlons, long-distance swimming, cross-country skiing and road race cycling, effective carbohydrate loading can improve overall performance by 2–3%.

Traditional carbohydrate loading protocols consisted of a three- to four-day 'depletion phase' involving hard training and a low-carbohydrate diet, followed by a three- to four-day 'loading phase', which involved tapered training and a high-carbohydrate diet. More recent studies have shown that glycogen stores can be increased to the same levels by following a high-carbohydrate diet for 36–48 hours while the athlete is rested. The recommended carbohydrate intake to achieve effective carbohydrate loading is 8–12 grams per kilogram of body weight.

If athletes have followed an effective carbohydrate loading plan, they typically experience weight gain (usually about 1 kilogram). This is due to the increased glycogen in the muscles and extra water, which is stored with the glycogen. Athletes need to be informed that this weight gain is a sign that they have effectively increased their glycogen stores and is not an increase in body fat. The fear of weight gain may prevent some athletes from carbohydrate loading.



Figure 8.6 For endurance events such as road race cycling, effective carbohydrate loading can improve overall performance by 2–3%.

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Hydration

Hydration before the event needs to be planned carefully and should start many hours before the event commences. As a guide, athletes should include 300–600 millilitres of fluid with the pre-event meal and another 300–400 millilitres approximately 20 minutes before the event, allowing enough time for a toilet stop if needed. Fluids should also be sipped regularly between the pre-event meal and the starting time, and using fluids that contain sodium will help fluid absorption. It is important for athletes to keep a drink bottle with them to help prompt them to consume enough fluid, as many athletes forget to hydrate well due to nerves, organising equipment or going over tactics/race strategy with coaches.

The pre-event meal

The aim of the pre-event meal is to ensure the athlete's glycogen stores are topped up and they are well hydrated. Establishing a good pre-event meal, which provides the right nutrients and fluids, provides psychological benefits for athletes as they know they have prepared well. This meal should be:

- high in carbohydrates – maximising fuel stores
- moderate in protein
- low in fibre – especially to avoid gut upset issues
- low in fats – foods high in fat take longer to digest
- familiar – don't experiment on event day.

The following foods are suitable to eat three to four hours before exercise:

- crumpets with jam or honey + flavoured milk
- pancakes with honey or maple syrup
- baked potato + cottage cheese + glass of milk
- baked beans on toast
- breakfast cereal with milk
- bread roll with cheese/meat filling + banana
- fruit salad with fruit-flavoured yoghurt
- pasta or rice with a sauce based on low-fat ingredients (e.g. tomato, vegetables, lean meat).



Figure 8.7 Crumpets with honey are suitable to eat three to four hours before exercise.

The following snacks are suitable to eat one to two hours before exercise:

- liquid meal supplement
- milkshake or fruit smoothie
- sports bars (check labels for carbohydrate and protein content)
- low-fibre breakfast cereal (rice bubbles/cornflakes) with milk
- cereal bars
- fruit-flavoured yoghurt
- fruit.

Some of the glycogen stores in the liver are released overnight to provide glucose for the brain, as the brain remains quite active during sleep. Athletes who compete in events that have early morning starts (such as some triathlons or endurance events) need to be aware of this and develop a nutritional plan such as getting up extra early to ensure they have time for an adequate breakfast or planning a high-carbohydrate snack within one to two hours of the event starting time. This enables them to top up the glycogen losses in the liver that occur during an overnight fast.

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During performance

The most important factor when considering whether carbohydrate intake during exercise will improve performance is the duration of the exercise. Table 8.1 summarises the time windows recommended for eating and drinking during exercise.

It is important that athletes plan their food and fluid intake carefully to meet carbohydrate targets during exercise. In endurance events, where a consistent carbohydrate intake is needed over many hours, it is important to think about the type of carbohydrate the athlete is going to consume. Repeatedly having the same type of sugars from sports drinks or energy gels can cause athletes to experience symptoms such as stomach cramps, bloating, the need to go to the toilet and potentially diarrhoea. A combination of 'sports foods' (such as gels and sports drinks) and real foods (fruit, muesli/sports bars, low-fibre sandwiches) is best tolerated. Another benefit of using a mix of sports foods and real foods is that the foods the athlete eats during the event can also be a good source of key electrolytes such as sodium, potassium and magnesium to help with hydration.

It is important that athletes carefully plan their food and fluid intake according to the event and identify where they will have opportunities to eat and drink. Consider a triathlon, for example: there is no opportunity for athletes to carry or consume food during the swim leg. However, athletes can carry more food and eat more easily on the bike than during the run leg.

It is very important that athletes train their diets to make sure the foods and drinks they plan to have during the event are well tolerated and don't result in any stomach upset, as this can significantly affect performance and may result in the athlete not even finishing the race. The general advice is not to try anything new on event day.



Figure 8.8 A triathlete is given a piece of banana during the cycling phase.

Table 8.1 Recommended time windows for eating and drinking during exercise

Duration	Carbohydrate targets	Examples of activities
Sessions shorter than 60–90 minutes	Typically, no need for extra carbohydrate Small amounts of fluid depending on sweat rates	5–10 km run Sprint triathlon
Sessions lasting longer than 90 minutes	Benefits to topping up fuel stores during the session Potential for dehydration depending on weather Fluid intake depends on sweat rate	Marathon Olympic triathlon Team sports
Ultra-endurance events longer than 4 hours	Unique fuelling and hydration requirements	Ironman Trail running
Multi-day events	Glycogen stores will gradually deplete over the duration of the competition Important to consume carbohydrates during and between sessions Potential for dehydration	Gala days Team sport tournaments

Source: Sports Dietitians Australia, 'Eating & Drinking during Exercise'

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Hydration

It is important that athletes are educated about hydration, and that any fluids provided to athletes are cool, palatable and conveniently available, or they will not be consumed. Research has shown that athletes typically only replace 30–70% of sweat lost during exercise.

Fluid requirements vary significantly between athletes and between exercise situations. Fluid losses are affected by:

- genetics – some people sweat more than others
- body size – larger athletes tend to sweat more than smaller athletes
- fitness – fitter people sweat earlier in exercise and in larger volumes
- environment – sweat losses are higher in hot, humid conditions
- exercise intensity – sweat losses increase as exercise intensity increases.

When planning for an endurance event, athletes should carefully monitor their fluid intake during training and try to simulate race conditions (intensity, duration and environmental conditions) where possible. Negative effects on performance start to occur at just 2% dehydration, so athletes should aim to keep their fluid losses to less than this. The potential effects of mild dehydration include:

- reduced mental function leading to poor concentration
- increased ratings of perceived exertion leading to feelings of fatigue at lower intensity
- delayed gastric emptying from the stomach leading to stomach discomfort
- poor aerobic performance
- impaired heat regulation.

By recording body weight immediately before and after exercise (with minimal clothing, if any) athletes will get a reasonably accurate idea of their fluid losses as a 1 kilogram loss in weight reflects approximately 1 litre of fluid loss.

For example, if an athlete weighs 70 kilograms before exercise and 68 kilograms after, the 2-kilogram loss of weight reflects their overall fluid losses over that exercise session (a 2.9% loss). It is also important to record any fluid the athlete has consumed over that session in order to calculate the overall sweat rate and develop a hydration plan according to this.

Over-hydrating

Consuming fluid in excess of requirements may cause some gastrointestinal discomfort and can lead to hyponatraemia (low blood sodium levels), which causes symptoms similar to dehydration and is potentially life-threatening. Hyponatraemia is unlikely to occur in events of less than two- or three-hours' duration, and athletes are at risk when large volumes of low-sodium drinks (such as water) are consumed when sweat losses are small. Those most susceptible to hyponatraemia are small females who have long race times (more than three or four hours), as these athletes tend to have relatively small sweat losses and plenty of time to consume large amounts of fluid during the event. As a result, structured hydration plans are often not advisable for these athletes.

The best way to prevent hyponatraemia is to focus on consuming sodium-containing fluids such as sports drinks and sodium-containing foods such as vegemite sandwiches, as well as limiting fluid intake to no more than sweat loss.



Figure 8.9 Staying hydrated during the Boston Marathon

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Post-performance

Recovery nutrition has received much attention and has been heavily researched in recent decades. Immediately following exercise, the activity of enzymes involved in refuelling (synthesising and storing glycogen) and repairing (repair of damaged muscle tissue and building of new muscle tissue) is increased significantly. Therefore, the aim of the recovery meal/snack is to provide carbohydrate to refuel and protein to repair muscle tissue as well as fluid to correct any dehydration. It also aims to boost adaptation from the training sessions and support immune function.

Rehydrating should commence immediately post-exercise.

The need for carbohydrates and protein will depend on the time of the next exercise session. The body is effective at replacing carbohydrates and promoting muscle repair and growth within the first 60–90 minutes post-exercise. Athletes are encouraged to consume foods and drinks that provide 1–1.2 grams of carbohydrate per kilogram of body weight within the first hour of finishing. This is especially important if the time between prolonged training sessions is less than eight hours. High glycaemic index carbohydrate foods have been shown to refuel muscle and liver glycogen stores more quickly, and these should be the basis of the carbohydrate consumed within the first hour. This meal should also be low in fibre, as this will slow the digestion and absorption of carbohydrate. Conveniently, the majority of high-glycaemic carbohydrates are low in fibre.

Search for the glycaemic index of different carbohydrates on the University of Sydney website (see https://cambridge.edu.au/redirect/11400).

A small amount of protein is also important for muscle recovery, especially after high-intensity sports and strength training. Athletes should aim to have approximately 15 grams of protein following high-intensity exercise, and recent research suggests that the optimal amount following strength training and power-based sports is about 300 milligrams of protein per kilogram of ideal body weight (21 grams of protein based on a 70-kilogram athlete).

Examples of low-fibre recovery meals that provide carbohydrate and protein include:

- milkshakes/smoothies
- liquid meal supplements based on milk
- yoghurt and fruit salad
- crumpets/muffins/toast with jam or honey with 300 millilitres of milk
- bowl of low-fibre cereal with milk
- chicken and salad roll
- tuna and crackers
- burrito.



Figure 8.10 Chocolate milk is an excellent recovery drink.

After high-intensity exercise, the immune system can be suppressed for many hours. Consuming a suitable recovery meal has been shown to improve the functioning of the immune system, which is important to help prevent athletes catching infectious illnesses.

Athletes need to think practically about their day-to-day training schedules and plan recovery meals accordingly. If athletes have only completed a short training session or trained at a low intensity, then it is highly unlikely that they have completely used their glycogen stores and therefore do not require such a high-carbohydrate recovery meal. If athletes routinely consume more carbohydrate than they need, it may lead to unwanted weight gain, which will hamper performance.

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Different needs depending on sport

Different sporting events vary significantly in their intensity and duration, as do athletes' nutritional needs in different sports. To highlight the extent of the different fuel needs of different sports, compare cyclists competing in the Tour de France with athletes in low-intensity and short-duration sports such as archery. The energy needs of cyclists in the Tour de France can be as high as 30 000 kilojoules a day on the longer-duration and higher-intensity stages, and may average 20 000–25 000 kilojoules a day over the 21-day event. An archer will not require significantly more energy (or carbohydrate) than their typical daily intake of 8000–10 000 kilojoules (depending on gender and normal weight).

Activity 8.1

Different needs depending on sport

1 Consider the sports in the table below and tick or cross the boxes appropriate for each sport.

Sport	Do they need a high-carbohydrate pre-event meal?	Will carbohydrate during the event improve performance?	Do they need a specific recovery meal after performance?
Elite ironman triathlete (9–10 hours duration)			
Midfield player in soccer match (90 minutes duration)			
Sprinter (100 m and only one race in a day)			
A competitive surfer in a 35-minute heat (only one heat per day)			
Elite rower (competing in two heats and a final in one day)			

2 Explain why you have ticked the boxes you have.
3 What sort of foods and drinks would you use for each of the boxes you have selected for the different sports?

Skills: analysis



Figure 8.11 Rowers need high carbohydrate diets to sustain energy and maintain peak performance.

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Practical application 8.1

1 Access a range of pre-packaged foods designed and marketed for athletes. What are the carbohydrate, fat and protein content of each and is it suitable for athletes?
2 With a partner, compare the major sports drink providers and their value for athletes.

Skills: research, collaboration, analysis

Quiz

Revise and summarise 8.1

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What is carbohydrate loading?
2 Outline the pre-performance nutritional needs of athletes.
3 Outline the nutritional and hydration needs of athletes while competing.
4 Outline the post-performance nutritional needs of athletes.

Depth Study

Think critically and apply 8.1

1 Compare the dietary requirements of a power athlete and an endurance athlete.
2 Research an elite athlete and their nutritional plan.

Skills: research



Figure 8.12 Yoghurt and fruit salad can be a low-fibre recovery meal.

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8.2 Reducing fatigue and influencing movement and injury prevention

Learning objective 8.2
EXPLAIN how sleep, nutrition and hydration can help to reduce fatigue, influence movement and prevent injury.

Sleep

Sleep plays a crucial role in reducing fatigue and positively influencing movement and injury prevention. Here's how:

Reducing fatigue

- Restoration and recovery: during sleep, the body undergoes various restorative processes, including muscle repair, protein synthesis and the release of growth hormones. This helps in reducing overall fatigue and replenishing energy levels.
- Cognitive function: adequate sleep improves cognitive functions such as attention, decision-making, and reaction times. This mental sharpness helps in reducing the feeling of fatigue during the day.
- Mood regulation: quality sleep helps in regulating mood and reducing stress, which can contribute to a feeling of overall wellbeing and reduced fatigue.



Figure 8.13 Sleep is crucial for efficient movement.

Positive influence on movement

- Muscle coordination: sleep enhances muscle coordination and motor skills. This is essential for smooth and efficient movement, whether in daily activities or athletic performance.
- Reaction time: well-rested individuals have faster reaction times, which is crucial for activities that require quick responses, such as sports or driving.
- Balance and stability: adequate sleep improves balance and stability, reducing the risk of falls and improving overall movement efficiency.

Injury prevention

- Muscle repair and growth: sleep is a critical time for muscle repair and growth. This helps in maintaining muscle strength and flexibility, reducing the risk of injuries.
- Inflammation reduction: quality sleep helps in reducing inflammation in the body, which can lower the risk of chronic injuries and pain.
- Improved focus and coordination: with better cognitive function and muscle coordination, individuals are less likely to make mistakes that could lead to injuries.

In summary, getting enough quality sleep is essential for reducing fatigue, enhancing movement and preventing injuries. It's a key component of overall health and wellbeing. How has your sleep been lately?

Guidelines

The QQRT protocol is outlined by Dr Matthew Walker in his website *Sleep Diplomat* (https://cambridge.edu.au/redirect/11401). It identifies four key elements of getting a good night's sleep:

QQRT the four sleep fundamentals: quantity, quality, regularity and timing

- **Quantity (total amount of sleep)**
  The typical adult needs between seven and nine hours sleep each night.

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- **Quality (continuity of sleep)**
  Frequent awakenings or fragmented sleep represents poor sleep quality.
- **Regularity (a consistent sleep schedule)**
  Going to bed at the same time and waking up at the same time each day leads to improved sleep patterns. Going to bed a maximum of 30 minutes before or after this time should be the aim.
- **Timing (aligning sleep schedule with your chronotype)**
  Some people need to go to bed early in the evening and others later in the night. Finding out your chronotype and managing sleep around this can increase the quality of sleep.



Figure 8.14 Hitting the snooze button

Practical application 8.2

Complete a sleep questionnaire that helps to determine your optimal sleep timing, available online at https://qxmd.com/calculate/calculator_829/morningness-eveningness-questionnaire-meq.

1 What did you discover about your sleep timing?
2 Do you need to alter your sleep habits after completing this questionnaire?
3 If you needed to improve one area of QQRT, which would you start with and why?

Skills: analysis

Planning and routines

Here are some guidelines to help you get a good night's sleep:

- Have any caffeine early in the day.
- In the evening dim the lights.
- Limit screen time prior to bedtime.
- Add blackout curtains or wear a sleep mask.
- Keep your bedroom cool.
- Take a warm bath or shower before bed.
- Don't eat too close to bedtime.
- Avoid excessive fluid intake before bed.
- Have a wind-down routine.
- Upon waking, go outside for 10 minutes.

Source: Huberman Lab

Monitoring

Sleep trackers are devices designed to monitor and analyse your sleep patterns. They collect data on various aspects of your sleep, such as:

- **Sleep duration:** how long you sleep each night
- **Sleep quality**: how restful your sleep is, including periods of wakefulness and restlessness
- **Sleep stages**: the different phases of sleep you go through, such as light sleep, deep sleep and REM (rapid eye movement) sleep
- **Heart rate**: your heart rate throughout the night
- **Breathing rate**: how often you breathe while sleeping
- **Blood oxygen levels**: the amount of oxygen in your blood
- **Body movements**: how much you move during sleep
- **Environmental factors**: conditions like room temperature and noise levels.

These devices can be **wearable** (like wristbands, rings or headbands) or **non-wearable** (such as sensors placed under your mattress or on your bedside table).

Sleep trackers can help you understand your sleep patterns and identify areas for improvement. They often come with apps that provide insights and recommendations to enhance your sleep quality.

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However, while sleep trackers offer valuable data, they are not as precise as medical sleep studies. A medical sleep study, also known as polysomnography, is a comprehensive test used to diagnose sleep disorders. Here's what it typically involves:

1 **Preparation:** You'll be asked to avoid caffeine and alcohol on the day of the test. You might also be instructed to wash your hair but avoid using any hair products.
2 **Arrival at the sleep centre:** You'll arrive at a sleep centre in the evening. The environment is designed to be comfortable and ressemble a hotel room.
3 **Attachment of sensors**: Technicians will attach sensors to your scalp, temples, chest and legs using a mild adhesive. These sensors monitor various physiological parameters, including:
   – brain waves (EEG)
   – eye movements (EOG)
   – muscle activity (EMG)
   – heart rate (ECG)
   – breathing patterns
   – oxygen levels in the blood.
4 **Monitoring during sleep**: You'll sleep in the centre overnight while the sensors record your body's activities. The data collected helps identify any disruptions or abnormalities in your sleep patterns.
5 **Post-study analysis**: After the study, a sleep specialist will analyse the data to diagnose any sleep disorders, such as sleep apnoea, restless legs syndrome, narcolepsy or insomnia.
6 **Follow-up**: Based on the results, your doctor will discuss treatment options or further steps to improve your sleep quality.



Figure 8.15 Sleep study participant

Nutrition

Nutrition plays a crucial role in reducing fatigue, enhancing movement and preventing injuries. Here are some key ways it can help:

Reducing fatigue

- Balanced diet: consuming a balanced diet with the right proportions of carbohydrates, proteins and fats ensures sustained energy levels throughout the day.
- Hydration: staying well hydrated is essential as even mild dehydration can lead to fatigue. Aim for at least eight glasses of water a day, more if you're active.
- Iron-rich foods: iron is vital for oxygen transport in the blood. Foods like spinach, red meat and lentils can help prevent iron-deficiency anaemia, a common cause of fatigue.
- B vitamins: these vitamins, especially B12 and B6, are crucial for energy production. Include sources like whole grains, eggs and dairy in your diet.

Enhancing movement

- Protein intake: adequate protein is necessary for muscle repair and growth. Lean meats, fish, beans and nuts are excellent sources.
- Omega-3 fatty acids: found in fish like salmon and flaxseeds, omega-3s help reduce inflammation and improve joint health, aiding smoother movement.
- Antioxidants: foods rich in antioxidants, such as berries and leafy greens, help reduce oxidative stress and muscle soreness, enhancing recovery and performance.

Injury prevention

- Calcium and vitamin D: these nutrients are essential for bone health. Dairy products, fortified plant milks, and sunlight exposure can help maintain strong bones.
- Magnesium: this mineral supports muscle function and can prevent cramps. Include nuts, seeds and whole grains in your diet.
- Anti-inflammatory foods: incorporating foods like turmeric, ginger and green tea can help reduce inflammation and lower the risk of injury.

By focusing on a nutrient-rich diet, you can significantly improve your energy levels, movement efficiency, and reduce the risk of injuries.

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Guidelines

A set of guidelines for nutrition can be found in the *Australian Guide to Healthy Eating*, published by the Department of Health and Ageing.



Figure 8.16 Australian dietary guidelines

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Planning and routines

Many athletes 'meal prep' to make it easier for them to achieve their nutritional goals. Meal prepping is a fantastic way to save time, eat healthier and reduce stress during busy weeks. Here are some tips and ideas:

1 Plan your meals: decide what to eat for the week. This can include breakfast, lunch, dinner and snacks.
2 Make a shopping list: write down all the ingredients needed and stick to the list to avoid impulse buys.
3 Batch cooking: cook large batches of staples like grains, proteins and vegetables. Portion them out into containers for easy grab-and-go meals.
4 Use versatile ingredients: choose ingredients that can be used in multiple dishes to keep things interesting.
5 Invest in good containers: use airtight containers to keep your meals fresh. Glass containers are great for reheating.



Figure 8.17 Containers are a great help in meal planning.

For example:

- Breakfast: overnight oats, smoothie packs, egg muffins or chia pudding.
- Lunch: salads, quinoa bowls, or wraps.
- Dinner: stir-fries or casseroles.
- Snacks: veggie sticks with hummus, yoghurt with fruit, or homemade energy bars.

Monitoring

Monitoring nutrition can be a great way to ensure an athlete is meeting their health and performance goals. Here are some effective methods to help keep track:

1 Use nutrition-tracking apps.
There are several apps designed to help you monitor your food intake and nutritional values. Some popular ones include:
   – MyFitnessPal: tracks calories, macronutrients and exercise.

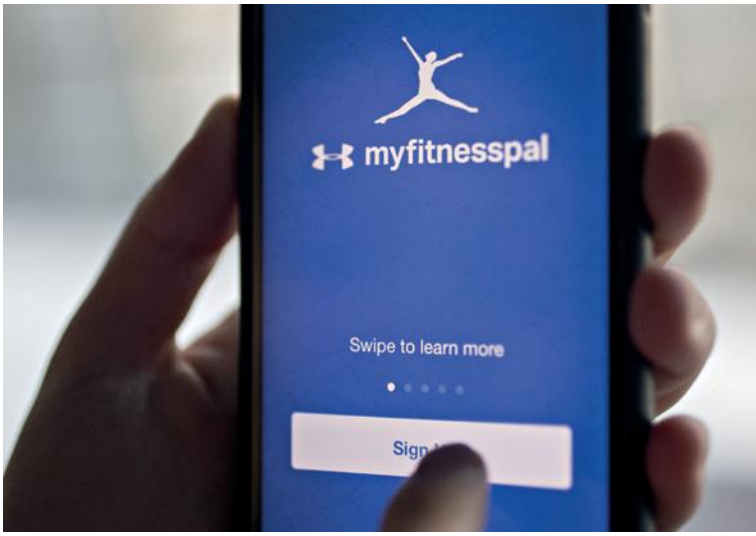


Figure 8.18 My Fitness Pal for tracking calories

   – Cronometer: offers detailed tracking of micronutrients and syncs with various fitness devices.
   – Lose It!: focuses on calorie counting and weight loss goals.
2 Keep a food diary.
Writing down what you eat and drink can be very insightful. You can do this on paper, on your computer or using a digital device. Note the portion sizes, times you ate and any relevant activities or feelings.
3 Read nutrition labels.
Pay attention to the Nutrition Facts labels on packaged foods. This can help you monitor your intake of calories, fats, sugars and essential nutrients like fibre, vitamins and minerals.
4 Consult a registered dietitian.
A dietitian can provide personalised advice and help you set realistic nutrition goals. They can also assist with monitoring and evaluating your progress.
5 Use online resources.
Websites like MyPlate, Eat for Health and the Australian Guide to Healthy Eating can offer valuable information on making healthier food choices.

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Hydration

Hydration plays a crucial role in maintaining overall health and optimising physical performance. Here's how staying well hydrated can help reduce fatigue, improve movement and prevent injuries:

Reducing fatigue

- Maintains energy levels: proper hydration helps maintain blood volume, allowing efficient transport of oxygen and nutrients to muscles. This can prevent early onset of fatigue during physical activities.
- Regulates body temperature: staying hydrated helps regulate body temperature, which is essential for preventing heat-related fatigue, especially during intense exercise or hot weather.

Improving movement

- Lubricates joints: water is a key component of synovial fluid, which lubricates joints and reduces friction. This can enhance flexibility and ease of movement.
- Supports muscle function: adequate hydration ensures that muscles are well-nourished and can contract efficiently, improving overall movement and coordination.

Preventing injuries

- Maintains muscle elasticity: hydrated muscles are more elastic and less prone to strains and tears. Dehydration can lead to muscle cramps and stiffness, increasing the risk of injury.
- Enhances recovery: proper hydration aids in the removal of waste products from muscles and tissues, speeding up recovery and reducing the likelihood of overuse injuries.

Guidelines

Staying hydrated is crucial for maintaining good health. The current recommendation in Australia is that adult men should be drinking 2500 mL (10 glasses) and women 2000 mL (8 glasses) per day. Athletes will have increased demands on these recommendations, depending on:

- Exercise: increase your fluid intake to compensate for the water lost through sweat.
- Environment: hot or humid weather can increase your need for fluids. High altitudes can also lead to dehydration.
- Health conditions: illnesses like fever, vomiting or diarrhoea require more fluids. Conditions like bladder infections or urinary tract stones also necessitate increased fluid intake.
- Pregnancy and breastfeeding: additional fluids are needed to stay hydrated during these times.

Planning and routines

Staying hydrated is essential for overall health and wellbeing. Here are some effective hydration routines to help you maintain optimal hydration throughout the day:

1. Start your day with water: drink a glass of water first thing in the morning to kickstart your metabolism and rehydrate after a night's sleep.
2. Drink before meals: having a glass of water before each meal can help with digestion and may even aid in controlling your appetite.
3. Carry a water bottle: always keep a reusable water bottle with you. This makes it easier to sip water throughout the day, whether you're at work, running errands or exercising.
4. Set reminders: use a smartphone app or set alarms to remind you to drink water regularly. This can be especially helpful if you tend to forget to hydrate.
5. Flavour your water: if plain water isn't appealing, try adding natural flavours like lemon, cucumber or mint. This can make drinking water more enjoyable.



Figure 8.19 Water bottles come in all shapes and sizes.

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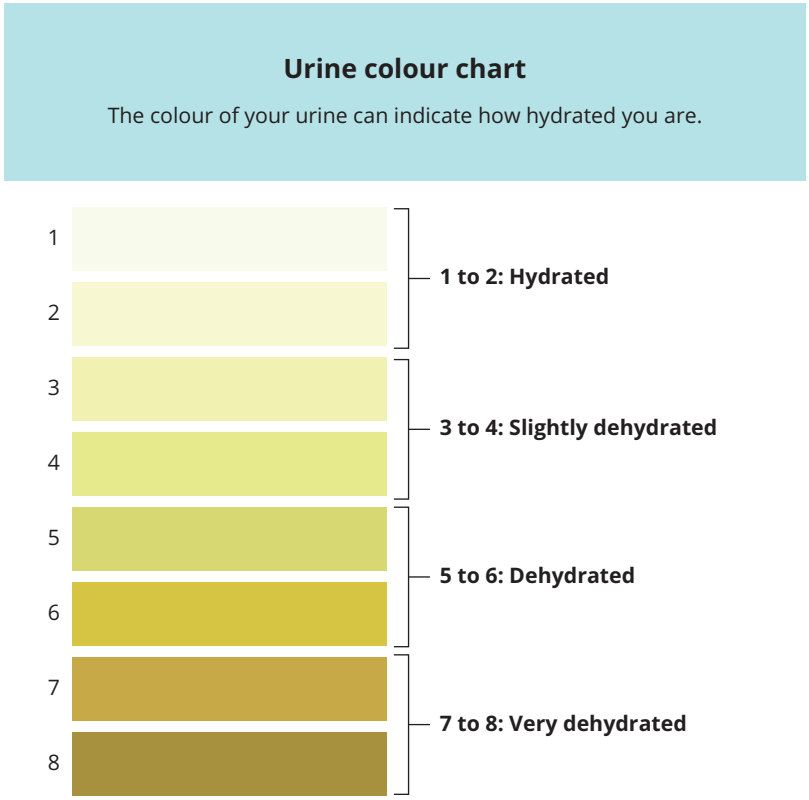




Figure 8.21 If plain water isn't appealing, try adding natural flavours

Figure 8.20 You can use this colour chart to check how hydrated you are.

6 Eat water-rich foods: incorporate fruits and vegetables with high water content into your diet, such as cucumbers, oranges and watermelon.
7 Hydrate during and after exercise: drink water before, during and after physical activity to replace fluids lost through sweat.
8 Track your intake: keep track of how much water you drink each day. This can help you stay accountable and ensure you're meeting your hydration goals.

Monitoring

Monitoring fluid intake is crucial for maintaining good health, especially for individuals with specific medical conditions or those at risk of dehydration or fluid overload such as athletes. Here are some key points to consider:

Why monitor fluid intake?

- Prevent dehydration: ensuring adequate fluid intake helps prevent dehydration, which can cause symptoms like dry mouth, excessive thirst and dark urine.
- Manage medical conditions: conditions like kidney disease, heart disease and certain medications (e.g. diuretics) require careful monitoring to avoid complications.
- Balance fluid levels: maintaining a balance between fluid intake and output is essential for overall health and can prevent issues like edema (swelling due to fluid retention) and electrolyte imbalances.

How to monitor fluid intake

1 Track all fluids consumed: this includes water, beverages, and foods that are liquid at room temperature (e.g. ice cream, gelatin).
2 Measure accurately: use a graduated container to measure the volume of fluids consumed.
3 Record intake: keep a daily log of all fluids consumed to ensure you meet your hydration goals.

Tools for monitoring

- Hydration apps: these can help track your daily fluid intake and remind you to drink water.
- Smart water bottles: some bottles track your water intake and sync with your smartphone.
- Urine colour charts: these provide a visual guide to assess hydration levels based on urine colour.
- Urine specific gravity test: a measurement of the concentration of solutes in urine. See https://cambridge.edu.au/redirect/11402.

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Quiz

Revise and summarise 8.2

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 How does sleep quality affect physical performance and movement?
2 What are the consequences of sleep deprivation on coordination and reaction time?
3 How does the duration of sleep impact muscle recovery and growth?
4 How do different macronutrients (proteins, fats, carbohydrates) affect energy levels and movement efficiency?
5 How does timing of meals and snacks influence energy availability and exercise performance?
6 How does hydration level influence muscle function and endurance?
7 What are the effects of dehydration on physical performance and cognitive function?

Think critically and apply 8.2

1 How does lack of sleep affect your ability to perform physical activities like sports or exercise?
2 What is the relationship between sleep and muscle recovery after a workout?
3 How can poor sleep patterns increase the risk of injuries during physical activities?
4 What are the signs of dehydration, and how can it impact your physical performance?
5 Why is it important to maintain proper hydration for joint health and flexibility?
6 What roles do vitamins and minerals play in keeping your muscles and body functioning well during exercise?
7 How does eating at the right times before and after exercise affect your performance and recovery?

Skills: analysis



Figure 8.22 Staying hydrated is crucial for maintaining good health.

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8.3 Using supplements and other products to improve performance

Depth Study

Learning objective 8.3

DISCUSS how supplements, micronutrients, protein, caffeine and creatine products can be used to improve performance.

Supplements

Although there is no universal definition of what constitutes a 'supplement' in sport, the AIS has proposed the following working definition:

> **Supplement:** single or multi-ingredient product in powder, limited volume liquid, pill or capsule form providing nutrients or other dietary components to achieve a specific health and/or performance benefit.

Australian Institute of Sport, 'AIS Sports Supplement Framework Position Statement: Contextual Information'

The AIS divides supplements into four groups depending on the level of research and legality of the product.

Group A and B supplements are recommended for use by athletes, Group C supplements are not recommended for use, and Group D supplements are banned.

Group A

Group A supplements are those for which there is strong scientific evidence for use in specific situations in sport using evidence-based protocols.

This includes:

- sports foods (e.g. sports drinks) which in some circumstances can be a more convenient or practical source of nutrients than a regular diet
- medical supplements (e.g. iron) being used to address clinical issues, including nutrient deficiencies. This should be done in consultation with a medical professional or sports dietician.
- performance supplements (e.g. caffeine – see below) that help an athlete perform at an optimum level. The AIS recommends using these under the guidance of an Accredited Sports Dietician.

Group B

Group B supplements are those for which there is emerging scientific evidence that they are both effective and safe. They require more research before they can be considered Group A supplements, but the AIS says they can be 'considered for use by identified individual athletes within research or clinical monitoring situations'.

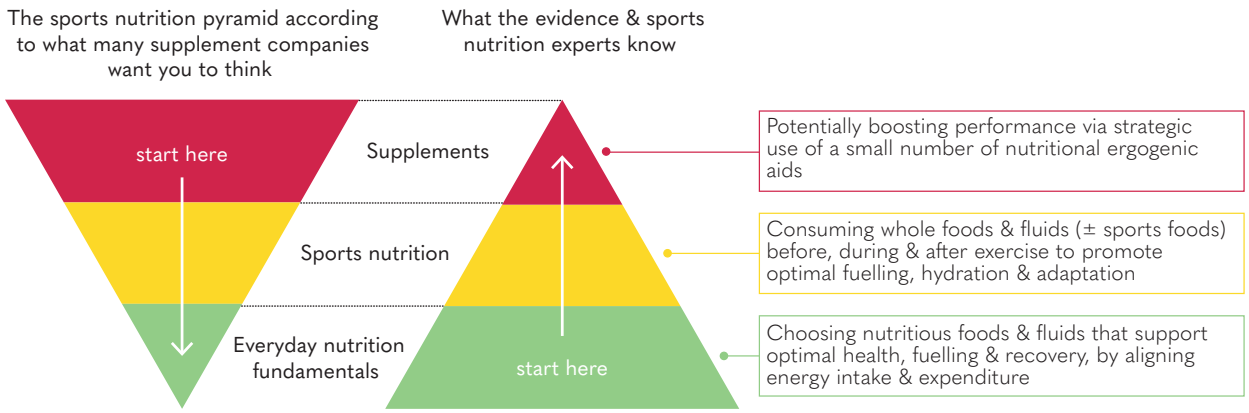


Figure 8.23 Visual overview of the AIS Supplement Framework

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Examples of Group B supplements include:

- food polyphenols which may have antioxidant or anti-inflammatory properties
- antioxidants (e.g. vitamin C) which protect against free-radical chemicals causing oxidative damage to the body
- tastants (e.g. pickle juice) which can help the central nervous system to activate
- other compounds which may potentially benefit the metabolism, body function and/or integrity (e.g. fish oil).

Group C

Group C supplements are those for which the AIS considers there is insufficient scientific evidence of benefits. These supplements are not recommended for use, although they 'may be permitted for use by identified athletes where there is specific approval from, or reporting to, a Sports Supplement Panel'.

Group C supplements include magnesium, prebiotics and phosphate.

Group D

Group D supplements include stimulants, hormone boosters, peptides and selective androgen receptor modulators (SARMs). These supplements are banned, and should not be used by athletes.

Micronutrients

Vitamin dietary requirements

Vitamins are a group of micronutrients that are only required in small amounts, and do not provide any energy in the form of kilojoules or calories. Although vitamins don't directly provide any energy, many vitamins play essential roles in the breakdown and metabolism of macronutrients (fats, carbohydrates, protein and alcohol) to produce energy. As well as their involvement in energy-production pathways, vitamins also play a key role in the building and repair of tissue and immune function.

Most vitamins are essential, as they are unable to be synthesised by the body, and therefore must be provided through a balanced diet. There are two groups of vitamins: fat-soluble vitamins (vitamins A, D, E and K) and water-soluble vitamins (all B vitamins and vitamin C).



Figure 8.24 The vitamin market is big business.

Table 8.2 Key vitamins for athletic performance

Vitamin	Contribution to athletic performance
Vitamin A	supports vision, immune function and cell growth, important for maintaining healthy skin and tissues
Vitamin B1 (Thiamine)	helps convert carbohydrates into energy, essential for muscle function and nerve signalling
Vitamin B2 (Riboflavin)	involved in energy production and helps maintain healthy skin and eyes
Vitamin B3 (Niacin)	supports energy production and DNA repair and helps reduce fatigue
Vitamin B6	important for protein metabolism and the production of neurotransmitters
Vitamin B12	essential for red blood cell formation, DNA synthesis and maintaining nerve health
Vitamin C	acts as an antioxidant, supports immune function, and aids in collagen synthesis for healthy joints
Vitamin D	crucial for bone health, muscle function and immune system regulation
Vitamin E	functions as an antioxidant, protecting cells from oxidative damage
Vitamin K	important for blood clotting and bone health

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The AIS has released two-page infographics on a number of different vitamins, as part of its Sports Supplement Framework.

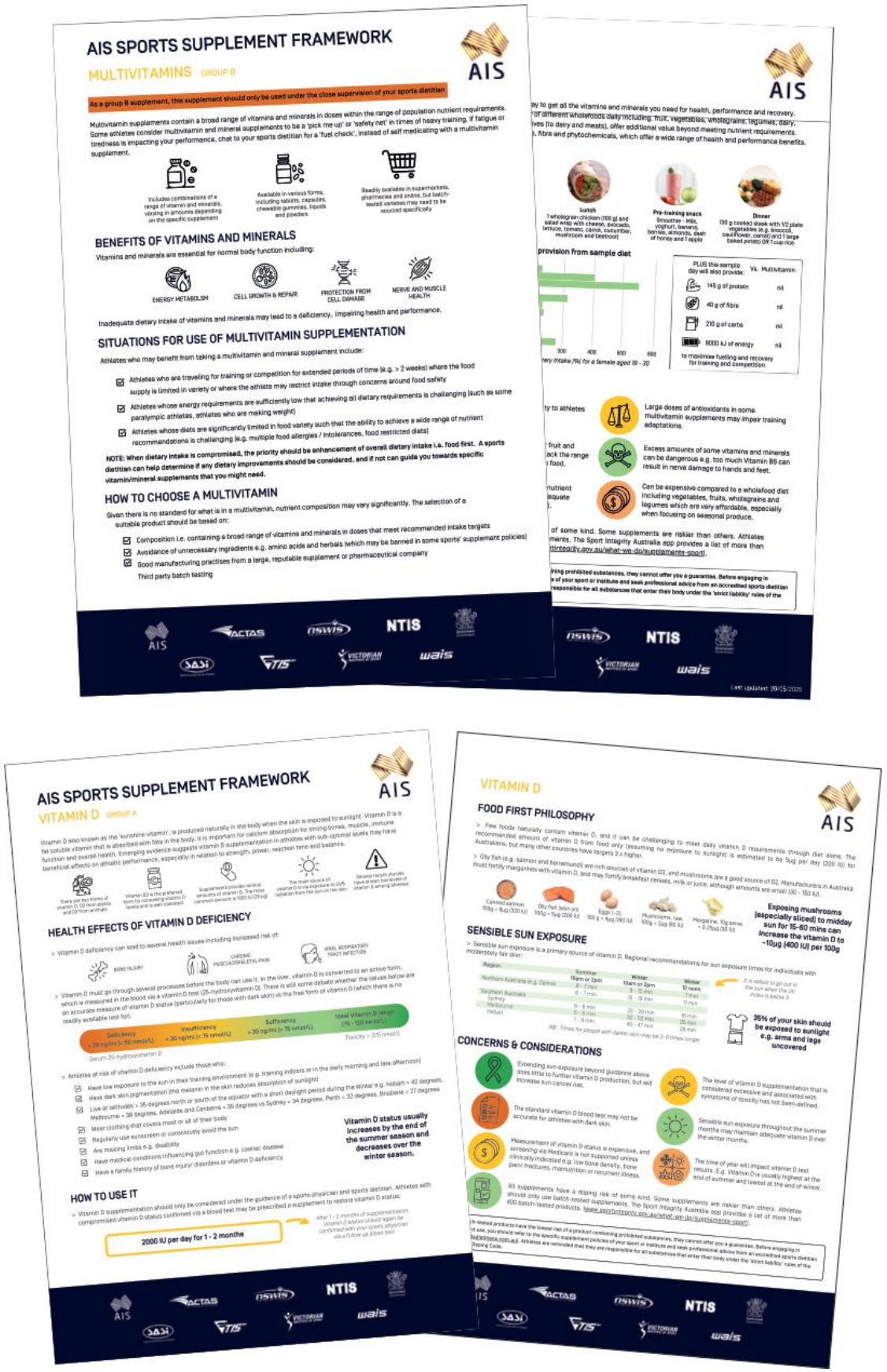


Figure 8.25 AIS infographics about multivitamins and vitamin D are available for download from the digital version of this textbook, or from the AIS via https://cambridge.edu.au/redirect/11403 and https://cambridge.edu.au/redirect/11404.

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Activity 8.2

AIS guidelines on vitamins

Read the AIS infographics on multivitamins and vitamin D.

1 What is the food first philosophy?
2 What are the benefits to athletes of multivitamins?
3 What is the benefit for athletes of vitamin D?
4 Is there any risk of negative side effects with supplementing multivitamins?

Skills: analysis

Mineral dietary requirements

Minerals are also essential micronutrients for optimal health and sports performance. Like vitamins, minerals do not provide energy. Key minerals include calcium, iron, magnesium, sodium, potassium, zinc, iodine and selenium.

Table 8.3 Key minerals for athletic performance

Mineral	Contribution to athletic performance
Calcium	Essential for muscle contraction, nerve function and bone health. Helps prevent muscle cramps and supports overall skeletal strength.
Iron	Crucial for oxygen transport in the blood and energy production. Prevents fatigue and enhances endurance.
Magnesium	Involved in over 300 enzymatic reactions, including energy production and muscle function. Helps prevent muscle cramps and supports heart health.
Potassium	Important for nerve transmission, muscle contraction and maintaining fluid balance. Helps prevent muscle cramps and supports cardiovascular health.
Sodium	Essential for maintaining fluid balance, nerve function and muscle contraction. Important for preventing dehydration and maintaining blood pressure during exercise.
Zinc	Supports immune function, protein synthesis and muscle repair. Important for recovery and overall physical performance.
Selenium	Acts as an antioxidant, protecting cells from oxidative damage. Supports immune function and thyroid health.
Phosphorus	Important for energy production and bone health. Helps with muscle contraction and recovery.
Copper	Involved in iron metabolism, energy production and antioxidant defence. Supports cardiovascular health and immune function.

Calcium and iron are two key minerals that are often deficient among certain athlete groups.

Calcium

Calcium is integral for bone structure, and also plays a role in muscle contraction. The development of strong bones occurs during childhood and adolescence. An adequate calcium intake, vitamin D status and regular weight-bearing exercise all contribute to the development of healthy bones. If these factors are not accounted for, the risk of fractures, **osteopenia** and **osteoporosis** is significantly increased in later life. The quality (density) of bone tissue gradually declines from the mid-twenties in both males and females, and even greater losses occur after menopause in females. Recent national surveys in Australia have identified that calcium intakes of children and adolescents are well below the recommended dietary intake (RDI) levels. Among this age group, there are also decreasing rates of physical activity; combined with a low calcium intake, this is a key risk factor for poor bone health later in life. Calcium-rich foods include dairy products, green, leafy vegetables and fish with edible bones such as sardines and canned salmon.

osteopenia loss of bone density
osteoporosis a disease that causes the bones to become weaker and easily broken

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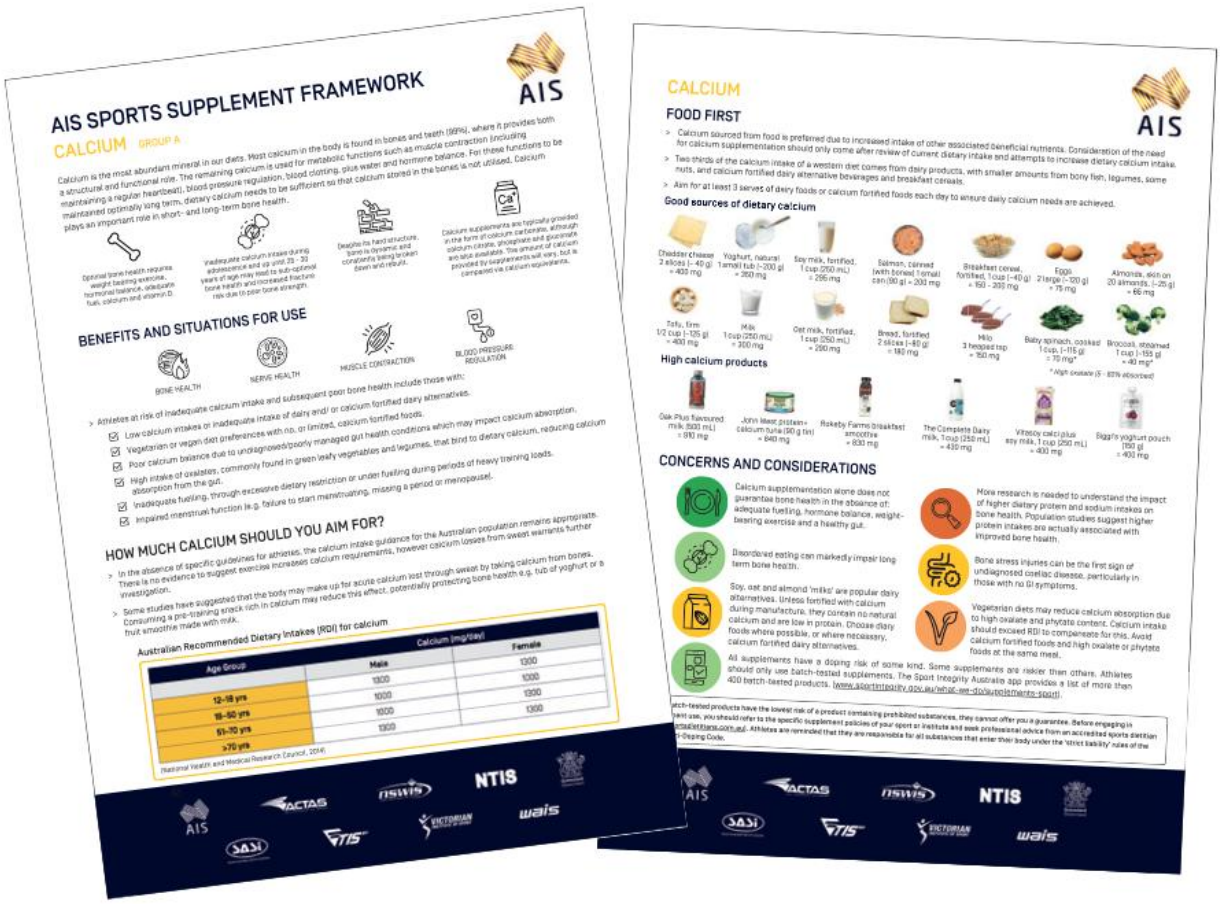


Figure 8.26 An AIS infographic about calcium is available for download from the digital version of this textbook, or from the AIS at https://cambridge.edu.au/redirect/11405.

Iron

Iron is a key component of haemoglobin, which is responsible for the transport of oxygen around the body. As well as having a significant impact on general health, low iron will negatively affect sports performance due to reduced oxygen delivery to working muscles. As a result, the muscle cells are unable to produce energy and eliminate acidic by-products effectively. Those most at risk of iron deficiency are females, vegetarians and endurance athletes (they have higher sweat losses). Athletes competing in low-weight category events (such as lightweight boxing and rowing), or events where having a low body weight is an advantage, are also at risk due to restricted food intake among these athletes. Foods high in iron include lean meats, green leafy vegetables, legumes, wholegrain products and fortified products such as breakfast cereals.

Sports anaemia is a condition experienced by many athletes – particularly during periods of heavy training – and presents as general lethargy and fatigue. This condition is not a true iron deficiency, as it is typically not the result of low iron intake but rather is due to significant increases in training load and training adaptations such as increased blood volume. Provided there is an adequate dietary iron intake, sports anaemia will generally resolve with the gradual tapering of the training load.



Figure 8.22 Athletes most at risk of iron deficiency include females and those who compete in endurance events, such as marathons.

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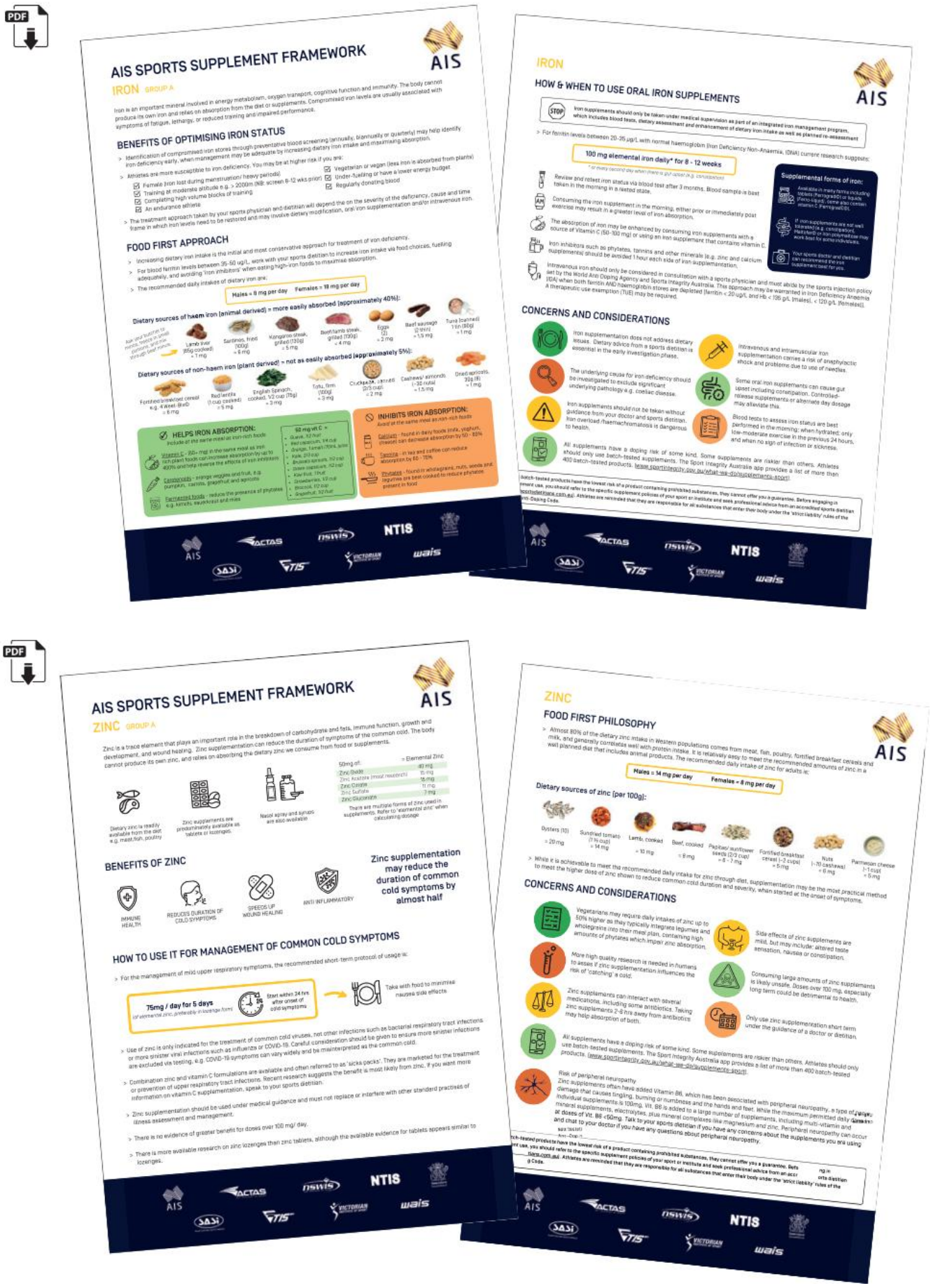


Figure 8.28 AIS infographics about iron and zinc are available for download from the digital version of this textbook, or from the AIS at https://cambridge.edu.au/redirect/11406 and https://cambridge.edu.au/redirect/11407.

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Taking additional micronutrients

Many athletes choose to supplement their diet with additional vitamins and minerals on top of their dietary intake, believing it will aid performance and recovery. Despite their widespread use, there is no clear evidence that general multivitamin supplements improve performance, and the absorption of these vitamins and minerals from a supplement is generally much lower than from eating the foods that contain them. Some research has indicated that these supplements may even prevent the development of certain training adaptations, and therefore may have a negative effect on performance.

Recent research indicates that certain nutrients may improve performance – for example, specific nutrients in beetroot may improve performance in sprint cycling events and power-based sports and magnesium may aid muscle recovery. However, more research is needed to confirm this and identify what the optimal dosage to achieve these benefits may be.

Activity 8.3

AIS guidelines on micronutrients

Read the AIS infographics on calcium, iron and zinc.

1 Why might an athlete supplement calcium?
2 Why might an athlete supplement iron?
3 Why might an athlete supplement zinc?
4 Are there any risks with supplementing these minerals?

Skills: analysis

Protein

Protein is important for the building and repair of new tissue, and as a result many athletes competing in strength and power sports take additional protein supplements as they believe it will help increase their muscle mass. Proteins are made up of a range of different amino acids and a range of different supplements are available in liquid or powder form. Protein is a Group A supplement, which means there is strong scientific evidence for use in specific situations in sport using evidence-based protocols.

There are several types of protein supplements, each with unique characteristics and benefits. Here's a quick overview:

1 Whey protein: this is a fast-digesting protein derived from milk, making it ideal for post-workout recovery. It contains all essential amino acids and is known for its high leucine content, which is crucial for muscle growth.
2 Casein protein: also derived from milk, casein digests more slowly than whey. It's often consumed before bedtime to provide a steady release of amino acids throughout the night.
3 Egg protein: made from egg whites, this protein is absorbed at a moderate rate and is free from dairy, making it suitable for those with lactose intolerance.
4 Soy protein: a plant-based protein that contains all essential amino acids. It's a good option for vegetarians and vegans and may help reduce cholesterol levels.
5 Pea protein: another plant-based option, pea protein is hypoallergenic and easily digestible. It's a good choice for those with dietary restrictions or allergies.

Each type of protein supplement has its own advantages, so the best choice depends on your dietary needs, fitness goals and any potential allergies or intolerances you might have.



Figure 8.29 Protein quality needs to be considered before supplementing.

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Supplementing protein benefits:

- building and maintaining muscle
- recovery
- satiety (feeling full).

It is important that athletes are educated about protein, as it is not used to fuel exercise performance (this only occurs under extreme conditions when carbohydrate and fat stores are exhausted). As protein is not a fuel, most athletes easily meet their protein requirements through their food intake without needing additional supplements. Despite this, many athletes still consume excess amounts of protein, and intakes of around 3 grams per kilogram of body weight are not uncommon among certain athlete groups – especially in male team sport environments. Historically, there has been concern that high-protein diets may have a negative effect on kidney function; however, there is no widespread evidence among healthy athletes to support this.

An important consideration regarding an athlete's protein intake is how they spread it out over the day. Recent studies have shown that strength gains, muscle hypertrophy and recovery are improved with small amounts of protein (15–25 grams) consumed regularly throughout the day. Many athletes do not evenly distribute their protein intake, and typically have small amounts at breakfast and snacks and large amounts at the evening meal. Protein supplements/shakes can be attractive to athletes as they are portable and convenient to consume in-between meals and after training sessions. The recommended serving size on many of the protein powders available may be as high as 50–60 grams of protein per serving, which is significantly more than required. The recommendation is 1.2–1.6 g of protein per kg body mass.

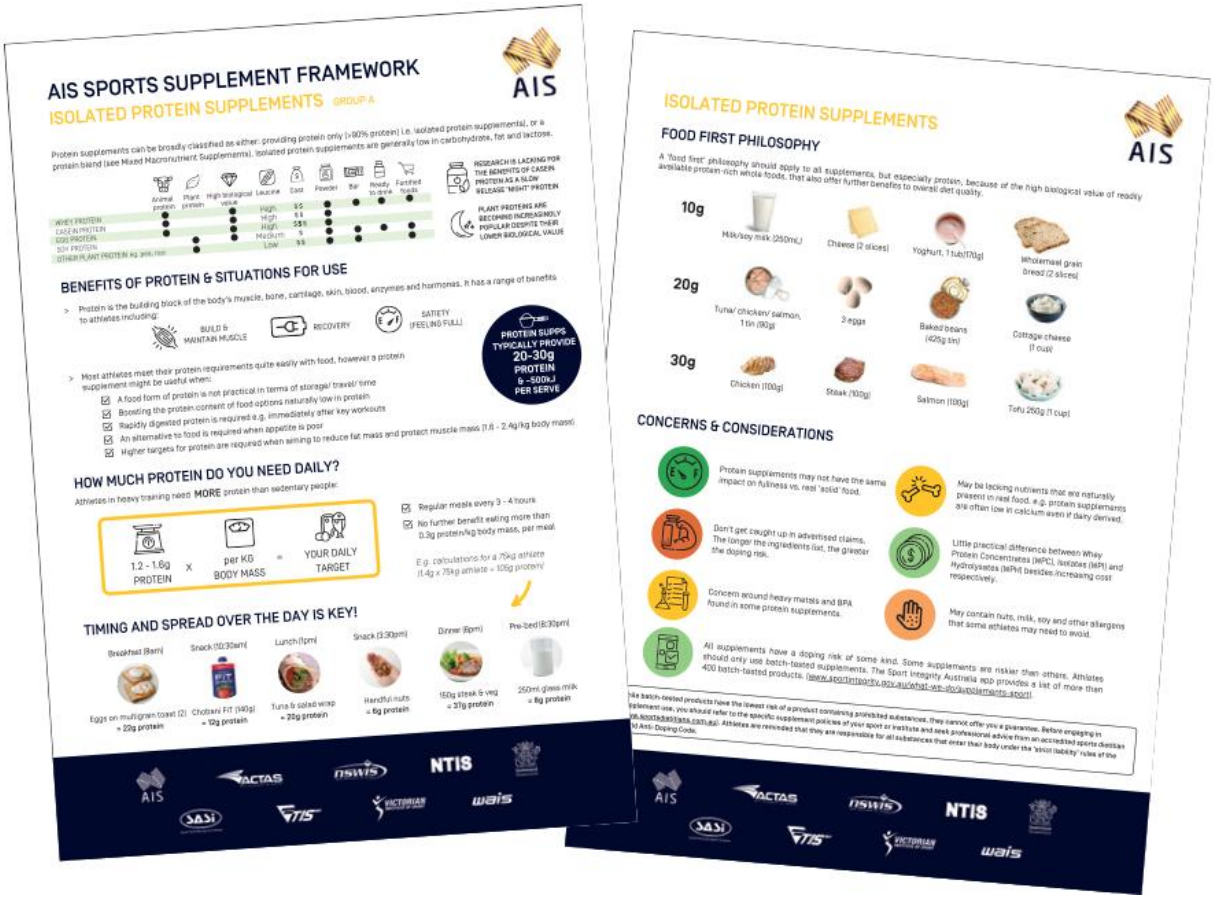


Figure 8.30 An AIS infographic about isolated protein supplements is available for download from the digital version of this textbook, or from the AIS at https://cambridge.edu.au/redirect/11408.

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Caffeine

Caffeine is a substance found naturally in the leaves, beans and fruits of a variety of plants, and is regularly consumed by some 90% of adults. The most common dietary source of caffeine is coffee, but cola drinks, energy drinks and specialised sports foods and supplements also contribute to regular intake. Caffeine is a Group A supplement, which means there is strong scientific evidence for use in specific situations in sport using evidence-based protocols.

Caffeine is rapidly absorbed and transported to all body tissues and organs, where it has a large variety of effects. These may vary between individuals and can be both positive and negative responses. These responses include the mobilisation of fats to the muscle cells, changes to muscle contractility, alterations to the central nervous system to change perceptions of effort or fatigue, stimulation of the release and activity of adrenaline and effects on cardiac muscle.

The major benefits of caffeine on exercise capacity and performance appear to be achieved by central nervous system effects. These effects reduce the perception of fatigue and allow for optimal pacing and performance to be maintained for a longer period. This is most likely to benefit endurance sports such as long-distance running, cycling, triathlons and cross-country skiing. The range of benefits include:

- nervous system alertness
- reduced perception of effort
- reduced pain
- improved performance.

In the past, caffeine has not been recommended among athletes due to its potential to act as a diuretic and contribute to dehydration. More recent studies have shown that small to moderate doses of caffeine have minor effects on overall hydration in people who are regular caffeine users. In addition, caffeine-containing drinks such as tea, coffee and cola drinks provide a significant source of fluid in the everyday diets of many people, including athletes. A decision based around using caffeine might be relevant to:

- endurance sports
- team and intermittent sports
- brief, sustained, high-energy sports
- single efforts involving strength or power
- pre-training energy boost if carrying fatigue.

Sports supplements and 'pre-workout' supplements are not required to list their caffeine content on the label. For example, several of the supplements in Table 8.4 have not listed their caffeine content; however, caffeine (methylxanthine) or guarana – which contains caffeine – are listed as ingredients.

Table 8.4 Pre-workout supplements

Pre-workout supplement	**Caffeine** (mg/serving/1 scoop)	**Caffeine source**
Ghost Legend	237 mg	Caffeine Anhydrous and DiCaffeine Malate
JD Nutraceuticals Altered State	235 mg	Caffeine Anhydrous
EHP Labs Pride	100 mg	Caffeine Anhydrous
Max's Betapump Compound X	300 mg	Caffeine Anhydrous
Optimum Nutrition Gold Standard Pre Workout	175 mg	Caffeine Anhydrous
Axe and Sledge Seventh Gear	350 mg	Caffeine Anhydrous
Redcon1 Total War	250 mg	Caffeine Anhydrous
Axe and Sledge Hydraulic	0 mg	
Cellucor C4	150 mg	Caffeine Anhydrous
Alien Supps UNO	375 mg	Tea Leaf Extract
Faction Labs Disorder	250 mg	Caffeine Anhydrous
GAT Nitraflex	325 mg	Caffeine Anhydrous

Source: https://powersupps.com.au/how-much-caffeine-in-pre-workout/

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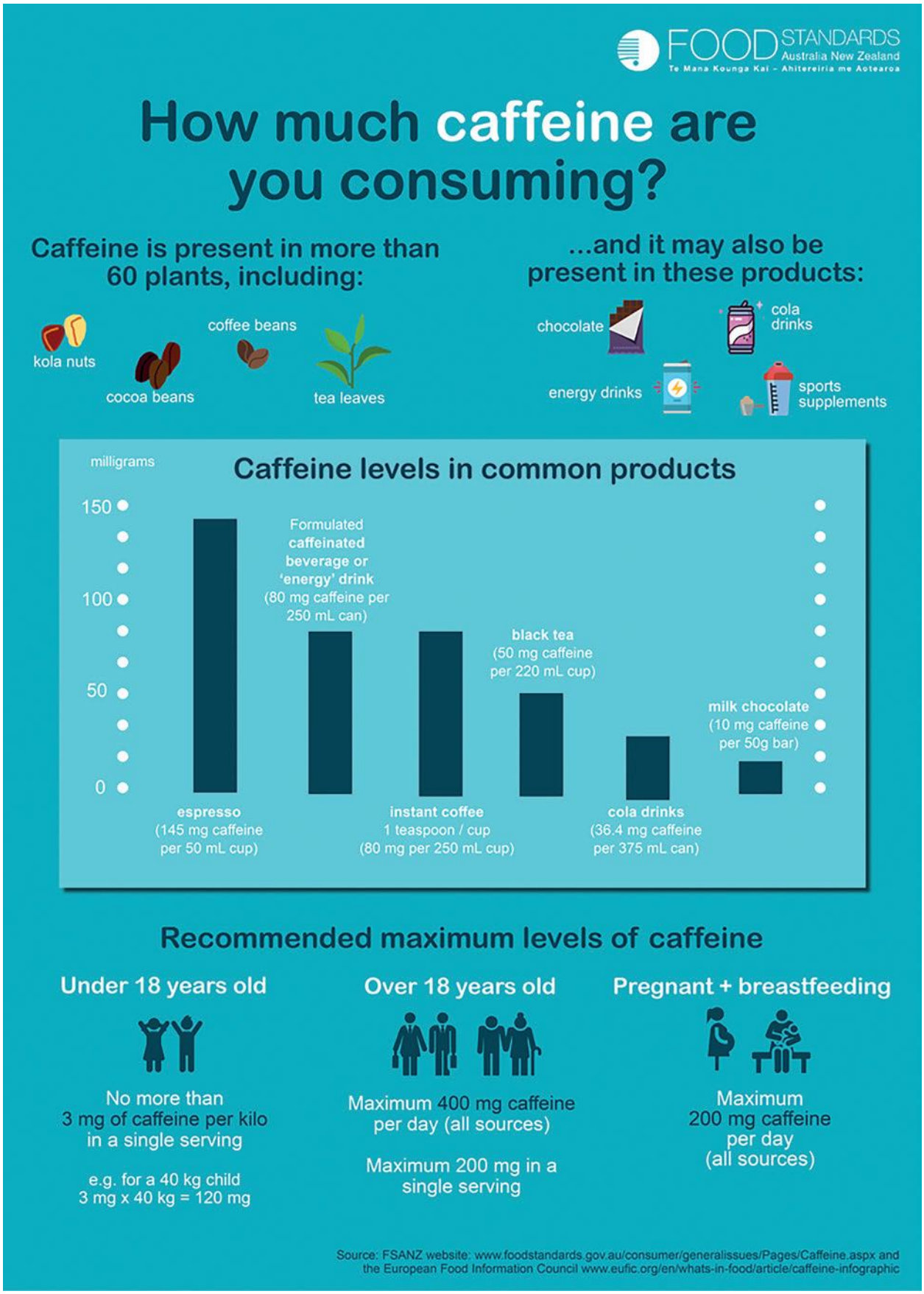


Figure 8.31 Caffeine content of common foods, drinks and therapeutic products (Australia)

Source: https://www.foodstandards.gov.au/consumer/prevention-of-foodborne-illness/caffeine

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Supplements are not subject to the same criteria as foods, and therefore they may contain significantly more caffeine per serve than common foods and drinks. This is a concern, as many of the 'pre-workout' supplements are popular among young athletes who may not be habitual caffeine users.

These sources also show that there are a variety of protocols of caffeine intake that can enhance performance. These include the consumption of caffeine:

- before the exercise bout
- spread throughout exercise
- taken late in long-duration exercise as fatigue is beginning to occur.

Different protocols may achieve optimal performance outcomes, even in the same sport or individual. Suitable or optimal protocols may be dictated by the specific characteristics of the event, the practical considerations of consuming a caffeine-containing product and the individual characteristics and preferences of the athlete. The athlete who is intending to use caffeine to enhance sports performance should experiment in training or less important events to determine the timing and dosages of caffeine that best suit their individual needs. It is generally accepted that 3 mg/kg body mass/day helps to avoid potential side effects of its use.



Figure 8.32 Coffee is synonymous with caffeine.

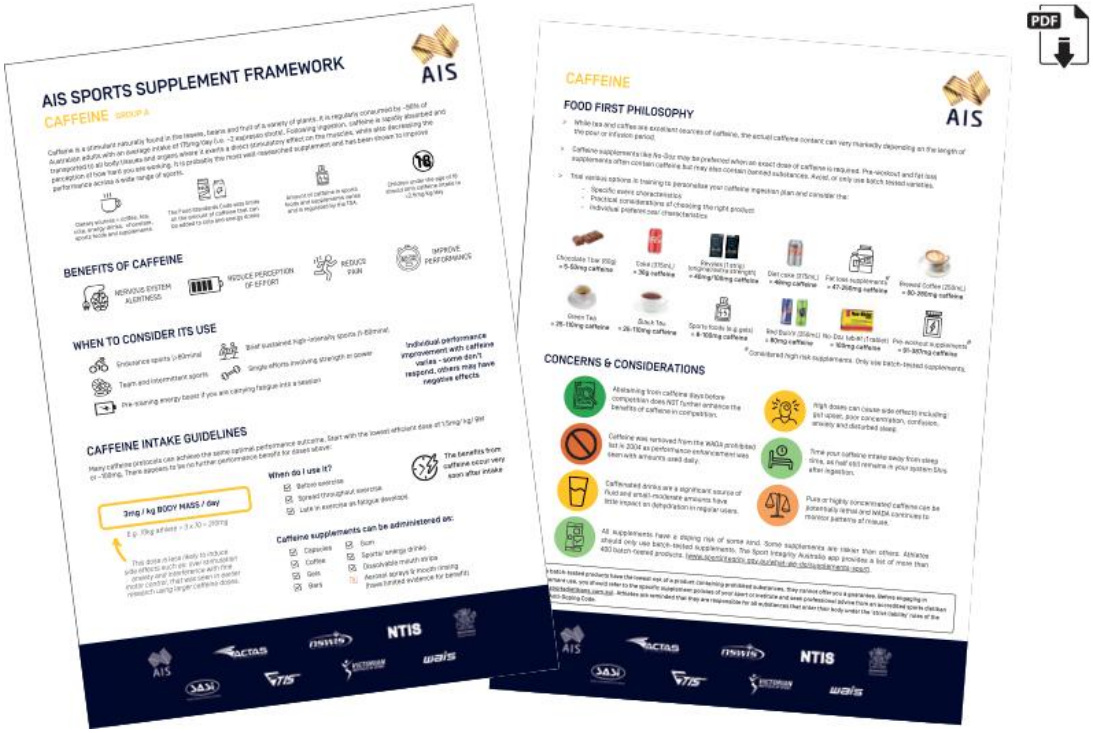


Figure 8.33 An AIS infographic about caffeine is available for download from the digital version of this textbook, or from the AIS at https://cambridge.edu.au/redirect/11410.

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Creatine

Creatine is a naturally occurring compound found in large amounts in skeletal muscle and the brain. Creatine is provided from dietary intake and synthesis from amino acids. The major source of creatine in the diet is from animal muscle – such as meat or fish – which typically provides 1–2 grams per day, or half the daily turnover. Creatine is a Group A supplement, which means there is strong scientific evidence for use in specific situations in sport using evidence-based protocols.

As vegetarians do not consume any significant creatine in their diets, they are reliant on the body making creatine from amino acids, and typically have lower creatine levels in their muscles.

Creatine performs several important functions related to fuel supply in the muscle. The best-known role is as a source of phosphate to regenerate ATP, which is the most important fuel source for sprints or bouts of high-intensity exercise lasting up to 10 seconds.

Studies in the early 1990s showed that muscle creatine and phosphocreatine in skeletal muscle could be increased by around 20%. These results are significant in terms of improving the exercise capacity of the phosphocreatine energy system and have led to the widespread use and popularity of creatine among a range of athletes. Since then, further studies have shown that there is considerable variability in different athletes' responses to creatine supplementation. Individuals with the lowest initial levels, such as vegetarians, may show the greatest responses, while individuals with higher resting creatine levels may not significantly benefit from supplementation. Strategies that enhance creatine uptake into the muscle cells include taking creatine with a carbohydrate-rich meal or snack (around 50 grams of carbohydrate).

Creatine supplementation has been shown to enhance the performance of exercise involving repeated sprints or bouts of high-intensity activity, separated by short recovery intervals. The benefits of creatine include:

- muscle strength, endurance and size
- maximal exercise performance
- recovery
- brain health.

Therefore, competition or training programs involving intermittent high-intensity work patterns with brief recovery periods (less than one minute) or resistance training programs, are most likely to benefit from creatine supplementation. Performance enhancements may be seen as the result of an acute loading protocol, but chronic creatine use may offer the greatest benefits. The following activities may benefit from creatine supplementation:

- high-intensity, single-max efforts for less than 30 seconds
- sports that involve repeated bursts of high-intensity efforts
- high-intensity sprint efforts undertaken within or at the end of endurance efforts
- to improve cognitive processing in the brain.



Figure 8.34 Creatine is one of the most researched supplements.

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The best-researched dietary creatine supplement is creatine monohydrate. It consists of creatine, a compound naturally found in muscle cells, combined with one molecule of water, hence the name 'monohydrate'.

There are several protocols of loading being established:

- Rapid loading may be achieved by five days of repeated doses (e.g. four doses of five grams) of creatine.
- Slow loading will occur over a longer period (28 days) with a daily dose of 3–5 grams.
- A maintenance dose of 0.03 grams/kg body mass per day will allow elevated levels to be sustained.
- Unloading: once the muscle creatine content has been saturated, it will take at least four weeks to return to resting levels.

A weight gain of 600–1000 grams is typically associated with acute loading and is due mostly to water retention.

Creatine monohydrate is the common source of creatine in commercially available supplements, and the experience of 20 years of research indicates it is safe and effective in the recommended dosages. Several other forms of creatine have been included in newer supplements, with claims of being a superior form of creatine. These include creatine serums, creatine malate and creatine ethyl esters. There is little to no evidence supporting marketing claims that these alternative creatine sources are more effective in increasing muscle creatine levels and achieving performance outcomes, or that they are associated with fewer side effects.

Creatine supplementation should be limited to experienced and well-developed athletes. Young athletes can make substantial gains in performance through maturation and skill or technique improvements without supplementation.



Figure 8.35 An AIS infographic about creatine is available for download from the digital version of this textbook, or from the AIS at https://cambridge.edu.au/redirect/11411.

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Activity 8.4

AIS guidelines on protein, caffeine and creatine

Read the AIS infographics on protein, caffeine and creatine.

1 What are the guidelines for supplementing protein?
2 Which athletes would supplement caffeine and what benefits do they gain?
3 What are the guidelines for supplementing creatine?
4 Which athletes would supplement with each of these and what benefits are they chasing?
5 What risks exist with supplementing protein, caffeine and creatine?

Skills: analysis


Quiz

Revise and summarise 8.3

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 What are dietary supplements and why might individuals choose to use them?
2 Discuss the potential benefits and risks associated with the use of dietary supplements.
3 Define micronutrients and explain their role in maintaining health.
4 Identify the key micronutrients and their primary food sources.
5 What are the consequences of micronutrient deficiencies and excesses?
6 Why is protein important for the human body and what are its main functions?
7 How much protein is recommended for different age groups and activity levels?
8 Describe the effects of caffeine on the human body.
9 What are the potential benefits and drawbacks of caffeine consumption?
10 What is creatine, and how does it function in the body?
11 Discuss the potential benefits of creatine supplementation for athletes.
12 Are there any known side effects or risks associated with creatine use?

Think critically and apply 8.3

1 Evaluate the ethical considerations and potential health implications of marketing dietary supplements to adolescents.
2 Discuss the role of protein in muscle protein synthesis and the factors that influence this process. How do different types of protein (e.g. whey, casein, plant-based) compare in their effectiveness?
3 Evaluate the environmental and ethical considerations of different protein sources. How do plant-based proteins compare with animal-based proteins in terms of sustainability?
4 Analyse the potential health risks associated with excessive protein intake. What are the long-term implications for kidney function and overall health?
5 Discuss the role of caffeine in athletic performance. What are the potential benefits and limitations of caffeine use in sports?
6 Evaluate the evidence supporting the use of creatine for cognitive enhancement. What are the proposed mechanisms, and what does current research indicate?

Skills: analysis, research

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Chapter summary

- Proper dietary and fluid intake before, during and after performance is crucial for maintaining energy levels, supporting muscle function and ensuring optimal recovery.
  - **Pre-performance,** athletes should focus on consuming a high-carbohydrate meal 2–4 hours prior to the event to provide essential energy. This meal can include foods like pasta, rice or whole grains. Moderate protein intake from sources such as lean meats, eggs or dairy helps support muscle function, while limited healthy fats like avocados or nuts can be included to avoid digestive issues. Hydration is equally important, with athletes advised to drink 500–600 mL of water 2–3 hours before the event and another 200–300 mL 20–30 minutes before starting.
  - During performance, quick-digesting carbohydrates like sports gels, bananas or energy bars help maintain energy levels. Sports drinks can also be beneficial as they replenish lost electrolytes, especially during prolonged activities. Regular sips of water or sports drinks every 15–20 minutes are recommended, with the amount varying based on the activity's intensity and duration.
  - Post-performance nutrition focuses on replenishing glycogen stores and supporting muscle recovery. Consuming carbohydrates such as sweet potatoes, fruits or whole grains is ideal. Protein intake is crucial for muscle repair, with sources like lean meats, fish or protein shakes being beneficial. Including healthy fats from avocados, nuts and seeds can support overall recovery. Rehydration is essential, and athletes should aim to replace 150% of the fluid lost during the event with water or electrolyte-rich drinks.
  - In summary, a well-balanced approach to diet and hydration before, during and after performance helps reduce fatigue and enhances overall physical performance. These practices ensure that the body functions efficiently, supports recovery and maintains optimal energy levels.
- **Sleep** is essential for reducing fatigue and enhancing movement.
  - During sleep, the body repairs muscles, consolidates memory and restores energy levels. Adequate sleep (7–9 hours per night) improves reaction times, coordination and overall physical performance.
  - Lack of sleep can lead to increased fatigue, slower reflexes and a higher risk of injury.
- **Nutrition** plays a crucial role in maintaining energy levels and supporting movement.
  - A balanced diet provides the necessary nutrients for muscle function and endurance.
  - Carbohydrates are the primary source of energy, proteins help in muscle repair and growth, and fats provide long-term energy.
  - Proper nutrition ensures that the body has the fuel it needs to perform well and recover quickly, reducing feelings of fatigue.
- **Hydration** is vital for maintaining physical performance and preventing fatigue.
  - Water regulates body temperature, lubricates joints and transports nutrients.
  - Dehydration can lead to muscle cramps, dizziness and decreased performance.
  - Athletes should drink water regularly throughout the day and during physical activities to stay hydrated and maintain optimal movement.
- **Supplements** can enhance athletic performance when used correctly. They include a variety of products like protein powders, vitamins and minerals. It's important to use them under professional guidance to avoid potential side effects and ensure they complement a balanced diet.
- **Micronutrients** such as vitamins and minerals are essential for overall health and performance. They support energy production, bone health and immune function. For example, vitamin D and calcium are crucial for bone strength, while iron helps in oxygen transport in the blood.

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- **Protein** is vital for muscle repair and growth. Athletes often use protein supplements to meet their increased protein needs, especially after intense workouts. Protein helps in building and repairing muscle tissues, which is essential for recovery and performance.
- **Caffeine** is a popular ergogenic aid that can improve endurance and reduce fatigue. It stimulates the central nervous system, enhancing alertness and concentration. Caffeine is often consumed through coffee, tea or supplements before workouts to boost performance.
- **Creatine** is another widely used supplement that helps in high-intensity, short-duration activities like sprinting or weightlifting. It increases the availability of energy in muscles, allowing for improved strength and power. Creatine is naturally found in meat and fish but is also available as a supplement.

Multiple-choice questions

1 Which of the following is a primary benefit of adequate sleep for athletes?
A increased muscle mass
B improved reaction times
C higher body fat percentage
D decreased flexibility

2 What is the main role of carbohydrates in an athlete's diet?
A building muscle tissue
B providing energy
C repairing damaged cells
D regulating body temperature

3 Which nutrient is essential for muscle repair and growth?
A carbohydrates
B fats
C proteins
D vitamins

4 How much water should an athlete drink 2–3 hours before an event?
A 100–200 mL
B 200–300 mL
C 500–600 mL
D 700–800 mL

5 Which supplement is commonly used to improve strength and power in short bursts of high-intensity activities?
A vitamin C
B creatine
C omega-3 fatty acids
D calcium

6 What is the primary benefit of consuming protein after a workout?
A increasing energy levels
B enhancing muscle repair
C improving flexibility
D reducing body fat

7 Which of the following is a quick-digesting carbohydrate suitable for consumption during exercise?
A wholegrain bread
B sports gels
C avocados
D chicken breast

8 Why is hydration important for athletes during performance?
A it increases muscle mass
B it prevents dehydration and maintains performance
C it reduces body fat
D it enhances flexibility

9 Which micronutrient is crucial for bone health and muscle function?
A vitamin D
B vitamin C
C iron
D vitamin B12

10 What effect does caffeine have on athletic performance?
A decreases endurance
B reduces alertness
C improves endurance and reduces fatigue
D increases body fat

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Exam practice

How to answer an exam question

Example question

A marathon runner includes carbohydrate loading in their diet plan for the week leading up to an event.

Explain what this means and why it would benefit the marathon runner but not a sprinter. (4 marks)

What is the question asking?

The key verb in this question is **explain**, which means you should address cause and effect – what it is about carbohydrate loading that is beneficial for the marathon runner.

Your answer should also explain what it is about sprinting that means carbohydrate loading would be ineffective.

Marking criteria

Criteria	Marks
• Provides detailed reasons on why AND/OR how carbohydrate loading can be beneficial for marathon runners AND not for sprinters.	4
• Provides reason(s) showing why AND/OR how carbohydrate loading can be beneficial for marathon runners AND not for sprinters.	3
• Outlines benefits of carbohydrate loading for marathon runners AND/OR why it is not beneficial for sprinters	2
• Provides some relevant information	1

Sample response

Carbohydrate loading usually consists of three to four days of hard training and low carbohydrates, followed by three to four days of tapered training and high carbohydrates. The aim is to maximise muscle glycogen stores for the event.

For endurance events lasting more than 90 minutes, such as marathons, carbohydrate loading has been found to improve overall performance by 2-3%. However, for events lasting under 60 minutes, adequate glycogen stores can normally be achieved without carbohydrate loading. In fact, it may have a negative effect on performance in short-duration, high-intensity events, such as sprinting.



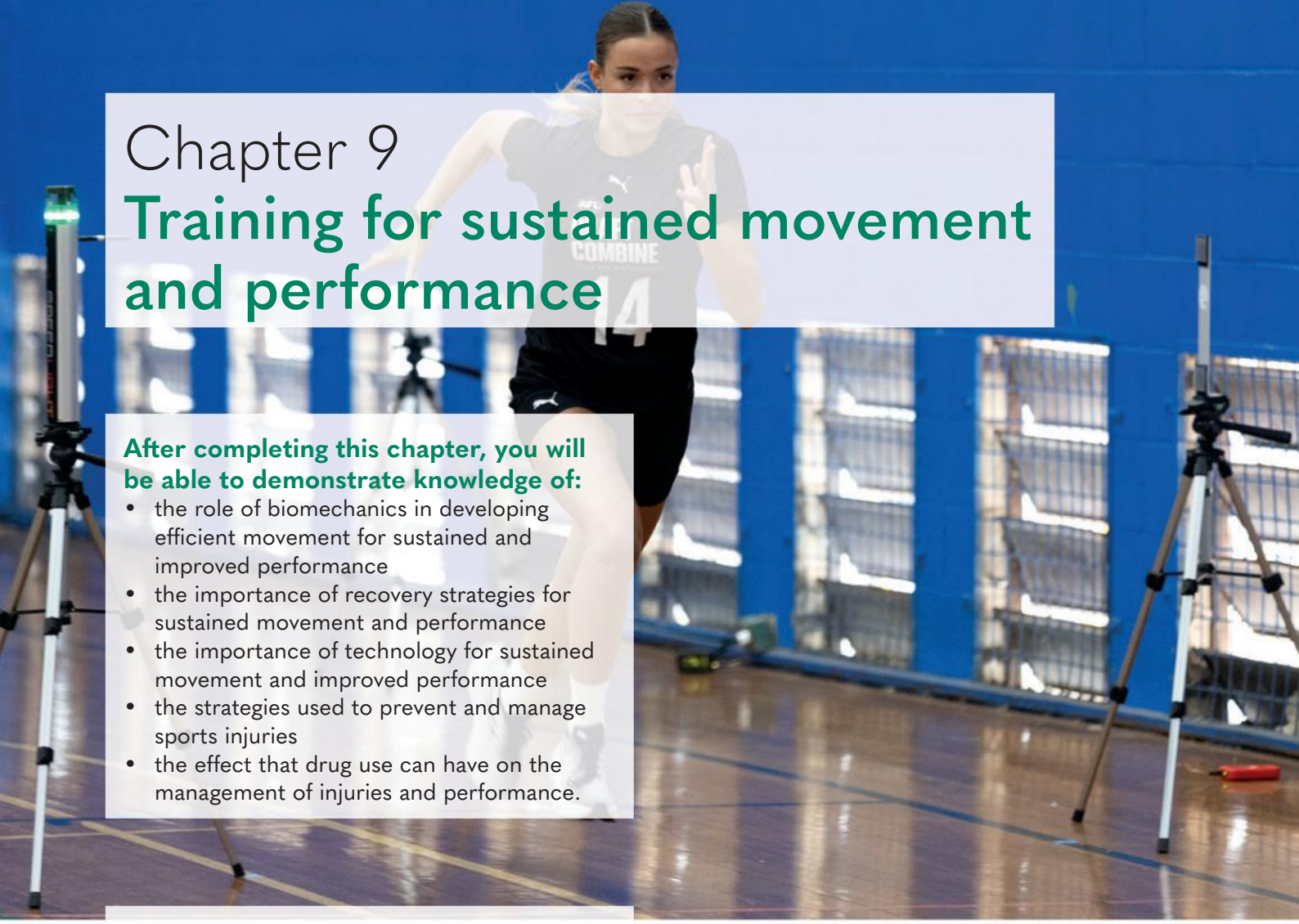
Video 8.2 Answering the exam question

Exam-style questions

1. Explain how adequate sleep contributes to athletic performance. Include at least three specific benefits in your answer. (5 marks)
2. Describe the role of carbohydrates, proteins and fats in an athlete's diet. How do these macronutrients support physical performance and recovery? (4 marks)
3. Discuss the importance of hydration for athletes. What are the potential consequences of dehydration on physical performance and overall health? (5 marks)
4. Evaluate the use of protein supplements in an athlete's diet. What are the potential benefits and risks associated with their use? (8 marks)
5. Analyse the effects of caffeine and creatine supplementation on athletic performance. How do these supplements work, and what are their potential benefits and drawbacks? (8 marks)

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Chapter 9
Training for sustained movement and performance



After completing this chapter, you will be able to demonstrate knowledge of:

- the role of biomechanics in developing efficient movement for sustained and improved performance
- the importance of recovery strategies for sustained movement and performance
- the importance of technology for sustained movement and improved performance
- the strategies used to prevent and manage sports injuries
- the effect that drug use can have on the management of injuries and performance.

Key terminology

Syllabus terminology:

biomechanical principles
biomechanics
fluid mechanics
force
POLICE
RICER
stability
TOTAPS

Other important terms:

kinematics
SIA
WADA



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Driving questions

1. Sport is meant to be good for your health, but is this always the case? Make a list of social, mental and physical harms that elite level sport can have on an athlete's health and wellbeing and propose strategies that can be implemented to alleviate these.
2. List examples of sports where athletes seem to be pushed 'too far' beyond what is ethically reasonable and analyse and discuss the forces and pressures that contribute to this.
3. If major change is to be made to better protect athletes, who is responsible for this? What are the policies and rules that could be enforced to ensure athletes are able to sustainably progress towards their athletic potential and reduce the ongoing effect post-retirement from sport?

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Introduction

Due to the intensity and scale of elite sport in today's highly marketable environment, athletes are pushing themselves, and being pushed by external forces, to 'squeeze' the absolute most out of their body in the pursuit of success. As a result, most elite athletes 'live extremely close to the edge' of overtraining, mental burnout and injury through the extreme lengths required for elite training and competition. As previously explored, there are several factors that are critical in maximising the athlete's potential development, while also caring for their health and wellbeing. These include accurate exercise assessment, careful programming and application of types and principles of training, and appropriate diet and sleep.

This final chapter of the focus area, Training for Improved Performance, explores the use and ethical considerations of a range of additional factors used to support sustained movement throughout an athlete's career as well as for improving performance. These include the application of biomechanical principles in sport, the importance of effective recovery strategies, the impact of technology, strategies to prevent and manage sports injuries and the use of drugs in sport. These factors all play a role in improving athletic performance as well as minimising the potential negative effect on the athlete's body using sustainable and evidence-based training methods, which promote good health and wellbeing throughout their sporting career and beyond.

9.1 Biomechanics

Learning objective 9.1
EXPLAIN the role of biomechanics in developing efficient movements for sustained and ongoing performance.

Video 9.1 Figure skater executing a multi-rotation jump (00:22)

Human movement is complex, involving the precise integration of different tissue structures, all working in unison to produce sustained, powerful and accurate movements. Consider the tissue types that make up the major anatomical structures of the synovial hinge joint at the knee: muscles, tendons, ligaments, bones, nerves, blood vessels, cartilage and synovial fluid. When an athlete jumps and lands, all of these play a significant role in ensuring the movement is both **safe** and **effective**, as the athlete produces and absorbs dynamic forces which are many times their own body weight. Now compare this to a figure skater landing from a multi-rotation jump. As a result of such intense movements, any force that exceeds the limits of the body tissues involved may lead to injury. This is seen in the case of decelerating while pivoting, shifting the tibia forward beyond the capacity of the anterior cruciate ligament (ACL) to absorb and maintain joint stability, leading to ligament rupture.

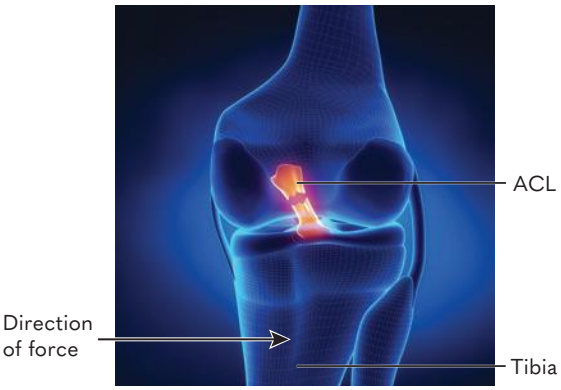


Figure 9.1 ACL injury (front view of knee)

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Likewise, inaccurate or suboptimal forces fail to produce the desired result for success, as seen in a weightlifter who is unable to produce the same force output as an opponent who has more technical refinement and muscular power. The study and application of biomechanics and biomechanical principles helps manage both scenarios, by helping to optimise athletic movement to reduce the risk of injury and maximise potential athletic output through movements which are more efficient (use the least energy to produce the desired result) and effective (capable of the greatest output possible from the capacity of the tissues).

Figure 9.2 outlines some foundational biomechanical principles relating to sport. Biomechanics was extensively covered in the *Cambridge Health and Movement Science Year 11* textbook.

Consider how the application of biomechanical principles intersects with the desired outcomes of training that lead to the anatomical changes (structural and material) and physiological adaptations (functional output) that will improve performance. An example of this can be seen in a six-week running program with a coach. As the athlete trains, their anatomical structures change (larger heart, stronger muscles, increased haemoglobin count), which facilitates increased physiological output (increased cardiac output, muscular endurance and VO_2 max). All of this increases the average running speed, which is further increased through the refinement of running technique using biomechanical analysis of gait (stride) patterns, contributing to increased running efficiency (using less energy to produce the same result).

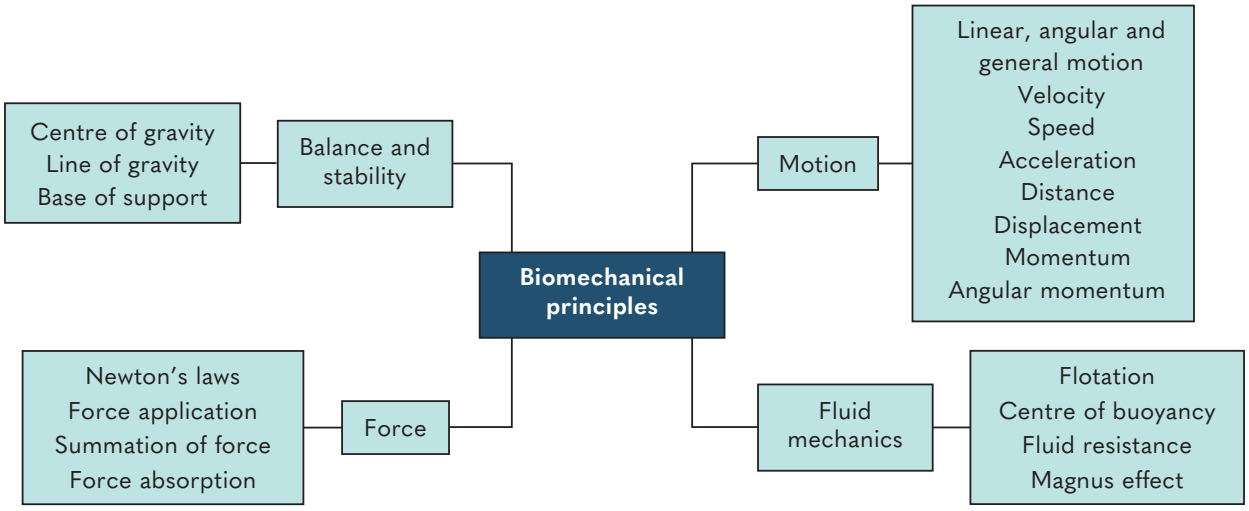


Figure 9.2 Biomechanical principles covered in the *Cambridge Health and Movement Science Year 11* textbook that are used to sustain and improve performance in sport

Activity 9.1

Revising biomechanical principles

Revise each biomechanical principle through identified and relevant sporting examples, demonstrating how each are evident within sport. For each, describe how the athlete uses or develops this to increase safety and/or success.

Skills: analysis

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In some way, all training seeks to enhance or utilise biomechanical principles to develop efficient movements for sustained and improved performance. Athletes should reflect on a range of training activities and innovations in different sports through the lens of biomechanics, seeking to increase their awareness of how these principles are applied.

In this section, biomechanics will be explored in relation to how it is applied to:

- general and sustained locomotor movements of the human body through **physical activity** as required for the various movements in dynamic team sports (such as running at different speeds and changing directions)
- specialised actions in sports requiring **sports-specific movements** where technical skills are required (such as high jump, cricket bowling and tackling in rugby)
- strong **functional movements** of the human body where maximal power and control are produced through basic human movement patterns (such as the hip and knee extension, upper body push and trunk rotation required for shot put)
- increased biomechanical output in sport through the development of **advanced equipment**.

kinematics the study of the motion and forces acting on objects

Physical activity

On land, the human body needs to be able to move from one location to another (locomotor skills), as seen in walking. Within sport, this movement often needs to be a faster pace and may require constant variations in speed and direction. Long-distance running requires straight line lower speeds for an extended period. In contrast, a basketballer accelerates and decelerates, going from being stationary to a full sprint over short distances, while also changing direction using their agility as they seek to manoeuvre past opponents.

The use of biomechanics to enhance physical activity is evident in the analysis and refinement of the joint angles required to produce different running speeds and changes of direction. This ultimately seeks to optimise the application and absorption of force associated with physical activity, a field of study known as **kinematics**. Within sprinting, this process is used to maximise acceleration potential (the positive increase in speed), by using specific angles of force that produce the greatest change in speed. Comparatively, a similar analysis in long-distance running is used to increase running efficiency by finding the optimal stride frequency, length and movement patterns. It also serves to decrease the risk of overuse injury by reducing the cumulative forces applied to the body over thousands of steps. Being able to change direction safely and effectively is a learned skill by which athletes develop the ability to apply powerful lateral forces to step past or away from an opponent. Each of these locomotor skills and physical activities requires the application of biomechanical principles.



Figure 9.3 A comparison of the joint angles of different runners during varied physical activities (tempo running, changing direction, acceleration)

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In relation to **injury and load management**, biomechanics can be used to help identify high-stress actions and forces during repetitive movements, which may lead to overuse injuries. Understanding this can lead to alterations in technique which reduce the strain on muscles, tendons and joints by redistributing these forces more evenly. For example, decreasing the stride length and frequency during running to alter foot and heel strike patterns, can lead to a reduction in force through the body and risk of running-related injuries (e.g. shin splints).

In relation to **enhanced movement efficiency and effectiveness**, refining the muscle activation patterns required for running will conserve energy while increasing speed. In endurance events, a marginal increase over a long time will make a significant difference, lowering the total average time. In sprinting, using the right muscle actions at the right time in the optimal direction will increase maximal output. Coaches and athletes use video technology to help analyse and provide feedback to athletes about optimal physical activity. While dynamic team sports often require unpredictable and varied movements, practice and training can increase biomechanical efficiency and effectiveness.

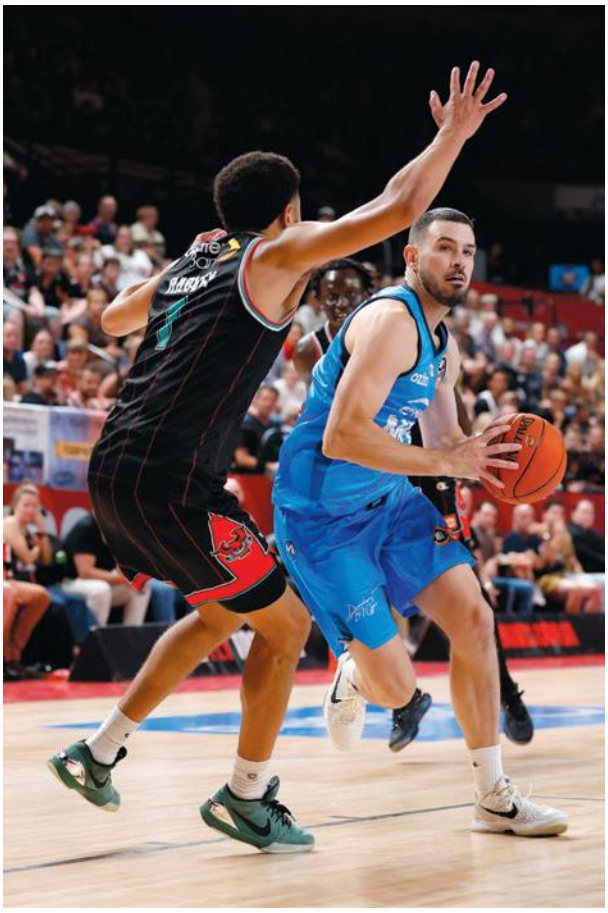


Figure 9.4 Dynamic team sports, such as basketball, often require unpredictable and varied movements, but practice and training can increase biomechanical efficiency and effectiveness.

Activity 9.2

The biomechanics of physical activity

Find instructional videos about optimal running technique for 5 km tempo pace, changing directions through agility poles and for sprinting (acceleration and speed maintenance). Take notes of the joint angles required for each physical activity, and summarise how they relate to enhanced movement safety, efficiency and effectiveness.

Skills: analysis, research

Practical application 9.1

Analysing physical activity

Using the analysis from Activity 9.2, work in small groups to create video recordings of one another performing the various physical activities of tempo running, changing direction, accelerating and speed maintenance. Identify still frames from these videos that demonstrate joint angles which are either optimal or sub-optimal according to the research and annotate these to present to the class.

Skills: collaboration, analysis, communication

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Sports-specific movements

Beyond the physical activities previously discussed that enable the athlete to move around a field with efficiency and effectiveness, most sports also require specific movements and skills, which often require the manipulation of equipment through technical skill execution. For example, an all-rounder in cricket must be skilled in the variations required for bowling, batting, catching, throwing and fielding. Applying biomechanical principles in the refinement of these skills leads to both enhanced performance through greater consistency and accuracy and can reduce the risk of injury. Some examples of sports-specific movements include somersaults in gymnastics, kicking in AFL, passing in netball, tackling in rugby, hurdling in athletics, clean and jerk in weightlifting, dribbling in hockey or Paralympic sprinting with prosthetics.

In some cases, great care is taken to develop technical proficiency and optimise movements that will decrease the risk of injury where there is a high chance of overuse or acute injuries. Video and expert analysis, and use of technology such as biomechanical feedback sensors allow athletes to be assessed and alter technique by changing joint angles in order to achieve the two important outcomes of sustained and improved performance. Some sporting examples include:

- In Rugby League and Union, safe tackling technique is essential for the players' health and wellbeing, to reduce the risk of collision-based injuries including concussion. By analysing and refining how the body maintains stability while applying and absorbing force, the athlete is able to use their body to effectively tackle opponents, while reducing the load and impact on the body.
- In cricket, promising fast bowlers are identified early for biomechanical analysis and technique correction, to reduce the immense loads that go through the lower back, shoulders, hips and knees. This reduces the risk of overuse injuries (e.g. stress fractures), particularly as the bowler is growing.
- In golf, there is the need to find the optimal balance between maximal performance through outstanding and powerful technique, while seeking to reduce the loads of rotation on any one particular body part, especially the lower back which is vulnerable to injury.
- In pole vault, there is a high degree of technical proficiency required to use the pole to get up and over the bar as high as possible, while ensuring the athlete lands safely on the mat.
- In swimming, athletes use fluid mechanics to create body shapes that minimise drag to decrease the energy required to propel through the water. Video analysis and feedback sensors on the hands are used to analyse forces and body actions, allowing subtle stroke corrections to be made to increase performance and reduce the risk of injury, particularly in the shoulder rotator cuff.
- In cycling, bike set-up is finely tuned to account for the individual athletes' unique anatomical structures, allowing them to produce force in the one position over a number of hours.
- In track athletics, throwers learn to refine the velocity and angle of projection of the object being thrown to produce the maximal effect, knowing that any variation will affect the outcome.



Figure 9.5 Using video and computer technology to analyse and improve a golfer's swing

Activity 9.3

Using biomechanics to improve sports-specific movements

For a selected sport, research and prepare a report which demonstrates how biomechanical principles are evident and applied to the execution of the specific technical skills required in that sport.

Skills: research, analysis

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Functional movements

Most sports also require the application of strength, power and force within the movements required for that sport. Consider the human movement patterns trained within specialised strength and conditioning programs, and how these transfer into the competitive arena. These functional and foundational movements include an upper body push, upper body pull, hip dominant movements and the use of ankles, elbows and knees to extend and flex the body as required. Connecting all these body parts and sequencing them together through complex movement patterns requires a highly functional core, including the many deep postural muscles around the trunk of the body. These dynamic movements involve synchronised and coordinated actions of these body parts to produce maximal strength and power in sports-specific contexts.

Therefore, in order to improve the effectiveness of these functional movements, athletes must develop the anatomical structures, by increasing the muscle size and or potential power output in order to increase performance. This can also reduce the risk of injury, as the body is able to handle the forces of competitive sport if they can be replicated within the gym. This is where complex resistance training, utilising elastic bands, chains, land mines, aqua bags and bosu balls, helps create dynamic movement challenges that athletes must react and adapt to as they execute more traditional movements. This training will transfer into greater performance on the field and reduced risk of injury as the body can withstand the physical demands of the game.



Figure 9.6 Elite footballers using bosu balls, aqua bags, elastic bands and land mines to enhance the training of dynamic functional movements such as lunges and squats

Activity 9.4

Analysing functional movements in sport

For three sports, select a single skill or movement to analyse, such as a baseball pitch. Find a slow-motion video and analyse the functional movements required to execute this skill and link this to the types of resistance exercises commonly used to train this movement.

Skills: research, analysis

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Equipment advances

There is a clear link between the development of advanced equipment and enhanced biomechanical advantage. Material and production innovations have led to lighter, more efficient and more powerful equipment. Obviously, these improve performance but can also be attributed to sustained performance, as the impact and load on the body may be reduced. Some examples to further investigate include the use of carbon fibre in cycling, the changing shape and materials in tennis racquets and golf clubs, the effect of carbon plates in running shoes, MIPS technology in cycling helmets, high performance track surfaces and protective equipment using 3D scanning and printing. The impact of technology in sport is further addressed later in this chapter.



Figure 9.7 Road cycling time trial uses advanced materials and production methods to create technologically advanced equipment, reducing weight and drag, which contributes to an increase in power.

Activity 9.5

Equipment advances and biomechanics

For a selected sport and piece of sporting equipment, research their historical development, highlighting how material and production advancements have enhanced the effect of biomechanical principles and led to sustained and improved performance.

Skills: research, analysis

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Activity 9.6



Biomechanics in sport

For a selected sport, research and prepare a report which demonstrates the application of biomechanical principles, considering how they relate to the physical activities, sports-specific movements, functional movements and technological and equipment advances required for sustained and improved performance in that sport.

Skills: research, analysis, communication

Practical application 9.2

Experiencing biomechanical principles in sport

In small groups, prepare a practical demonstration of the application of three biomechanical principles in a selected sport. Encourage all students to practise the skills, taking note of the principle in action, as well as the effect of equipment on performance.

Skills: collaboration, communication, analysis

Revise and summarise 9.1



Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Identify how relevant biomechanical principles are used to develop both **sustained** and **improved** performance for the following elements of sport:

- physical activity and general movement
- sports-specific movements and skills
- functional movements used to apply strength, power and force
- equipment advances.

Think critically and apply 9.1



For a sport or physical activity that you are personally interested in, consider how you can assess, refine and apply biomechanical principles to increase the efficiency and effectiveness of your own movements.

Skills: analysis, creative thinking

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9.2 Recovery strategies

Learning objective 9.2
JUSTIFY the importance of recovery strategies for improved movement and sustained performance.

Intense athletic training and competition places enormous strain on body systems, leading to the breakdown of complex molecules into simple ones, and changes within the body. This form of metabolism is known as **catabolism**, and is seen in muscle protein breakdown, glycogen and fat breakdown for fuel (known as glycolysis and lipolysis respectively), lactate accumulation and changes in hormone levels such as increased cortisol. The effects of the catabolic state can last from three to 24 hours, and during this time it is critical for athletes to rest well and consume the right foods and fluids. Once the body has fully restored homeostasis, the body then enters a state known as **anabolism**, where it rebuilds the broken molecules, particularly the micro-damage in muscle fibres. At the point where muscle fibres have been rebuilt, energy stores replenished and hormonal levels reset, the athlete is in prime condition to train or play once again.

Consider the intense playing schedules of many elite competitions. In the NBA, teams play on average 3.5 games per week. In the EPL, football teams may play up to 60 games across 40 weeks. Baseball teams will play over 160 games in six months. Planning microcycles around intense playing schedules, allowing for adequate recovery and then scheduling enough training sessions to maintain strength and conditioning and work on team game play and preparation is a great challenge.

Figure 9.8 demonstrates the three phases of recovery and how various recovery strategies following exercise aim to restore and rebuild a range of physiological characteristics, as well as psychological recovery. In order of time taken for recovery, these include:

- **Metabolic recovery:** restore all energy and fuel stores, clear metabolic waste products (e.g. hydrogen ions from anaerobic exercise), rebalance hydration and electrolyte stores.
- **Neuromuscular recovery:** intense exercise causes fatigue in the central and peripheral nervous system. Chemical imbalances and mild inflammation impair function and need to be reset. Athletes perceive this as general fatigue, and this is evidenced in a decrease in coordination and potential power the day after a game.
- **Structural recovery:** the longest aspect involves the repair of micro-damage to muscles, ligaments, tendons, connective tissue and bone.

Therefore, it is widely recognised that effective recovery strategies are a critical aspect in

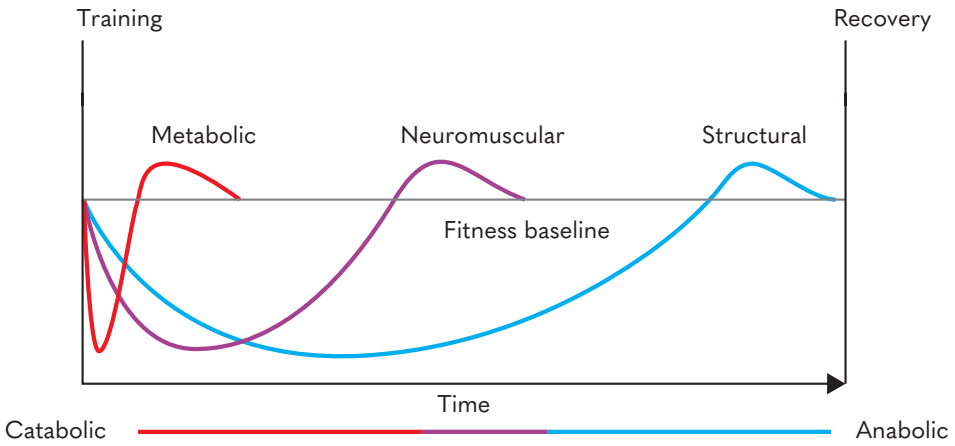


Figure 9.8 Recovery strategies following exercise aim to restore and rebuild a range of physiological aspects, including metabolic recovery.

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maximising athletic performance, reducing risk of injury and overtraining. Some fundamentally important recovery strategies have been previously addressed, namely the importance of effective cool-downs, quality sleep and ensuring adequate hydration and nutrition. In the next section, technology used to monitor and track athlete readiness to train and compete is explored. This technology assesses an athlete's ongoing quality and rate of recovery and sense of wellbeing which helps to ensure they are not risking overtraining.

Physiological recovery strategies

The goal of physiological recovery strategies is to quickly and effectively move through the catabolic and anabolic states of recovery. In doing so, all body systems are restored to full function, and hopefully the body's adaptation to the stimulus of exercise through supercompensation leads to a higher level of potential capacity.

Cool-down

It is generally assumed the cool-down only includes the five minutes of light activity after an intense game or training, but in fact it is a process of hours (and even days) which includes physical exercises and the consumption of food and fluids. These essential activities kick-start the process of metabolic and neuromuscular recovery. By gently slowing body systems back to resting levels, homeostasis is restored, particularly hormonal balance. The natural increase in cortisol and adrenaline following competition triggers a stress response which disrupts recovery and sleep.

Cool-downs including gentle exercises, static stretches and deep breathing signal to the mind and body that it can now rest (these activities were covered in more detail in Chapter 6). Continued movement of the body prevents blood and lymph from pooling, helping to cycle metabolic waste products out of the muscles to be removed. Static stretching helps relax and realign fatigued muscle fibres, decreasing next-day soreness and fatigue.

Post-exercise consumption

Consuming electrolytes and fluids is most effective immediately post-exercise (150% of fluids lost) to restore hydration levels. If the athlete can consume 20–30 grams of protein and 70–100 grams of carbohydrates within 60 minutes, the body is able to better absorb these nutrients, in preparation for the structural recovery that will commence during the anabolic window of recovery. These activities are considered part of a comprehensive cool-down and are often continued the following day during recovery sessions.

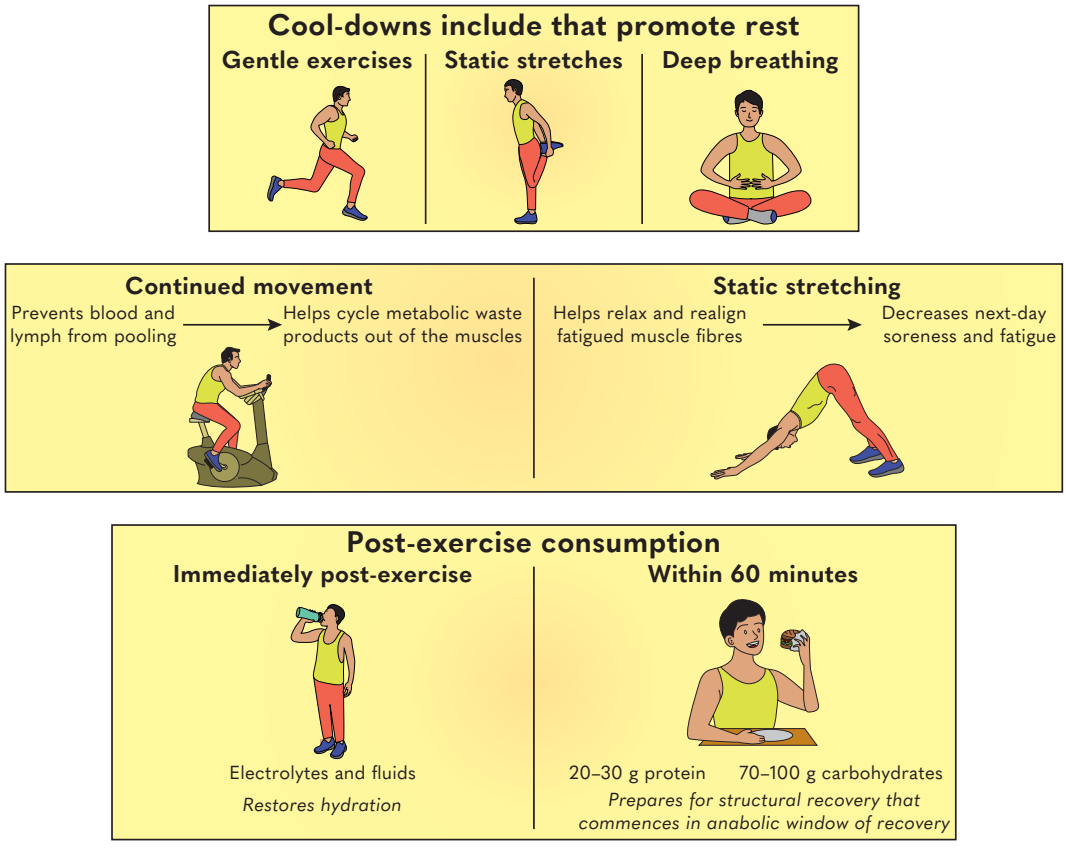


Figure 9.9 Essential activities that promote physiological recovery

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Hydrotherapy

The different techniques involving water that are used for different purposes in recovery, generally all promote neuromuscular recovery.

- **Warm water immersion** increases vasodilation, promoting blood flow around the body to help remove waste and deliver nutrients. The moving water from spa jets is relaxing and reduces muscle tension and soreness. Injured athletes should avoid excessive heat exposure which increases inflammation and pain.
- **Cold water immersion** is a unique way to promote neuromuscular recovery. There is conflicting research about the degree of physiological value, but many athletes report positive effects on perceived recovery from doing three to 12 minutes in 8°C to 12°C water following intense aerobic and anaerobic exercise. It should not be used following strength training, as it has been shown to impair hypertrophy.
- **Contrast water therapy** is another popular method where athletes move from cold water (one minute) to warm water (three minutes) from three to five times (able to be done in the shower). This leads to a deep sensation of relaxation and relief with the warm water helping to reduce neuromuscular tension from exercise.



Figure 9.10 Elite footballer using cryotherapy to enhance recovery following pre-season training

Psychological recovery strategies

The intense emotions of winning and losing under the pressure of thousands of spectators watching in person and more online is a unique experience only elite athletes experience. Many struggle to sleep after competition, due to racing thoughts and heightened emotions. It is important that this period of recovery also considers psychological strategies to instil emotions of positivity, contentment and motivation, while also managing the anxiety and frustration of negative performances.

Relaxation

There are a range of activities an athlete can use to induce a sense of psychological calm and relaxation immediately after a performance and in the days after. These are very personal, and athletes should experiment with different strategies to find what works for them. As previously discussed, sleep is crucial in recovery. While sleep is a passive activity, these relaxation techniques can also help athletes sleep longer and more deeply, where the body sets about the busy work of repair, growth and adaptation.

- Deep breathing and meditative exercises increase parasympathetic nervous system activity and lower cortisol and adrenaline levels to lower heart rate, blood pressure and muscle tension. They can help the athlete disconnect and take their mind of the intense events and memories of competition. Yoga is excellent as it can relax the body as the athlete benefits from the gentle static stretches while breathing deeply.
- Massage is used for physiological and neurological recovery to relax fatigued muscles, release specific points of tension and help drain metabolic waste products out of the muscles into the lymph system. However, it is also excellent for psychological relaxation as well.
- Socialising, hobbies and music are other common personal methods of relaxation. Spending time with family, playing some golf or enjoying music can have the effect of disconnecting and relaxing.

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Figure 9.11 Football team using stretching, meditation and breathing exercises to relax during a training camp

Activity 9.7

Recovery strategies of elite athletes

Find media articles and videos that highlight the various strategies elite athletes use to recover. Highlight these and use as examples for the strategies outlined.

Skills: analysis, research

Practical application 9.3

Recovery strategies

Using available facilities and resources, plan to experience a range of recovery strategies which elite athletes use. These could include preparing a recovery meal, experiencing warm, cold and contrast water therapy and practising relaxation techniques. Take note of the experience and the effect on the mind and the body.

Skills: collaboration, analysis

Revise and summarise 9.2

Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Explain what the process of recovery from physical activity involves.
2 Explain how physiological strategies promote recovery.
3 Explain how psychological strategies promote recovery.

Think critically and apply 9.2

Research the evidence base for a range (three to five) of popular recovery strategies commonly used by athletes and seen across social media. Reflect on the strategies which seem to be the most important and popular, and contrast with the strategies which have the strongest evidence base. What patterns do you see?

Skills: research, analysis

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9.3 Technology

Learning objective 9.3
EXAMINE the importance of technology for improved movement and sustained performance.

Technological developments have had a remarkable effect on society, including the world of sport. In general terms, electronic, engineering, communication, computing and production advancements have changed the landscape of sports competition, training and the experience of fans. Technology in sport is evident in the methods used in training to enhance performance, reduce injury risk, collect and analyse data, improve accuracy of officiating, fan engagement and stadium management. Consider the extent to which global sports such as tennis, cricket, football and basketball have been influenced by technology.

However, there are significant ethical considerations raised with the increasing use of technology in sport. Important questions include the following:

- Has technology gone too far and has it diminished the spirit of human endeavour through sport?
- Has sports technology compromised athlete health and safety more than it has protected it?
- Is it fair that some athletes have different levels of access to technology and does this affect the spirit of competition and sport?
- Has technology made historical sporting achievements less notable?

Due to the rapidly changing nature of technology, some of the examples presented in this section may have been further innovated or may have even disappeared and been replaced by other technologies by the time you are reading this textbook. You should research current technological advancements and assess their effect on sport.

Training innovations

Technological innovations have greatly advanced training methods, leading to the increased effectiveness of programming, training and monitoring of athletic progress. The increased use of digital technology has led to large amounts of data being produced that can be used to measure the effectiveness of training on performance. Some examples of training innovations include:

- Augmented reality (AR) and virtual reality (VR) using visual headsets, mobile apps, tracking sensors and connected cameras to overlay digital content and provide real-time data to create realistic and immersive game simulations for coaches, fans and athletes. These technologies are being used in training to provide real-time feedback to athletes to improve technique, visualise set plays, develop team tactics, prepare for opposition tactics and improve in-game decision making.
- Biomechanical analysis using high-speed cameras to analyse and improve technique to increase movement efficiency and effectiveness.
- Technology used to assess and monitor strength and conditioning training programs, such as force plates (see Case study 5.1, on p 159) and velocity-based training that can accurately measure a range of strength and power metrics to improve performance and detect potential injury risk.



Figure 9.12 Using force plates to measure an isometric mid-thigh pull, comparing the strength of left and right legs as well as strength progress

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Equipment advances

The development of equipment has been driven by the use of modern materials and production techniques to create sports equipment which is generally lighter, stronger and more individualised. Examples include the following:

- Carbon and graphite as materials have incredible strength to weight ratios and increase the stiffness and lower the weight of many pieces of sports equipment including tennis racquets, bikes, golf clubs, running shoes, skis, helmets, body armour and water craft.
- Production of equipment has been enhanced using 3D analysis and printing of equipment for individual athletes, such as shoe soles, protective gear (helmets, mouthguards and body armour), bicycle parts (time trial handlebars), tennis racquets and golf club grips, prosthetics for para-athletes and fitted sports clothing.
- Track and field surfaces are increasing performance through shock absorption and increased grip and are generally less affected by inclement weather.
- Equipment for para-athletes to help them overcome sensory and mechanical impairments such as lightweight wheelchairs, personalised carbon running blades and assistive devices to assist with sight and sound.
- Rehabilitation equipment for graduated exercises (floating treadmill that reduces body weight), electro, ultrasound and laser therapy to stimulate healing and rehabilitation and the use of VR and fitness wearables to track activity and guide exercises.
- Smart apparel and devices that can measure performance metrics for performance analysis, such as GPS tracking, shoes with accelerometers, power gauges on bikes, stroke power detectors in swimming, smart mouthguards and helmets that measure potential concussion.
- Officiating has been improved using cameras and laser technology to assist referees and umpires to make accurate decisions. Hawk-Eye cameras, video assistant referees, goal-line technology, photo-finish cameras and smartwatch technology has revolutionised many sports, reducing the human error in officiating.

Case study 9.1

Impact of Technology in Cricket: Revolutionizing the Game in 2024

Cricket has transformed dramatically from its origins to become a global phenomenon, engaging millions around the world. This evolution has been significantly propelled by technological advancements, altering how the game is played, experienced, and enjoyed. The impact of technology in cricket has been pivotal in this transformation, making the sport more accessible and appealing to a broader audience. This 2024, we're witnessing an unprecedented revolution in cricket, thanks to the latest technologies that are enhancing every aspect of the game.

Traditionally, cricket was a simple sport, with minimal equipment and reliance on physical skill and strategy. However, as technology progressed, its integration into sports became inevitable and highly beneficial. Today, technology is not just an add-on; it's a crucial component in the development and execution of the game, influencing training, performance analysis, fan engagement, and even the decision-making process during matches. ...

The integration of technology in cricket has been nothing short of revolutionary. As we move through 2024, we are witnessing firsthand how these technological advancements are reshaping the game, making it more dynamic, inclusive, and engaging for everyone involved. The journey of cricket's evolution through technology is a powerful reminder of how innovation can elevate sports to new heights, offering unprecedented opportunities for enhancement and growth.

continued

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Case study 9.1 *continued*



Figure 9.13 Traditionally, cricket was a simple sport, with minimal equipment and reliance on physical skill and strategy.

Revolutionizing the Game: The Impact of Sixes Cricket on Modern Cricket

In the modern era, the impact of technology in cricket has redefined how the sport is played, experienced, and enjoyed, extending beyond professional stadiums to innovative entertainment venues like Sixes Cricket. As a blend of restaurant, bar, and cricketing experience, Sixes Cricket has emerged as a unique player in the cricketing world, offering an engaging way for fans to connect with the game .... By utilizing virtual bowlers and quality cricket batting cages within a social setting, Sixes Cricket offers guests the chance to experience the thrill of batting against world-class bowlers, without the need to step onto a cricket field. This innovative approach not only enhances the social aspect of cricket but also makes the sport more accessible to a wider audience.

The significance of Sixes Cricket in the broader context of cricket's evolution lies in its ability to marry technology with entertainment, creating a new avenue for fan engagement. In an age where digital experiences are highly sought after, Sixes Cricket provides a tangible way for people to interact with the sport, blending the physical and digital worlds seamlessly. This is particularly impactful in regions where cricket is a beloved sport, as it offers a novel way to enjoy cricket year-round, regardless of weather conditions or outdoor space limitations.

Moreover, Sixes Cricket plays a crucial role in introducing the sport to those who may not have had the opportunity to play cricket traditionally. By lowering the barriers to entry, such as the need for equipment, playing fields, or advanced skills, Sixes Cricket democratizes the sport, making it more inclusive. This inclusivity is vital for the growth of cricket, as it opens up the sport to a broader demographic, including families, casual fans, and those looking for an enjoyable group activity. ...

The impact of Sixes Cricket on modern cricket is multifaceted, offering a bridge between traditional cricket and the digital age. It exemplifies how technology can be harnessed to enhance the cricketing experience, making the sport more accessible, enjoyable, and engaging for a wide range of audiences. As cricket continues to evolve, the innovative approach of Sixes Cricket serves as a model for how technology can be used to bring the sport into the future, ensuring it remains relevant and beloved by generations to come.

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Case study 9.1 *continued*

Enhancing Player Performance and Skills

The intersection of technology and cricket has ushered in a new era where player performance and skill enhancement are more scientific and data-driven than ever before. ...

Wearable technology has become a cornerstone in monitoring and improving player fitness and performance. Devices like fitness bands and smartwatches are now standard gear for cricketers. ... By analyzing trends over time, coaches can make informed decisions on workload management, ensuring athletes are in peak condition for their matches.

The revolution doesn't stop at fitness tracking. The cricket world has also embraced advanced batting and bowling simulators, which have become crucial in skill development. These simulators recreate match conditions, allowing players to practice without being on the field. They can face a variety of bowling styles and speeds in a controlled environment, which is invaluable for refining their techniques. Batting simulators, equipped with sensors and cameras, provide instant feedback on every shot, analyzing aspects such as bat speed, angle, and the point of impact. This immediate feedback loop helps players to make adjustments in real-time, accelerating the learning process.

Bowling simulators are equally sophisticated, offering bowlers the chance to work on their deliveries against virtual batsmen. These technologies can simulate different pitch conditions, allowing bowlers to adapt their techniques to various environments. This kind of practice was unimaginable a few decades ago but is now a fundamental part of training regimes in professional cricket.

Another critical technological advancement in cricket coaching and training is the use of video analytics. High-speed cameras capture every minute detail of a player's technique during practice sessions and live matches. This footage is then analyzed using specialized software to evaluate performance and identify areas for improvement. ... Simulation technologies and video analytics [also] allow players to experience match-like conditions repeatedly, helping to build confidence and reduce anxiety under pressure. This mental conditioning is crucial for performing well in critical moments of the game.

Game Strategies and Analytics

... In recent years, cricket has seen a significant shift towards data-driven decision making. Teams and coaches now rely on big data and AI to craft winning strategies. These technologies sift through vast amounts of data, from player performance records to historical match outcomes, to provide insights that were previously unimaginable. For instance, analytics can predict an opposing batsman's weakness or a bowler's likelihood of success against certain players. This depth of analysis allows teams to make informed decisions on everything from team selection to field placements and bowling changes. ...

Another critical area where technology has made significant inroads is in monitoring player health and preventing injuries. Wearable devices are now common, providing real-time data on a player's physical condition during training and matches. This data, when analyzed, can alert support staff to potential overexertion or the onset of an injury, allowing for immediate intervention.

Moreover, predictive analytics play a crucial role in assessing injury risks. By analyzing data on players' physical exertions and match conditions, AI models can predict the likelihood of injuries. This allows teams to proactively rest players or adjust their training regimens, significantly reducing the risk of injuries. For example, the Indian Premier League (IPL) teams have been pioneers in using predictive analytics for injury prevention, utilizing the insights to manage their players' workloads effectively throughout the gruelling tournament schedule. ...

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Case study 9.1 *continued*

As technology continues to evolve, its integration into cricket is expected to deepen further, offering even more sophisticated tools for strategy formulation and health management. The potential benefits are immense, from developing unbeatable strategies based on AI's predictive powers to creating near-bulletproof health management protocols that keep players at their physical peak. ...

Enhancing Audience Engagement and Experience

Gone are the days when watching cricket was a passive activity. Today, VR [Virtual Reality] and AR [Augmented Reality] technologies are turning fan engagement into an immersive experience. Through VR headsets, fans can now enjoy a 360-degree view of the match as if they were sitting in the stadium, regardless of their physical location. This technology brings the excitement of the game to fans who can't attend the matches in person, bridging the gap between the stadium and the living room.

AR apps take this a step further by overlaying digital information onto the real world, enhancing the live game with stats, player information, and more. Imagine pointing your phone's camera at the TV during a live match and instantly getting statistics about the player currently batting. This layer of interactivity enriches the viewing experience, making it more engaging for fans.

One notable example of AR in action is at The Oval in London, where fans used an AR app to unlock exclusive content and experiences during the match.

These technologies are not just gimmicks; they represent a new era of fan engagement, offering a richer, more informative, and interactive experience.

The digital revolution has also transformed how fans connect with their favorite teams and players. Social media platforms like Twitter, Instagram, and Facebook have become vital tools for fan engagement and community building. Teams and players share behind-the-scenes content, match highlights, and personal stories, providing fans with a glimpse into the lives of their cricketing heroes. ...



Figure 9.14 Beth Mooney and Alyssa Healy of Australia take selfies with fans during the Women's T20 International Series, 2024. Social media has transformed how fans connect with their favourite teams and players.

continued

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Case study 9.1 *continued*

Social media and digital platforms will continue to evolve, offering new ways for fans to connect with the sport and with each other. The potential for personalized content, based on fans' preferences and viewing habits, could make every fan's experience unique. ...

Innovations in Cricket Equipment

... The traditional cricket bat and ball have received a high-tech makeover, significantly influencing player training and performance analysis. Smart cricket bats, embedded with sensors, are a groundbreaking innovation in this domain. These sensors capture detailed data on every shot played, including the bat's speed, angle, and the point of impact with the ball. This information is instantly relayed to players and coaches, providing immediate feedback that can be used to refine techniques and improve performance.

One of the leading examples of this technology is the PowerBat technology, developed in collaboration with Microsoft and Spektacom. Used in professional leagues, such as the Indian Premier League (IPL), it offers insights into the batsman's playing style and efficiency, enabling personalized coaching and development strategies.

Similarly, smart cricket balls equipped with microchips have made their way into the game. These balls can measure speed, spin, and bounce accurately, offering a deeper analysis of a bowler's delivery. This technological advancement not only aids players in honing their skills but also enhances the viewing experience for fans, providing them with detailed statistics during live broadcasts. ...

The development of impact-sensing technology in helmets is a notable advancement in this area. These helmets come equipped with sensors that can detect the severity of an impact, providing immediate data on potential concussion risks. This technology is instrumental in making quick decisions about a player's fitness to continue in the match, significantly reducing the risk of long-term injuries.

Moreover, protective gear such as pads and gloves has also seen technological enhancements. Materials that are both lightweight and highly protective are now used, allowing players to move freely while being adequately shielded against injury. Smart vests, which monitor heart rate and impact, are increasingly being used in practice sessions to ensure player wellbeing.

The ... advancements in protective gear have been a game-changer. With players often facing balls bowled at high speeds, the enhanced protective equipment provides a much-needed assurance of safety, allowing players to focus on their game without fear of injury. The integration of technology in safety gear also means that potential injuries can be quickly assessed and managed more effectively, ensuring players' health is always a priority. ...

Challenges and Ethical Considerations

... Cricket is steeped in tradition, with a history that spans over a century. The introduction of high-tech equipment and analytical tools has sparked debates among purists who fear that excessive reliance on technology may dilute the essence of the sport. For example, while Hawk-Eye and the Decision Review System (DRS) have made cricket fairer, some argue that they undermine the authority of on-field umpires and the traditional aspect of human error being part of the game's charm.

The challenge lies in integrating technology in a way that respects cricket's traditions while embracing the benefits that innovations bring to the game. This requires a delicate balance, ensuring that technology serves as an aid rather than becoming the focal point of the sport. Governing bodies like the International Cricket Council (ICC) play a crucial role in this, setting regulations that dictate the extent and manner in which technology can be used, ensuring it enhances rather than overshadows the sport.

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Case study 9.1 *continued*

Another significant concern is the accessibility of advanced technologies, which can vary greatly between wealthy and less affluent cricketing nations or even among domestic teams. High costs associated with implementing technologies like real-time performance tracking systems or advanced analytics software may widen the gap between rich and poor teams, potentially affecting the level playing field that sports strive to offer. ...

The rapid advancement and integration of technology in cricket also bring about ethical considerations related to data privacy and the potential for misuse. Wearable tech and analytics tools collect vast amounts of personal data from players, raising concerns about who has access to this data and how it is used. Ensuring that data privacy laws are adhered to and that players' personal information is protected is paramount.

Additionally, the potential for technology to be misused, such as unauthorized enhancements to equipment or exploiting data analytics for unsporting purposes, poses a risk to the game's integrity. This necessitates robust frameworks and regulations to govern the use of technology in cricket, ensuring that it is used ethically and in the spirit of the sport.

Addressing these challenges and ethical considerations is crucial for ensuring that technology continues to benefit cricket without detracting from its essence or fairness. This involves ongoing dialogue among all stakeholders, including players, coaches, governing bodies, and fans, to find common ground that respects cricket's traditions while embracing innovation. ...

The Future of Cricket: Navigating Technology's Impact Beyond 2024

... Technology has undeniably revolutionized cricket, making it more exciting, engaging, and fair. As we move forward, the continued integration of technological innovations promises to enrich the sport even further, offering new opportunities for players to excel, fans to connect, and the game to grow globally. The future of cricket, shaped by technology, looks bright, filled with possibilities that were once unimaginable.

By embracing the benefits while carefully navigating the challenges, cricket can continue to evolve, preserving its essence while exploring new frontiers. The impact of technology in cricket is a testament to the sport's adaptability and resilience, ensuring that it remains relevant and beloved by millions around the world for generations to come.

'Impact of Technology in Cricket: Revolutionizing the Game in 2024', Sixes Social Cricket Blog, 1 April 2024

1 Summarise the ways in which technological developments have influenced cricket performance, participation and engagement.
2 Research and compare how technological developments have influenced another sport of your choice.
3 Describe the ethical considerations of the increasing influence of technology in sport.

Skills: analysis, communication

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Recording and monitoring training and performance

A range of technologies and equipment are used to help record and monitor training programs and competitive performances. Embedded technologies such as those found in shoes, clothing, helmets, sports equipment, mouthguards, wearables, GPS sensors, motion capture systems, biomechanical analysis cameras and software and increasingly, AI, are all used to gather and analyse immense amounts of data that can more accurately and reliably track the effect of training programs and quality of performances. These metrics are used by coaching teams to assess performances, training sessions and track development and progress. Monitoring athlete recovery and wellbeing is another area of valuable data assessment. By gathering player feedback through mobile apps tracking sleep, mood, fatigue, as well as their physical output, special software is able to monitor for changes which may indicate overreaching, which can become overtraining if not managed well.

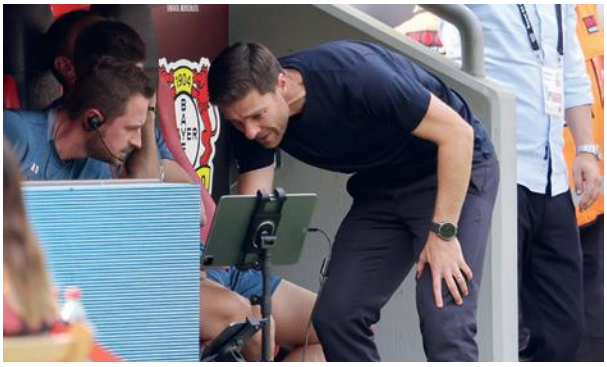


Figure 9.15 Use of video, computer and communication software during a football match to analyse the game and to prepare feedback to improve performance

Activity 9.8

Depth Study

Technology in sport

For a selected sport, research, analyse and compare the effect of technological developments on training and performance.

Skills: research, analysis, collaboration

Practical application 9.4

Comparing the effect of technology in sports equipment

For a sport of your choice, find two pieces of sporting equipment, one modern and one old, that have a marked difference in technological development. Use each piece of equipment and compare the effect on performance.

Skills: collaboration, analysis

Revise and summarise 9.3

Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

Demonstrate how technology has been used to improve:

- training innovations
- equipment advances
- recording and monitoring training and performance.

Think critically and apply 9.3

Pose arguments for and against the following ethical questions in relation to technology in sport, and debate these with the class.

- Has technology gone too far and has it diminished the spirit of human endeavour in sport?
- Has sports technology compromised athlete health and safety more than it has protected it?
- Is it fair that some athletes have different levels of access to technology and does this affect the spirit of competition and sport?
- Has technology made historical sporting achievements less notable?

Skills: collaboration, analysis

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9.4 Management and prevention of sporting injuries

Learning objective 9.4
EXPLAIN strategies used to prevent and manage sports injuries.

Injuries are inherent to all forms of physical activity, in particular competitive sport with the increased intensity. While it is impossible to prevent injuries from occurring, there are a wide range of strategies which can reduce the severity or risk of an injury. It is in the interest of all stakeholders to invest time and resources in effective injury prevention, management and rehabilitation, as an injured athlete obviously cannot compete and no one wants to see an 'expensive asset' sitting on the sideline, unable to fulfil their potential and achieve their goals.



Figure 9.16 Brodric Martin is checked for injury during a pre-season game between the Detroit Lions and the Pittsburgh Steelers in 2024.

Activity 9.9

Common injuries in sport

Brainstorm 10 different **types** of sporting injury. Link each type of injury with a common body part and issue type, and a common sporting cause. Identify strategies to reduce the severity or risk of the injury occurring.

Skills: collaboration, creative thinking, analysis, communication



Figure 9.17 Helen Housby injures her finger during a Suncorp Super Netball match between NSW Swifts and Collingwood Magpies in 2021.

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Classification of sports injuries

Sports injuries are classified (grouped into like categories) for a number of important reasons, including:

- to enable the effective diagnosis of injury type and severity
- to prescribe immediate actions of treatment and an effective rehabilitation plan (e.g. broken bones having similar timeframes for healing, requiring similar protections)
- to identify common causes and gather statistics on the rates of certain injury types, leading to the research and implementation of strategies to reduce risk (e.g. the best strength training methods to reduce incidence of hamstring strains in AFL)
- to enable clear communication between professionals (physiotherapists, doctors and coaches) using the same anatomical language, such as left medial ligament.

Sports injuries are classified according to:

- **cause** of injury: direct or indirect
- **type** of injury: soft or hard tissue
- **onset** of injury: overuse or acute.

Direct and indirect

Understanding whether an injury was caused by external or internal force helps diagnose the injury type and can be used to guide prevention strategies.

Direct injuries result from external forces (object or person) coming into contact with the body, where the site of injury is at the site or point of impact (e.g. fractured eye socket from an elbow in basketball). Collision, combat and contact sports all increase the risk of direct injuries. Good technique and safe equipment and facilities can reduce the risk and impact of direct injuries.

Indirect injuries result from excessive internal forces, greater than those which the body can absorb and handle. There are two causes of indirect injuries:

- internal forces acting on body tissues which are greater than the capacity of the tissue to withstand, often caused by overexertion, fatigue, poor technique or lack of appropriate fitness (e.g. a sprint in the 4th quarter leading to a strained hamstring)
- an external force applied to the body, but the injury site is at a location distant from this. For example, falling on to an outstretched hand, leading to an elbow dislocation.



Figure 9.18 Collision, combat and contact sports all increase the risk of direct injuries.

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Soft or hard tissue

All body tissues are unique in their specific roles, structures and limitations. Understanding the type of tissue that has been injured allows professionals to effectively plan rehabilitation.

Soft tissue

Soft tissue injuries include damage to:

- muscles and the tendons which connect them to bones (strained, torn or pulled). Muscles can also become bruised with internal bleeding (known as a contusion or hematoma).
- ligaments which cross joints and connect bone to bone (sprained, torn or pulled)
- cartilage and joint capsules inside joint spaces (sprained or torn)
- skin injuries including lacerations, abrasions/grazes, punctures or blisters
- any damage to organs other than bones and teeth (eye, lungs, kidney, testicles, etc.).

Soft tissue injuries are graded according to severity, labelled as **Grade 1, 2 or 3**. These indicate the likely timeframe and guide the treatment and rehabilitation plan required for complete healing.

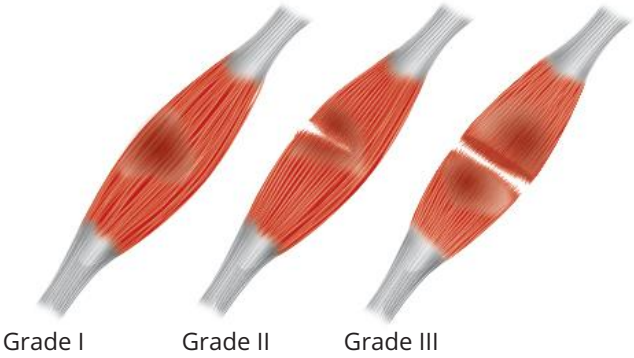


Figure 9.19 Grades of severity of strain and tears in muscle fibres

Table 9.1 Summary of the three grades of soft tissue injury

	Grade 1 / 1–2	Grade 2 / 2–3	Grade 3
Damage	Slightly stretching or tearing	Partial tear of a moderate number of fibres	Complete rupture or tear of muscle ligament or tendon
Pain	Mild, most noticeable during movement	Moderately noticeable during rest and movement	Severe and sustained for days to weeks
Swelling / bruising	Minimal or none	Moderately present and visible	Significant and clearly visible
Function	Minor impact on movement or strength	Limited strength, movement and stability	Severe loss of movement, strength and stability
Recovery time	1–3 weeks	3–6 weeks	3 months or more (may need surgery)
Example	Mild ankle ligament sprain	Moderate hamstring strain	Achilles ligament rupture

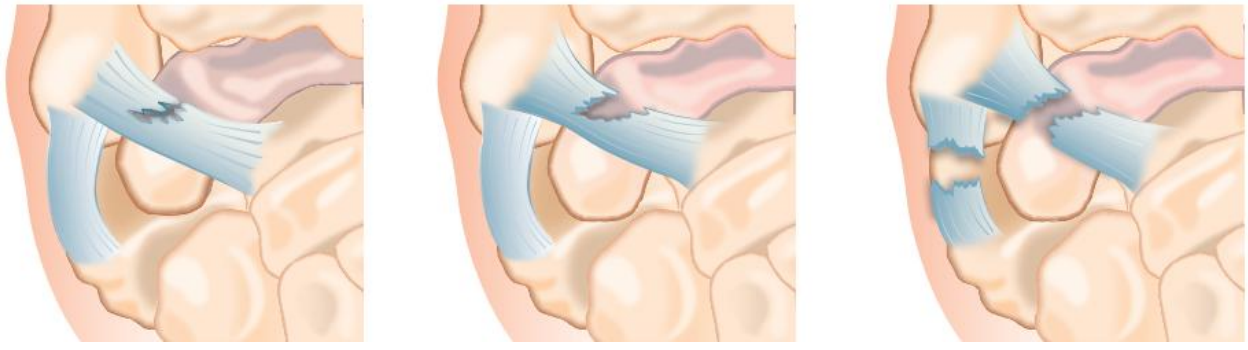


Figure 9.20 Grades of severity of strain and tears in ligaments

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Hard tissue

Hard tissue injuries involve bones, joints and teeth. There are two major types:

- Fractured (broken) bones: Types of fractures include hairline (stress), greenstick (partial), simple (closed), compound (open), comminuted (fragmented), compression (from impact between bones) or transverse, oblique or spiral fractures (referring to the angle of fracture). Fractured bones can also damage surrounding soft tissues, such as in the case of a punctured lung or torn artery.
- Dislocations: Joint integrity is reduced through the forced and sustained separation of bones that form a joint. Subluxation involves a temporary separation of the bones before they come back together. Note that many dislocations also cause damage to soft tissues surrounding a joint, such as a dislocated humerus (shoulder) tearing the rotator cuff and joint capsule.

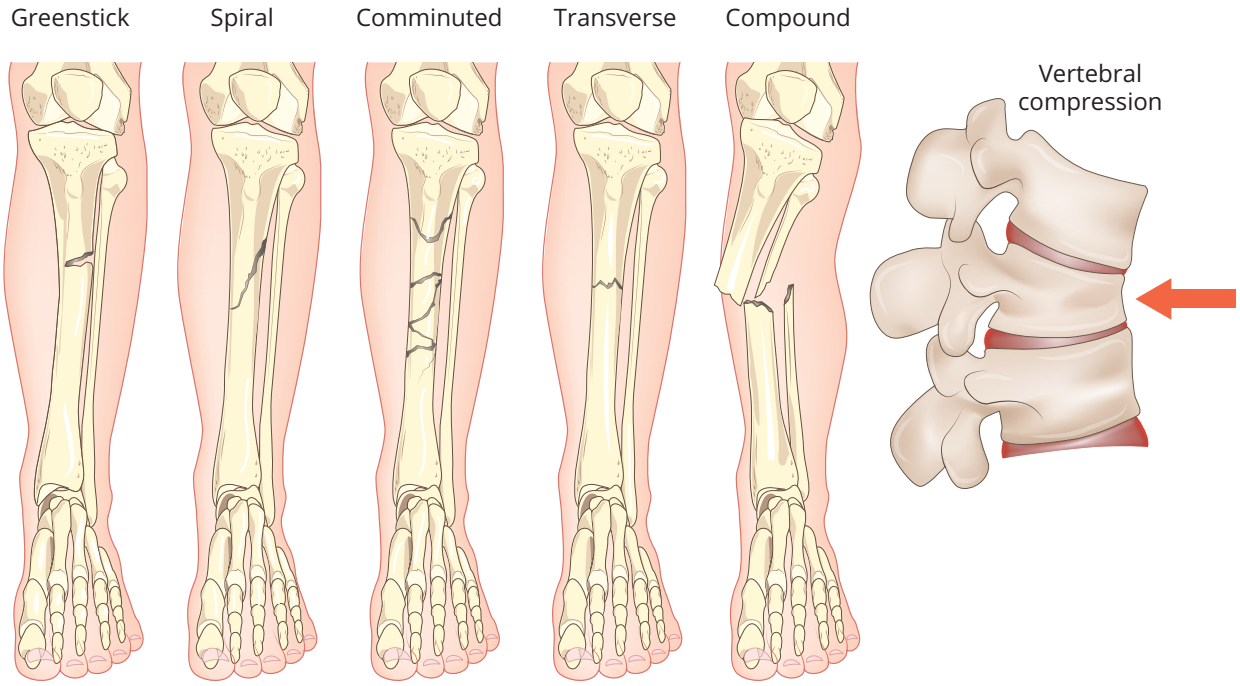


Figure 9.21 Examples of some bone fracture types

Overuse

Injuries that develop over time are referred to as **overuse** injuries. These result from physical activity leading to mild damage and trauma to tendons, ligaments and bones. Poor technique, excessive load, incorrect equipment or footwear and inadequate rest and recovery can cause tissues to become **chronically** inflamed, requiring an extended period of rest to decrease pain, swelling and restore function.

Common sites of overuse injuries are where ligaments connect with bones or tendons connect with muscles or bones. These attachment sites where one tissue type is fused with a different tissue type are a potential source of weakness, as seen in craft or construction where different materials that are joined together are weaker than a single material type.

Common examples include **tendonitis** (itis = inflammation), **bursitis** (inflammation of bursae, which are fluid-filled sacs that cushion between muscles, tendons and ligaments) and **stress fractures** in bones leading to pain and weakness. See Figure 9.22 for some typical locations.

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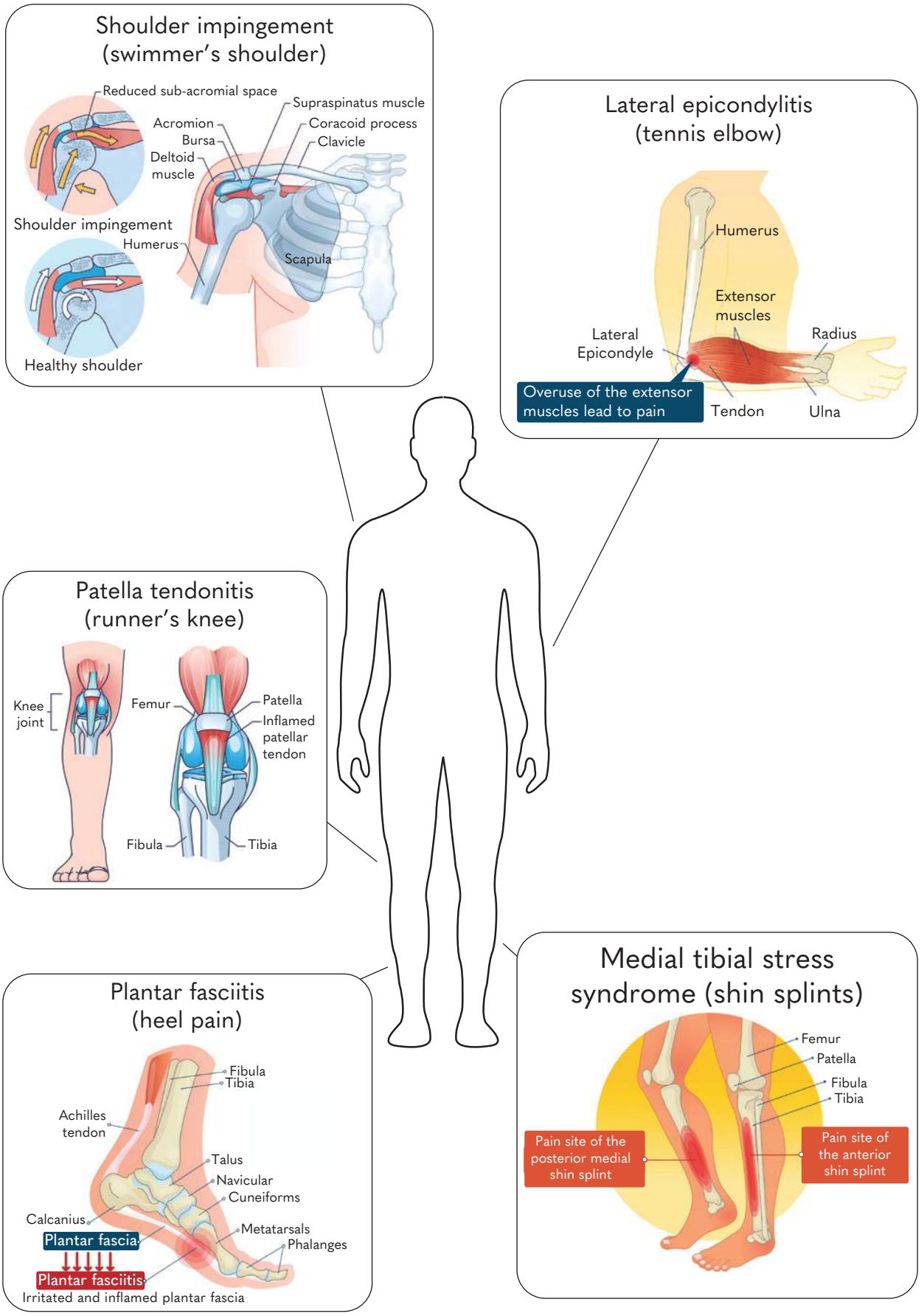


Figure 9.22 Common examples of overuse injuries

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Activity 9.10

Classifying and researching common sports injuries

For a selected sport, research the rates and severity of common injury types and arrange according to classification. Critically analyse the mechanism of the more common and severe injuries in this sport.

Skills: collaboration, creative thinking, analysis, communication

Assessment of sports injuries

Assessment of sports injuries requires a high degree of education and training and should be undertaken by skilled professionals (sports trainers, sports physiotherapists or sports doctors). There are two contexts that require an accurate assessment of sports injury:

- immediately during competition, where there has been an acute injury, and a rapid assessment of the nature and severity of injury is required. In this case, the decision made will be to either:
  - allow the athlete to continue playing (no further risk of injury)
  - temporarily remove the athlete for further assessment and possible immediate interventions to allow them to continue to participate (apply temporary bandaging or strapping)
  - fully remove the athlete from the game as the athlete is unable to safely continue, and determine whether supports are needed to protect the injury (crutches, braces).
- outside of competition, where a more thorough expert assessment using scans (X-ray, MRI) allows a more accurate diagnosis of the nature and severity of injury, and the planning of an appropriate rehabilitation program.

TOTAPS

The TOTAPS protocol is used to guide sports injury assessment, especially in the context of an injury during a game. At each step, the assessor is aiming to determine the cause, type and severity of injury and whether the athlete can safely continue or not.



Figure 9.23 A sports physiotherapist performs a TOTAPS assessment during a tennis match.

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Table 9.2 Summary of the TOTAPS protocol for sports injury assessment

Step	What?	Why?	How?
Talk	Ask questions of the athlete about the injury.	Answers indicate possible injury classification and severity.	Where does it hurt? What happened? Did you feel or hear anything? How severe is the pain? Has this happened before?
Observe	Visually inspect the injury.	Some injuries provide visual signs of injury type and severity.	Look for deformity, swelling, bruising. Check for discomfort on face and movement limitations. Compare both sides of the body.
Touch	Use hands to feel around the injured site.	Detect the level of tenderness, pain or deformity.	Gently palpate around injury, asking for sites of increased pain and look for discomfort. Feel for any deformity, comparing both sides of the body.
Note: At this point of the assessment, the type and severity of injury should be known. For serious injuries, TOTAPS will be stopped as the athlete is unable to continue and requires further assessment and care. If there is a chance they may be able to continue playing, continue with TOTAPS.			
Active movement	Athlete moves the injured body part unassisted.	Assess level of unhindered range of motion.	Athlete performs movements through full range of motion, observing limitations and level of pain. Skip next step if easily passed.
Passive movement	If unable to complete active movement, assistance is provided to check range of motion.	Assess range of motion, and the site and level of pain.	Trainer supports movement of the injured site to assess joint and muscle range of motion, observing limitations and level of pain.
Skills test	Undergo a range of increasingly demanding physical skills to test ability to safely return to play.	Ability to perform the intensity and skills required for the sport.	Example for ankle sprain: stand → single leg balance → walk → jog → jump → hop → change directions → sprint → sports skills (kicking). If all skills are passed and athlete feels stability and strength, they may continue.
Note: If the athlete passes these tests, the athlete should be able to return to play. If at any point they fail a test, they may need to be removed or given extra supports to allow them to more safely return to play (e.g. with ankle strapping). Accurate and expert assessment is required to do this safely.			

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Management of sports injuries

Accidents in sport can lead to life-threatening issues potentially affecting the nervous system (brain and spinal cord), cardiovascular system (heart attacks or excessive bleeding), respiratory system (asthma attacks) and the skeletal system (complex fractures and dislocations). In these severe cases, DRSABCD and emergency protocols should be followed to provide first aid support until professional medical help arrives.

Hard tissue or life-threatening injuries

Fractures and dislocations leading to hard tissue injuries, will generally require removal from competition, and medical attention for further scans and follow up supports such as a cast or brace. Most bones take 6–8 weeks to heal and can then be gradually loaded up again. Complex fractures require surgery to reset them, sometimes with the use of hardware to help secure them as they heal. Damage to surrounding soft tissue from dislocations is considered a soft tissue injury once the joint has been relocated (called a closed reduction, which should only be attempted by trained professionals).

Occasionally, athletes can play on with minor finger dislocations or minor subluxations if the pain is bearable and full function is restored with strapping supporting the injury until a full assessment can be completed later after the game.

Immediately following a hard tissue injury, rest and immobilise using braces, splints, slings and bandaging, ensuring the pain is minimised until medical attention can be accessed. Athletes with serious fractures, dislocations or possible spinal damage should not be moved, and left in a supported comfortable position until medical help arrives. Less seriously injured athletes can be moved only if comfortable to do so, using a stretcher or Medicab if available, with the priority being on the injured athlete, not the game.

Soft tissue injuries

For less serious sports injuries that are not life-threatening, it is assumed there is some degree of internal damage to **soft body tissues**, with cells being broken apart and separated from one another, leading to the disruption of homeostasis and healthy functioning. This damage triggers the **three phases of the inflammatory response**, which may vary depending on the tissue type and severity of injury. A detailed understanding of these phases will help students recognise the importance of the various steps of rehabilitation, and how management procedures ensure the time to return to play and chance of reinjury is reduced. These phases overlap one another with many variables and differences depending on the injury.

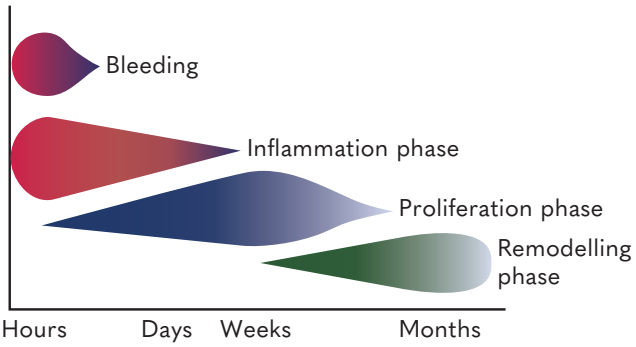


Figure 9.24 The three overlapping phases of the inflammatory response

A summary of the three phases of the inflammatory response, from injury to return to full health, include:

1. **Inflammation phase (0–72 hours)**: Immediately following an injury, the body responds by **protecting** and cleaning debris from the injured site, by initiating an acute inflammatory response. The body increases blood flow through vasodilation and sends immune (white blood) cells to clear damaged tissue and bacteria. Fluid accumulates around the injury, increasing swelling, discolouration and heat. Special chemicals signal pain to nearby nerve endings, the body's inbuilt mechanism for initiating rest and preventing further injury.
2. **Proliferation phase (from 48 hours up to six weeks):** As inflammation starts to decrease and the injured site is cleared of waste, the process of **rebuilding** begins through the repair and regeneration of damaged tissues and blood vessels. Specialised cells help collagen (a protein found mostly in connective tissue) to be laid down in a disorganised manner across the injured fibres to act as a bridge or scaffold for healthy cells to form across.
3. **Remodelling phase (from four days to beyond six months):** The temporary, weak and inflexible collagen fibres transition and transform into the original cell type through specialised processes and cell division. Gradual increase in load and stress through light exercises (aerobic,

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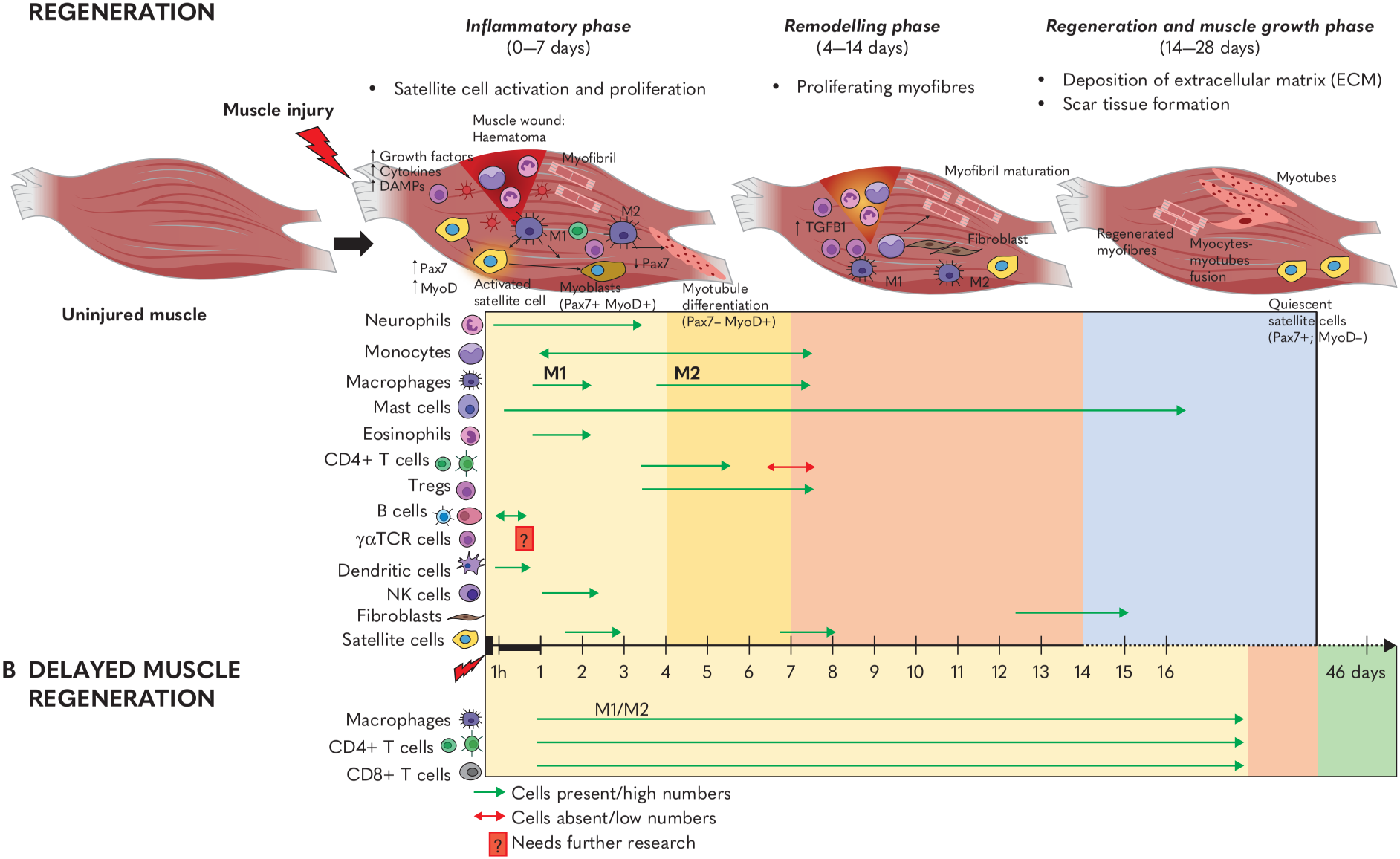


Figure 9.25 Detailed image of torn muscle fibres, showing the three phases of the inflammatory response

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strength and flexibility) stimulate increased strength and flexibility of the new tissue, as the collagen becomes more organised, becoming what is called scar tissue. Continued training ensures scar tissue is minimised, as it is less flexible and weaker than surrounding healthy tissue. Scar tissue sites are at an increased risk of reinjury, and effective rehabilitation decreases the amount of scar tissue. As the injured tissues continue to heal and new healthy cells form, they return to full homeostasis, ready to be gradually progressed through training to preinjury levels of capacity.

During the initial stages of **soft tissue injury** where internal bleeding and inflammation is most evident, certain procedures support the body's natural healing processes. The commonly used **RICER** (rest, ice, compression, elevation and referral) protocol has been adapted, with many people now using **POLICE** to guide the early stages of rehabilitation. POLICE has an increased emphasis on active recovery, while still maintaining the important aspects of RICER. It is assumed that injured athletes will seek referral to the appropriate medical professional to diagnose and guide all steps of rehabilitation, which may include general practitioners, sports doctors, scanning services (X-ray, MRI), specialist surgeons and physiotherapists.

Table 9.3 Summary table of the POLICE protocol for soft tissue injury management

Step	What?	Why?	How?
Protect	Rest and reduce movement and load on the injured site.	To prevent further injury.	Use braces, crutches, bandaging, moon boots to protect and safely rest to reduce risk of injury.
Optimal Loading	As soon as possible, introduce gentle movements and weight bearing actions within mild pain limits.	Promotes early tissue healing, mobilises movement of healing blood in and waste products out, reduces muscle atrophy, reduces stiffness to restore full range of motion.	Active range of motion movements, progress to weight bearing and gradually introduce more challenging activities, such as light walking and static stretches within mild pain limits.
Ice	Apply cryotherapy using ice bags (with clingwrap) or cold water immersion to cause vasodilation and removal of waste products and swelling.	Icing can slow initial inflammation and reduces pain immediately post-injury. Ice applications twice per day for the first 2–4 days helps remove waste and debris through vasoconstriction, allowing fresh blood and healing properties to cycle into the injured site.	Inflammation is necessary for healing and so there is now less emphasis on excessive icing. A few cycles of effective icing can help ease intense swelling and pain while still supporting natural healing processes.
Compression	Apply compression around the injury using bandages.	Reduce excessive inflammation and associated pain. Can also protect the injured site and provide a sense of support.	Use cling wrap while icing to increase depth of cryotherapy, and then compression bandaging afterwards.
Elevation	Raise the injured body part above horizontal while not active in the first few days.	Help drain blood, lymphatic fluid and waste away from the injury and reduce excessive inflammation and associated pain.	Lay down, or sit with leg or arm elevated so gravity can help drain waste fluid away.

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Skin injuries

Serious **skin injuries** such as a deep laceration or puncture through the skin require immediate medical attention and the priority is to control bleeding through **pressure** and compressions using sterile pads and bandages, **elevation** and **rest** (**PER**). Less serious injuries follow similar procedures and can be managed, allowing an athlete to continue performing. The goal is to control infection through hygienic practices and materials and prevent further damage through bandaging and taping.



Figure 9.26 Road cyclist having his skin injuries attended to as he continues to race

Rehabilitation of sports injuries

Following the initial management of a sports injury, the athlete commences a period of rehabilitation, seeking to restore the body part to preinjury levels of capacity, as fast and safely as possible. Rehabilitation procedures start as soon as injury occurs. The use of cold and optimal loading of the injury using gentle loading and range of motion movements is considered the first step of rehabilitation, seeking to work within the limits of mild pain. Rehabilitation continues until the athlete returns to full competition as these procedures gradually increase function and capacity. In this context, rehabilitation includes the time-frame from immediate injury until the athlete is ready to recommence at the level of competition at which they performed prior to injury. This period is also one of vulnerability as the effects of reversibility cause a reduction in tissue tolerance to endurance, load and stretching. Introducing excessive volume or load of exercise may cause reinjury and must be carefully managed. The following steps overlap with one another, being used at various points throughout rehabilitation.

Progressive mobilisation

The first benchmark of rehabilitation is to restore pain-free and full range of motion (ROM) in the muscle and joints. Restriction is caused by swelling during the acute inflammatory phase, loss of function from damaged body tissue and scar tissue. Optimal loading is used to progressively increase ROM as soon as possible. Conversely, excessive rest and inactivity will increase joint stiffness, leading to increased scar tissue which is difficult to reduce once it hardens. Figure 9.27 shows a simple progression. It should be noted that these can all be done within mild pain limits, as the increased blood flow promotes healing and builds confidence. Even those with a full knee joint replacement will stand the following day and take a few steps assisted with a frame.

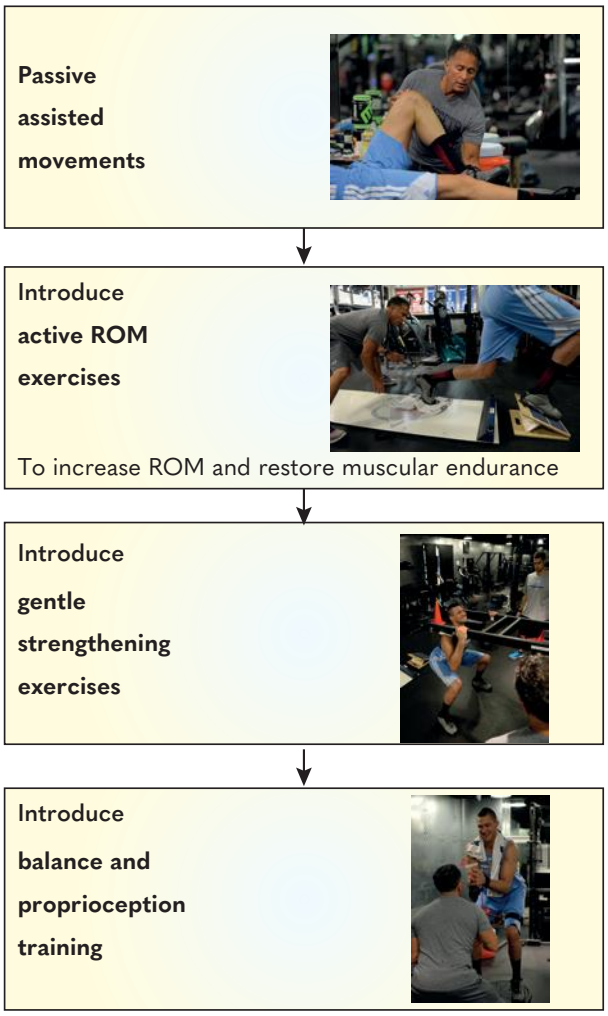


Figure 9.27 A simple rehabilitation progression

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An example of progressive mobilisation is the restoration of knee flexion following ACL reconstruction surgery, where the joint is greatly restricted and can take up to four weeks to gradually restore full ROM. This can be tested each week by lying prone and flexing the knee and measuring the extent of knee ROM using a goniometer. Common exercises include rhythmical movements such as seated heal slides, gentle hamstring and quadricep static and PNF stretching, isometric quadricep contractions, then start to apply gentle loads using light weights or bands to progressively mobilise the injured area, until it is able to move through the full ROM without pain. Throughout this time, the athlete can ride a bike and may simply move the pedal back and forward until a full revolution can be completed.



Figure 9.28 Sam Kerr uses an exercise bike to increase joint mobilisation following injury.

Graduated exercise

While progressive mobilisation is the benchmark for rehabilitation, all activities that work to restore ROM can be considered graduated exercises. However, once the athlete has reached the stage where they have regained pain-free full ROM, they continue to build various aspects of tissue tolerance and capacity while developing the components of fitness at varying rates of overlap with one another. Skilled physiotherapists understand the various progressions of exercises and take a cautious approach to gradually introduce new levels of intensity, ensuring the athlete can tolerate it and allow the body time to respond to the stimulus. In this way, they apply the principle of specificity and progressive overload. As they concurrently train these components of fitness within the injured (and surrounding) tissue, there is a constant monitoring of progress as they work towards preestablished goals. Most of these exercises refer to either muscular injuries or loss of muscle function due to reversibility from loss of function in surrounding joints. Some of the areas of focus and graduated progressions include flexibility training, strength training, endurance training, and agility, balance and coordination training.

Graduated flexibility training

Injured tissues, especially muscles, lose their flexibility through reversibility, leading to loss of ROM. Athletes use and progressively increase flexibility training throughout rehabilitation to restore flexibility to preinjury levels. Initially, this training helps to align and organise collagen fibres in the desired direction and then builds elasticity into new tissue. Once the desired level has been reached, flexibility should be maintained, and stretching used to prepare for more intense exercises.

Progressions include:

- static stretching → PNF (as soon as possible as this increases muscle length faster) → dynamic stretching when able to handle the gentle rhythm of movements.

Graduated strength training

Reversibility is most evident in the loss of strength from muscle atrophy. Inactive muscles start to decrease in size and strength within days, and this must be offset as much as possible early on and continue to build throughout rehabilitation.

Progressions include:

- **Isometric contractions** can be used for immobile joints, as surrounding muscles can be activated using isometric exercises, and biofeedback devices can be strapped on, to provide feedback of muscle engagement.

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This is commonly seen after knee surgery with seated quadricep contractions targeting the vastus medialis, as this part of the quadricep protects the joint.

- As ROM increases, introduce **isotonic contractions** using body weight and light-resistance training strength exercises targeting affected muscles. Develop strength progressively and start to introduce power as the body can tolerate increased intensity. Preset goals for strength should be targeted, such as 70% of preinjury one-rep max (1RM). Use unilateral training to avoid imbalances between sides of the body.

Graduated endurance training

Injured muscle fibres benefit from both **cardiovascular endurance** and **muscular endurance training**. This can be introduced as soon as the athlete has full ROM.

Progressions include:

- active movements through ROM, increasing the volume and intensity and use of the injured body part (e.g. gentle cycling for five minutes to increase hamstring blood flow) → body weight and low weight muscular endurance training of targeted muscles (e.g. seated leg extensions with 2-kilogram ankle weights for 20 repetitions).
- Athletes should also perform aerobic and anaerobic training from early stages, using an option which doesn't involve the injured body part. Hand cycles, exercise bikes and aqua aerobics are safe ways to activate the cardiovascular system to reduce reversibility and the effects of detraining.

Agility, balance and coordination training

This commences as soon as the athlete can safely start to restore proprioception which is impacted through injury and contributes to increased risk of reinjury.

Progressions include:

- simple balance exercises (e.g. balancing on one leg)
- the progressive introduction of increasingly difficult challenges through activities involving hopping, changing direction and changing speeds
- the inclusion of sports-specific training, such as footballers attempting to balance on a bosu ball while volleying a football, to increase challenge and interest.



Figure 9.29 It is important for physiotherapists and athletes to have a positive relationship throughout rehabilitation, which can last for many months.

Activity 9.11

Comparing rehabilitation programs

For a selected sport, research and source comprehensive rehabilitation programs for two different injuries. Identify examples of graduated exercises, identifying the principles and types of training utilised throughout.

Skills: research, analysis

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Training

At some point through rehabilitation, athletes commence and start to reintegrate back into training. They may start with individual activities focused on fitness and skill development, and progressively increase the challenge. Small-sided games with non-contact will build confidence, before starting to build intensity and level of contact. Regular meetings with physiotherapists, coaches and strength and conditioning trainers ensure there are no ongoing concerns as training volume and intensity is increased. As the athlete passes relevant tests, and feels ready to start to compete, they may participate in training games, lower level games (reserve grade) or may play shorter minutes to build confidence and fitness back to preinjury levels.

Use of heat and cold

The external application of cold is used to trigger vasoconstriction to reduce blood flow and swelling. Use of cold through cryotherapy (outlined earlier as an important element of POLICE) is used to control excessive inflammation and associated pain but should not be used for extended periods. Cold is generally used in the first 2–4 days, and then also following physical therapy sessions in the early stages of rehabilitation to reduce swelling from the gentle exercises if swelling increases. Some injuries can also induce an inflammatory response after activity, despite no further damage or injury being sustained. Cold can be used in these circumstances to remove waste products and introduce healthy blood flow.



Figure 9.30 The external application of cold is used to trigger vasoconstriction to reduce blood flow and swelling.

The use of heat causes vasodilation and increased blood flow to the area. This can be in the form of warmed towels and pads and is used to increase the temperature and elasticity of damaged tissues prior to exercise, especially during the early stages of rehabilitation if the athlete is immobile due to injury.

Return to play policies and procedures

National sporting associations (e.g. Netball Australia, Play Rugby League and Football Australia) develop a vast array of policies (governance documents to guide organisational decisions and processes) for regional associations and community clubs to use. These aim to ensure an enjoyable experience for all through positive competition as well as supporting the health, safety and wellbeing of everyone. Policies commonly cover specific issues such as child protection, discrimination and harassment, sun protection, safe grounds, equipment and facilities, as well as head injury polices.

A common policy is one which guides the safe return to play (RTP) following injury. These help those responsible for athlete health, safety and wellbeing know when an athlete is allowed to recommence competition following injury or medical incidence. Generally, these policies require a medical professional to provide formal medical clearance for the athlete to resume a specific level of training or competition (such as being able to play contact again).



Figure 9.31 RTP policies generally require a medical professional to provide formal medical clearance for the athlete to resume a specific level of training or competition.

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There can be stages within return to play policies. The clearance of a surgeon is required following surgery, physiotherapy clearance is often required following rehabilitation of a muscle strain or joint sprain, and a strength and conditioning coach can provide clearance further down the path of rehabilitation as they monitor progress through ongoing fitness testing procedures. Finally, there is also the agreed consensus between a coach and an athlete, particularly regarding the psychological readiness and confidence required to return after injury.

Certain injuries and medical issues stand out as requiring particular attention, such as any heart-related issue, concussions following head injury, major fractures and joint injuries requiring surgery and a range of other circumstances and conditions where medical clearance is required.

Beyond formal medical and professional clearance, there are several other considerations and procedures in the RTP process, including:

- **Graduated return to activity protocols:** As discussed in the previous section on rehabilitation, having an established plan for the gradual introduction of prescribed exercises throughout rehabilitation will ensure safe progressive overload aiming to RTP as quickly and safely as possible.
- **Risk assessment and monitoring of injury:** Each sport, individual athlete and injury profile brings inherent risks for reinjury throughout RTP. Assessing the risks and planning to minimise these is required whenever there is an introduction of a new type, volume or intensity of activity. For instance, the first session involving contact for a rugby league player may start with some rules on the intensity of contact initially, and gradually increase as the player passes each successive level.
- **Sport-specific functional testing:** All sports understand the physical requirements and levels of the fitness components required for safe and effective participation. Testing of these levels following injury is progressively done throughout rehabilitation, prior to full RTP. Tests should be specific to the sport, such as force plate testing to compare left and right leg squat strength for a rugby player.
- **Psychological readiness:** It is critical that the player expresses confidence throughout rehabilitation as they are introduced to each graduated step. This is key for serious and repeated injuries, as players can develop anxiety over reinjury, which can impair performance. Conversations could include medical professionals, trainers, coaches and possibly sports psychologists.
- **Stakeholder involvement:** A key feature of all RTP policy and procedures documents is the ongoing collaboration of all relevant stakeholders, to ensure that a variety of informed voices are considered. There are circumstances where medical professionals should hold the power to remove an athlete from play, which is advisable as coaches and players have external pressures to perform which may cloud decision making. This is particularly evident in concussion guidelines. Parents should also have a say for junior athletes.

Activity 9.12

Comparing RTP policies

Research and source the RTP policies for at least two sports and compare and critique the common and unique features of each. Present findings to the class to gain a wider understanding of the various considerations across different sports.

Skills: research, analysis

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Case study 9.2

Concussion

NEWS REPORT

Concussion in Sport: Marianna Tolo

Australian Sports Commission, 23 September 2024

As she prepares to start the WNBL season with new club Bendigo Spirit next month, Australian Opals star Marianna Tolo has shared her experiences with concussion in sport, and why the message, 'If in doubt, sit it out', is so important.

Video 9.2 Marianna Tolo: Watching teammates suffer concussions (02:24)



Video 9.2 Marianna Tolo discusses watching teammates suffer concussions (02:24). Scan the QR code to watch the video.

While she has never personally experienced a concussion, Tolo has witnessed many head knocks during her illustrious career that has included three Olympic Games and four WNBL titles.

One occasion during her time playing overseas highlighted the importance Australian sport places on proper diagnosis and treatment of concussion.

"My teammate got an elbow to the head and straight away felt dizzy and couldn't concentrate. She spoke to the medical staff, and they just said to take it easy – we didn't have a concussion protocol in place.

"Seeing the difference in medical care overseas made me feel really grateful to be Australian because our medical staff have the knowledge and resources to help you through concussion diagnosis and recovery."

The 2024 AIS Concussion and Brain Health Position Statement provides clear return to sport protocols after concussion.

To align with both the UK and New Zealand, the AIS advises a minimum standdown period of 14 days symptom free (at rest) before returning to contact sport training and a minimum of 21 days before returning to competitive contact for all youth (under-19s) and community sport.

continued

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Case study 9.2 *continued*

For high performance and professional athletes over the age of 19 with daily access to health care professionals, the advice is at least ten days symptom-free before returning to contact activities.

Tolo said it's important athletes are aware of the guidelines and don't try and hide head knocks and symptoms to keep playing.

"One of my teammates got a knock to the head and wasn't feeling 100 per cent but didn't want to talk to the doctor because she didn't want to miss the World Cup at home." Tolo said.

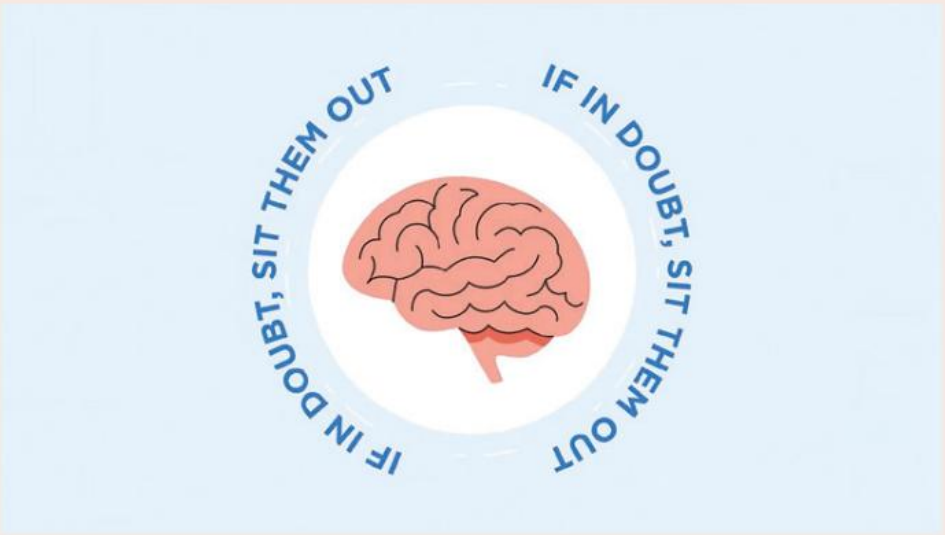
"A couple of us convinced her to see the doctor and she ended up being able to continue to play.

"This shows that getting tested doesn't always mean you will have to sit out, but if you do go on to play and you weren't supposed to, the consequences could be quite high."

Tolo encouraged anyone experiencing any concussion symptom to seek help from trusted medical professionals.

"I really encourage all people to seek help and advice from professionals no matter the severity, because you never know what might happen. You might seem fine now but down the track you never know."

To read the 2024 AIS Concussion and Brain Health Position Statement and access the supporting online resources, visit the Concussion in Sport website via this link: https://cambridge.edu.au/redirect/11412.



Video 9.3 AIS video about concussion (01:11). Scan the QR code to watch the video.

1 After reviewing the article and watching the video, summarise the reasons why there is now increased emphasis placed on return to play policies and procedures following concussion.
2 Access the Australian Sports Commission website and summarise the key features of the return to play guidelines following concussion.

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Case study 9.2 *continued*

3 Who is responsible for ensuring that concussion RTP guidelines are adhered to?
4 As a class, discuss the various pressures that stakeholders face when implementing these guidelines, and who should have the final responsibility for clearance.

Skills: research, analysis

Revise and summarise 9.4


Quiz

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Define each sports injury classification, providing examples for each with likely cause and indicators.
2 Outline the steps involved in sports injury assessment.
3 Outline the management of common soft and hard tissue injuries.
4 Summarise the three stages of the inflammatory response.
5 Outline the following components of a rehabilitation program:
   a progressive mobilisation
   b graduated exercise
   c training
   d use of heat and cold.

Think critically and apply 9.4

In small groups, select a sport, and research a wide range of preventive measures that can be used to reduce the risk or severity of common injuries in this sport, considering the physical preparations, measures to make the environment safer and use of protective equipment.

Skills: collaboration, analysis, research

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9.5 Impact of drug use on injury management and improving performance

Learning objective 9.5
DISCUSS the effect that drug use can have on the management of injuries and performance.

By definition, a drug is any substance which produces a physiological or psychological effect on the body or mind. Athletes may use drugs to manage medical conditions, improve athletic performance, for pain management or for recreational purposes. In doing so, there are many considerations to be made regarding the value, legitimacy and efficacy of using various drugs for these purposes.

World Anti-Doping Agency (WADA) globally promotes, coordinates and monitors anti-doping in sports, ensuring fair, level, drug-free sports

Sport Integrity Australia (SIA) the national organisation responsible for compliance with WADA and safeguards the integrity of sports to protect athletes and prevent doping

Legal and illegal use of drugs in sport

Legal

There are valid and legal reasons why an athlete may need to use a particular drug. Doctors routinely prescribe medications to treat a range of diagnosed medical conditions, such as for asthma, depression, anxiety, ADHD or infections. Other legal medications available 'over the counter' may be used to manage pain (anti-inflammatories) or relieve the effects of mild infections. It is important to note that there are a wide range of legal medicinal drugs which also contain illegal substances for athletes. Athletes must ensure they do not inadvertently take a banned medication for a legitimate reason. In these cases, there are procedures whereby the athlete can apply for a therapeutic use exemption (TUE) allowing them to use a necessary medication. A TUE application, with supporting medical evidence, is assessed by the Australian Sports Drug Medical Advisory Committee (ASDMAC). They consider four key criteria when determining whether or not to approve an application to use a banned medication:

1 It is medically necessary for the athlete to use it
2 It does not improve the athlete's performance beyond normal levels
3 There is no other treatment it is reasonable for the athlete to take
4 The athlete's medical issue was not the result of prior misuse of the medication

If ASDMAC is satisfied that these criteria are met, they will provide a certificate to the athlete, their doctor and the sporting body. The certificate is valid for national-level competitions. Athletes competing internationally can gain assistance from ADMAC in having the certificate recognised by the relevant international body. Finally, legal recreational substances such as alcohol and caffeine are considered drugs due to their effects and are used by athletes at their own discretion.

Illegal

There are a range of reasons why athletes use drugs illegally. Often these substances have a legitimate reason for their existence, but are known for having a pronounced enhancement on performance when used in a contrary manner. Such use of drugs is referred to as doping, and the **World Anti-Doping Agency (WADA)**, alongside **Sport Integrity Australia (SIA)**, formerly known as the Australian Sports Anti-Doping Authority (ASADA), are responsible for the oversight of athletic drug testing and enforcement of the rules governing illegal drug use in sports.



Figure 9.32 WADA and SIA oversee the process of setting and enforcing the rules and testing for drugs in sport.

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Some of the more common illegal drugs used in sport include:

Performance and image-enhancing drugs (PIEDs) These drugs have a direct effect on either the anatomy or physiology of the athlete, leading to increased performance or the altering of body shape for aesthetic purposes. Common examples include:

- *Anabolic steroids and human growth hormone:* mimic the effects of the male hormone testosterone, thereby increasing the protein synthesis in muscle cells, promoting faster tissue repair and increased hypertrophy (muscle size) and therefore potential power and strength. Psychologically these can also increase aggression and competitiveness. They are commonly used in sports requiring strength, power and speed (athletics, weightlifting, rugby) as well as for any athlete recovering from injury.
- *Erythropoietin (EPO):* stimulates increased production of red blood cells in bone marrow, therefore increasing oxygen-carrying capacity. This can be replicated through blood doping, where additional blood (athlete or donor) is put into the body.
- *Stimulants (amphetamines):* Activate the central nervous system, leading to increased mental focus, physical energy and reduced perception of fatigue.

Masking agents Some drugs are taken to hide the presence of other banned drugs through testing procedures and work by diluting urine samples.

Weight control and aesthetic purposes Athletes who compete in sports with weight divisions (boxing, wrestling, weightlifting) or sports that are judged on the aesthetic (or look) of performance (gymnastics, diving) may use diuretics (including laxatives) to quickly lose weight or change appearance.

Mental focus, pain suppression and sedation Beta blockers are known to slow heart rate and reduce muscle tremor and anxiety, which is useful for target sports requiring steady focus, such as archery. Narcotics (opioids), stimulants and anti-inflammatories may be used to dull the sensation of fatigue or pain, allowing athletes to push beyond safe physical limits. Sedatives can be used to relax and induce sleep, but are banned due to the risk of reliance and addiction.

NB: Recreational illegal drugs are also banned for use and will be tested for.



Video 9.5 The 11 anti-doping rule violations explained (03:57). Scan the QR code to watch the video.

Video 9.5 The 11 anti-doping rule violations explained (03:57)

Activity 9.13

Sport Integrity Australia – further education

Scan the QR code to watch Video 9.5.

1 Summarise the 11 reasons why an athlete might violate the anti-doping regulations.

Access the AIS Sports Supplement Framework on the Australian Institute of Sport government website.

2 Summarise this framework to understand how the AIS categorises various supplements and drugs to protect athletes and ensure any products used are safe, permitted and effective. Note this covers content related to supplementation as well as drugs, as there is a degree of overlap between these substances in relation to sport.

Skills: research, analysis

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Health implications

Legal drugs have many positive effects when used appropriately, but many also have a range of side effects to be considered and managed in consultation with a medical professional. Regarding illegal drugs, one of the primary reasons they are placed on the banned substances list is due to the great risk of harm to the physical and mental health of users.

For athletes who use performance-enhancing drugs to cheat, they often feel that the perceived benefits of increased athletic performance outweigh these potential harms. It is therefore important to protect athletes from the pressures which may lead them to risking their health, which in many instances can be life-altering or threatening. Examples of these health implications include:

- **Anabolic steroids:** increased heart attacks, strokes and blood pressure, liver damage and cancer, hormonal imbalances, sexual and reproductive impairment and mood disturbances
- **Human growth hormone:** enlarged bones in face, hands and feet, enlarged heart, hypertension and heart failure, diabetes, chronic joint swelling and pain
- **Stimulants:** heart problems, addiction, psychological impairment (anxiety, hallucinations)
- **Erythropoietin:** thickened blood, increasing blood pressure and risk of heart attack and stroke
- **Diuretics and laxatives:** dehydration, muscle cramps, kidney damage and failure, low blood pressure and fainting. These are also associated with eating disorders, and are more common in female athletes in aesthetic sports.
- **Beta blockers:** low heart rate and blood pressure, breathing difficulties and increased fatigue
- **Non-steroidal anti-inflammatory drugs (NSAIDS):** mild drugs for short-term suppression of pain and inflammation. Excessive use can cause damage to liver, kidneys and the gastrointestinal system
- **Narcotics (opioids) and steroidal anti-inflammatory drugs (SAIDS):** Used for long-term and severe pain and medical conditions (asthma, arthritis, IBS). These drugs can be highly addictive and lead to weight gain, adrenal (hormonal) suppression and mood changes.

Activity 9.14

PIED further research

Select three distinct performance- or image-enhancing drugs to research. Deepen your understanding of the nature of the drug and how it works, the short-term effects and reasons for use in sports and potential long-term health implications.

Skills: research, analysis



Figure 9.33 Common substances used in sport for dishonourable reasons

Ethical considerations

Ethical arguments for bans

The use of drugs in sport is highly controversial, with some arguing it would be easier to remove restrictions on substances and leave the athlete responsible for making their own decision about what to safely use. However, the primary ethical reason performance and image-enhancing substances and methods are banned is because they severely compromise the integrity of fair competition and the spirit of sport, which has always protected itself from any form of cheating.

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Figure 9.34 At the 2019 Swimming World Championships, the 400 m silver medallist Mack Horton of Australia refused to share the podium with gold medallist Sun Yang of China, whom he had previously called a 'drug cheat'. At the time, Sun was facing allegations of doping rules violations.

Another strong ethical argument for banning PIEDs, often need protecting from their own drive to succeed at all costs, as well as the immense external pressures they face. Many PIEDs can have life-altering effects when used in such a manner, and athletic success should not be held above individual health.

The popularity and positive role modelling of elite athletes challenge the ethics of using substances to gain an unfair advantage. Using drugs to improve sports performance is considered to be socially irresponsible, as it encourages young athletes to copy the example set by their role models.

Ethical issues around sanctions

There are strict consequences for breaking the rules of WADA/SIA in relation to failing a test for a banned substance, or one of the rules related to sports drug possession and drug testing procedures. The severe consequences raise concerns about the impact these may have on an athlete's career. Though the integrity of sport is more important than the athlete's career, unintentional and minor offences which are not related to enhanced performance may be given a warning or shorter ban of several months. Generally, doping violations directly linked to performance enhancement receive a minimum two-year ban, extending to four years for more serious violations. The most serious of breaches or repeat offenders may be banned for life. All sanctions also extend to complete removal from any aspect of involvement in any WADA-aligned sport, including training with coaches and teams while banned.

There have been many instances of genuine mistakes and inadvertent doping leading to lengthy sanctions. This may be the result of mistakes in following the detailed rules imposed by SIA, inadvertently taking a legitimate medication for a medical condition without prior approval, or unknowingly consuming a contaminated substance which contains a banned substance. In these cases, athletes may appeal to a court of arbitration; however, many cases are upheld, and athletes still face lengthy bans, raising ethical questions about the fair punishment for such errors.

Athletes who break the rules and are banned from sport also suffer the ongoing consequence of being labelled as cheats by the media, fans and other athletes, even if they are now 'clean'. The damage to reputation affects their ability to return to the sport due to this increased pressure and can take a toll on their mental health and wellbeing. This can have flow-on effects by jeopardising future contracts and involvement in the sport, as well as decreasing future sponsorship potential due to the harm done to the athlete's profile.

Ethical issues around testing

Drug testing is also highly complex and expensive, and not all sports and athletes are equally tested, meaning that some athletes may escape punishment. There is also the challenge of the athlete's privacy, as testing requires the full unobstructed viewing of the sample collection process and some athletes may not be comfortable doing this. Bio-sampling and gene testing also raise concerns about the storage of very private information about an athlete. A final ethical consideration is the appropriate age and level of competition to start the process of testing for drugs. If this involves athletes under the age of 18, there are issues around child protection and privacy which must also be managed, as well as a range of religious and cultural challenges which must be sensitively catered for.

To protect health, safeguard privacy and ensure that sport remains an inspiring force within society, free from corruption, a largely zero tolerance approach is taken with minimal grounds for grace if one is found guilty of breaking the laws surrounding drug use in sport.

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In contrast with wider society, the perceived lack of the presumption of innocence means that drug testing procedures can be personally challenging and in the instance where a mistake has been made, an athlete's career and reputation can be tarnished forever. At the end of the day, the responsibility for adhering to the rules will always fall solely on the athlete and they must be exceedingly familiar with the rules, ensuring they carefully follow all requirements related to the legal use of drugs in sport and drug testing procedures.

Case study 9.3

Positive drug tests

NEWS REPORT

Banned swimmer Shayna Jack tells documentary 'someone's not going to get through' the fallout from a positive test

Tracey Holmes
ABC News, 16 July 2021

Banned swimmer Shayna Jack tells documentary 'someone's not going to get through' the fallout from a positive test

Australian swimmer Shayna Jack has admitted she "didn't want to be here anymore" amid the fallout for returning a positive drug test and that "one day someone's not going to get through it and … Sports Integrity and other organisations in the world are going to have blood on their hands".

Jack is one athlete featured in a new documentary by investigative journalist and doping specialist Hajo Seppelt … Titled *Doping Top Secret: GUILTY – How athletes can unintentionally become dopers*, the documentary hears from several athletes who have fallen foul of sport's strict anti-doping regime which immediately assumes guilt, leaving no room for the possibility of innocence.

It goes further.

Working with the Cologne doping control laboratory, recognised as one of the world's best, a series of tests are conducted where athletes' skin is lightly brushed with banned substances to simulate a possible handshake or hug from a person who themselves has been in contact with a contaminated substance.

Within hours, the athletes return positive tests that would result in a doping ban.

Some of the athletes were still returning positive urine samples two weeks after the brief encounter. …

Jack tested positive to Ligandrol on the eve of the 2019 World Swimming Championships but had a potential four-year ban for a first offence halved by the Court of Arbitration (CAS).

It heard from one of the world's top anti-doping experts, Professor Mario Thevis – also interviewed for the documentary – that the low amount in Jack's system was "pharmaceutically irrelevant".

continued

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Case study 9.3 *continued*

During the hearing, SIA "accepted that there was no direct evidence that [Jack] 'intentionally' ingested Ligandrol … and there 'was no evidence of any long-term usage' of the substance".

…

"I would be angry with the world, and I would be a completely different person that I could not recognise in the mirror anymore," Jack says in the documentary.

"And I didn't want to be here anymore… I am not going to stop until I prove my innocence and fight to get myself back in the pool… One day someone's not going to get through it and … Sports Integrity and other organisations in the world are going to have blood on their hands."

…

CAS arbitrator and the man who investigated Russia's systemic doping program, Professor Richard McLaren, is also interviewed for the documentary and was presented with the findings of how easily innocent athletes could test positive.

"The scientific evidence looks compelling," he said.

"If you're the person who's got the anti-doping rule violation hanging over your head, your idea of fairness might be quite different than the doping control organisation that tested."

"I think the system is perhaps more loaded against the athlete."

That position has been long argued by critics of sport's current anti-doping regime, but change remains unlikely with authorities sticking to the strict liability clause that states if an athlete tests positive he/she is automatically guilty, the only question that remains is "to what degree".



Figure 9.35 Shayna Jack addresses the media on 2 August 2019, saying 'I won't stop until I clear my name'.

McLaren shares the views of organisations such as WADA and the International Olympic Committee that, "the whole system would fall apart if you had to put the burden on the doping authority rather than on the athlete".

Seppelt describes the situation as a "real dilemma for sports organisations" but says that is no reason "to remain silent" on the issue.

The potential to net innocent athletes, whose lives can be ruined, in the pursuit of actual dopers is currently sport's most wicked problem.

Shayna Jack was banned from competition from 2019 to 2021, but returned when the ban was lifted and won gold medals in relay events at the 2024 Olympics.

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Case study 9.3 *continued*



Figure 9.36 Shayna Jack at the 2024 Olympic Games

1 Summarise the main points of Shayna Jack's story of failing a doping test.
2 What lessons are to be learned from this for future athletes?
3 Describe the impact these events had on Shayna's life and career.

Skills: analysis

Ethics of legal and recreational drugs

A distinct issue in the ethics of drugs in sport, relates to the entirely legal, but questionable use of painkillers in sport, as well as other recreational drugs for personal reasons. Most sports take a great physical toll on an athlete's body and living with chronic pain is a reality for many. The use of medications for pain management can cause harm to the athlete's body organs, as well as the mental health issues of addiction through dependency. Ethical concerns are raised regarding the masking of pain to allow continued performance, when pain is the body's natural response to injury. Many athletes choose to have direct anesthesia and will take a pain-killing injection for an injury considered stable and unlikely to worsen, such as a bone bruising. Another example is the use of sedatives, to help athletes calm down and sleep following intense competition and activity, especially for those who compete at night. These can be addictive, and athletes may seek a stronger effect as dependency increases. Similarly, recreational drugs can be used to either stimulate or depress the central nervous system and have their own dangers and effects on the body and mind. Legal drugs such as alcohol and excessive caffeine present concerns; however, illicit substances such as cocaine and cannabis can be tempting for athletes to use, often to help manage the pressure of elite sport and competition.

Activity 9.15

Media review: drugs in sport

Find a range of media articles related to the use of drugs in elite sport. Summarise your findings according to the nature of the issue, the ethical dilemmas that are raised and how the policies and procedures related to drugs in sport have been applied.

Skills: research, analysis

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Drug testing

Almost all sports come under the oversight of WADA and SIA and therefore athletes at a certain level of competition are tested for the presence of illegal substances in their body. Drug testing is a complex procedure. A summary of the process involves the following steps:

Notification of testing: Athletes are informed by a Doping Control Officer (DCO) or chaperone (for those aged under 18) that they have been selected for a drug test. This can occur during in-competition or training, or with advance notice for out-of-competition testing. Athletes must report for testing, and failure to do so is considered a failed test. There are some exemptions and reasons for delay which can be requested, such as medical emergency or medal ceremony. Notification for testing can be random, meaning it can be done anywhere without notice, or be part of targeted or seasonal testing for specific athletes or sports with a higher risk of doping.

Sample collection: For urine tests, athletes select their sealed tamper-proof beaker and must provide a sample within full view of a DCO or chaperone of the same gender. For blood tests, the athlete follows certain procedures and will provide a blood sample for analysis. Blood samples are also collected as part of the Athlete Biological Passport (ABP) program, which are used to create individual profiles whereby specific markers are measured and provide a baseline for future testing and comparison. This decreases the scale of variability between individuals and an athlete has a smaller margin for variance in these markers, such as haemoglobin and steroidal counts. Endurance-, strength- and power-based sports are targeted due to the increased risk of doping.

Sealing and documentation: Careful attention is taken to split the sample into two A and B samples and the athlete signs off on all labels and packages, reducing the risk of error and interference.

Transport and analysis: Samples are safely taken to a WADA-approved laboratory for analysis and storage. A positive test for Sample A triggers a notification process, and Sample B is analysed as required.

Legal processes: If an athlete is found guilty by a panel, a sanction is imposed by SIA (a department of the Australian Government) under the guidelines of WADA.



Figure 9.37 Knowing all athletes are 'clean' is foundational to the sense of fair competition and being able to duly recognise amazing human endeavour, free from the influence of drugs.

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Activity 9.16

Sport Integrity Australia – further education

Access the educational resources provided through the Australian Government's website 'Sport Integrity Australia' (https://cambridge.edu.au/redirect/11413)). Create a summary of the major policies and procedures which are used to ensure that sports are kept drug-free.

Skills: research, analysis


Quiz

Revise and summarise 9.5

Complete the quiz in the Interactive Textbook and answer the questions below on paper or in the Interactive Textbook.

1 Complete the following revision table for commonly used PIEDs.

Drug	Common reason for use in sport	Long-term risks
Anabolic steroids		
Erythropoietin		
Diuretics		
Beta blockers		
Opioids		

2 Outline four ethical considerations relating to the use of drugs in sport.

3 Summarise drug testing procedures.

Think critically and apply 9.5

Propose and discuss the appropriate age and level of competition at which to introduce drug testing, and evaluate educational programs used to reduce the incidence of use of PIEDs in the community as well as in sport.

Skills: collaboration, communication, analysis

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Chapter summary

- A range of factors are considered when training for sustained and improved performance, ensuring the athlete's health and wellbeing are cared for. These include the application of biomechanical principles, effective recovery strategies, technological advancements, injury management and the ethical use of drugs.
- **Biomechanical principles** are applied across a range of areas in sport and are used to ensure training and competition are both safe and effective.
- They are used to improve the economy of *physical activity*, by minimising the load on body parts while maximising output, as seen in the refinement of running, sprinting and agility.
- They are applied to the development of safe and effective *sports-specific movement* and skills, helping athletes to successfully produce and absorb force through accurate and coordinated skills such as fast bowling in cricket.
- They are applied to strength programs to develop the functional movements required to improve performance and reduce injury risk, such as those seen in executing an effective tackle in rugby.
- Intense athletic schedules require effective **recovery strategies** to reduce the risk of injury and overtraining, as well as enhancing performance. These seek to restore energy levels, reset the nervous system, and repair muscle and tissue damage.
- *Physiological strategies*, such as extended cool-down and hydrotherapy, are used over the first 1–2 days after intense activity to restore body systems back to homeostasis and reduce fatigue.
- *Psychological strategies* deal with the athlete's state of mind and emotions after intense competition, as they seek to relax and positively look forward to the next session or game.
- **Technology advancements** are extensively used in sport to sustain and improve performance.
- *Training innovations*, such as the use of AR, VR and accurate measurement devices, allow the effect and progress of training to be carefully monitored, while also providing a unique opportunity to develop the cognitive and tactical awareness of the athlete.
- *Equipment advances* have been driven through the use of innovative materials (carbon), production methods (3D printing), officiating technology (VAR) and rehabilitation equipment (cryosaunas), which have all advanced athletic training and performance.
- *Recording and monitoring of training and performance* using computer software and telecommunication equipment (GPS sensors) have increased the range of data available to measure and monitor performance more accurately.
- **Managing sporting injuries** well is a high priority for everyone involved in sport given the inevitability of injuries and their impact on athletic performance over a career and beyond.
- *Classifying injuries* into the sub-categories of direct or indirect, soft or hard tissue and overuse injuries helps guide the best rehabilitation plan to maximise recovery and reduce risk of reinjury. Protocols such as TOTAPS are used to *assess* the nature and extent of injury.
- Soft tissue injuries must be carefully *managed* using protocols such as POLICE to support the body's natural healing mechanisms and reduce recovery time.
- All injuries are unique and require specific *rehabilitation* procedures and timings, with a general focus on progressively mobilising the injury and undertaking a graduated exercise program to restore the strength, flexibility, endurance and other components of fitness impacted by the injury, using heat and cold as required.
- The final steps in the *return to play* must adhere to policies and procedures intended to focus on the athlete's health and wellbeing as the main priority, as key stakeholders all work together to reduce the risk of reinjury.
- The **use of drugs** to sustain and improve performance is a contentious issue. There are many legal and evidence-based drugs which athletes can use for medical conditions and pain management if appropriate, but also many temptations to use illegal drugs to enhance image and performance. Strict rules and testing procedures enforced by Sport Integrity Australia help protect the health of the athlete and the spirit of fair competition.

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Multiple-choice questions

1 How do biomechanical principles support athletic performance?
- A by promoting overtraining to build muscle strength to improve performance
- B by ensuring safe and effective training programs to improve performance
- C by reducing the need for recovery after intense exercise
- D by prioritising psychological strategies over physical conditioning

2 Effective recovery strategies are essential for athletes to:
- A enhance performance and reduce the risk of overtraining
- B reduce the number of training sessions that are needed
- C increase fatigue levels to increase fitness
- D deal with psychological stress

3 What is the purpose of monitoring and recording training data using technology such as GPS sensors?
- A to track an athlete's mental state
- B to measure and monitor performance more accurately
- C to reduce the need for physical training
- D to focus only on recovery strategies

4 When managing sports injuries, why is it important to classify them into categories such as soft or hard tissue injuries?
- A to help guide the best rehabilitation plan and reduce reinjury risk
- B to determine the level of psychological support needed
- C to decide if the athlete can train without any rehabilitation
- D to avoid using protocols during recovery

5 What is the primary purpose of drug testing procedures enforced by Sport Integrity Australia?
- A to promote the use of performance-enhancing drugs
- B to protect the health of athletes and ensure fair competition
- C to eliminate recovery strategies in training programs
- D to prioritise the physical fitness of athletes

Exam practice

How to answer an exam question

Example question

Explain how progressive mobilisation is used for rehabilitation after a sports injury, and give an example. (6 marks)

What is the question asking?

The key verb in this question is **explain**, which means you should try to show how progressive mobilisation has an effect on restoring range of motion.

Note that the question also asks you to give an example, so you will need to use a specific type of sports injury.

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Marking criteria

Criteria	Marks
• Demonstrates a comprehensive understanding of how progressive mobilisation is used for rehabilitation after a sports injury • Supports response with a relevant example	6
• Demonstrates a sound understanding of how progressive mobilisation is used for rehabilitation after a sports injury • Provides a relevant example	5
• Describes how progressive mobilisation is used for rehabilitation after a sports injury • Provides an example	4
• Outlines how progressive mobilisation is used for rehabilitation after a sports injury • May provide an example	2–3
• Provides some relevant information	1

Sample response

A sports injury can lead to restricted movement because of swelling from inflammation, and loss of function from damaged body tissue and scar tissue. Too much inactivity will increase joint stiffness, leading to increased scar tissue.



Video 9.6 Answering the exam question

Progressive mobilisation gradually increases range of motion (ROM) back to pre-injury range. This can start with passive assisted movement, and proceed through active ROM exercises, then gentle strengthening exercises, and finally balance and proprioception training. This can be done within mild pain limits, as the increased blood flow promotes healing and builds confidence.

Example: After ACL reconstruction surgery, the knee joint is greatly restricted. Mobilisation exercises can include rhythmical movements such as seated heel slides, gentle hamstring and quadricep static and PNF stretching, isometric quadricep contractions. As movement improves, the athlete can start to apply gentle loads using light weights or bands to progressively mobilise the injured area, until it is able to move through the full ROM without pain.

Exam-style questions

1 Explain how biomechanical principles are applied in sports-specific movements to improve performance and reduce injury risk. Use examples in your response. (6 marks)

2 Discuss the effectiveness of soft tissue injury management procedures in supporting injury management and rehabilitation. (6 marks)

3 Analyse the role of technology in enhancing athletic performance. In your response, include examples of training innovations and equipment advancements. (5 marks)

4 Evaluate the importance of effective recovery strategies for athletes with intense training schedules. In your response, include both physiological and psychological recovery methods. (8 marks)

5 Outline the ethical considerations athletes must consider regarding the use of drugs for performance enhancement. (4 marks)

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Depth studies

Additional support for the depth studies, including a dedicated section on research skills, is available in the Interactive Textbook.



Chapter
Chapter 10: Depth studies

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Chapter 10
Depth studies



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As part of your Year 12 Health and Movement Science course, you are required to undertake at least two depth studies. One of these depth studies will be a formal school-based assessment task.

A depth study gives you the opportunity to engage more deeply with an aspect of the course. It consists of an investigation or activity – or a series of investigations/activities – that extends on one or more of the concepts in the course. You may do one depth study for each of the two course components – Health in an Australian and Global Context, and Training for Improved Performance – or you may do depth studies that look at elements from each component.

You may complete a depth study individually or as part of a group.

Possible depth study ideas include (but are not limited to):

- completing a profile of a sport or an individual athlete
- completing a case study of a health-related organisation or group
- designing and completing an experiment, or series of experiments, to test a claim
- performing a literature review for a specific focus area, with analysis of the evidence and data
- investigating and reporting on a particular health issue that affects Australians
- as a group, undertaking a large-scale case study which can be broken into parts such that each student can work independently on their part.

The final presentation for a depth study will summarise the work you have completed, presented in a format that is appropriate. Possible presentation formats include:

- essay
- report
- poster
- presentation
- speech
- video
- podcast.



Figure 10.1 You might decide one of your depth studies will be a case study of a health-related organisation or group.

Refer to the Interactive Textbook for more information about completing your depth studies. There is also a downloadable file on research skills.



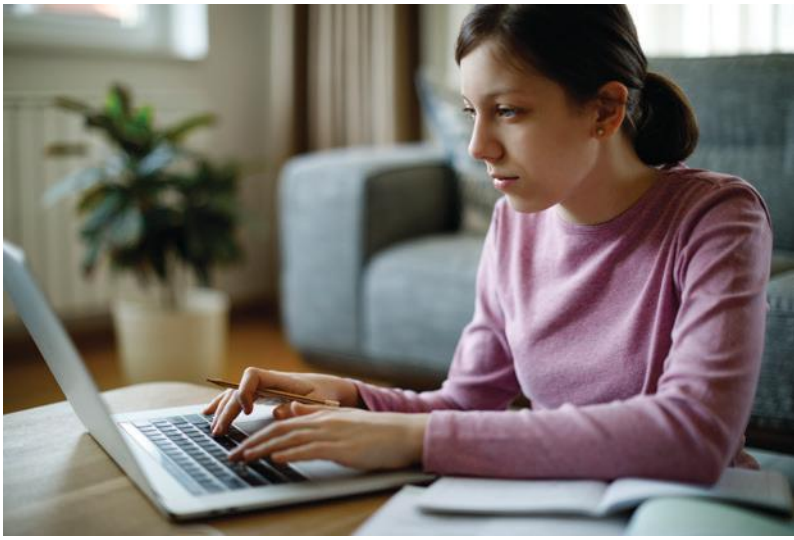


Figure 10.2 The final presentation for a depth study will be presented in a format that is appropriate.

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Depth study topics

Your teacher may guide the class through specific depth studies, or you may work on a topic of your own choice. The only requirement is that it builds on material and concepts you have looked at in the course.

Textbook suggestions

Throughout this textbook, you will see that a number of the activities and case studies are flagged with an icon:



This icon indicates that the authors think the activity or case study has potential to be explored further in a depth study.

Sample depth study

Here is a sample depth study: a profile of a sport, with suggestions of how to link it to aspects of the syllabus.

Note that this is only an example. As you saw on the previous page, depth studies can cover a wide range of methods.

The Modern Pentathlon combines five distinct disciplines into a single event: running, swimming, shooting, fencing and horse riding. It requires a 'complete athlete' who is able to excel across a range of unrelated physical challenges.

Modern Pentathlon was introduced to the Olympic Games in 1912 (Stockholm). There was only a men's event, and it was competed over five days.

Since then, there have been many changes to how the Modern Pentathlon is run. By the 1996 Atlanta Olympics, it had become a single-day event, and the 2000 Sydney Games saw the introduction of Modern Pentathlon for women.

More recent innovations include the 2009 combining of the running and shooting components, requiring athletes to alternate running laps with shooting at a target – in addition, at this time sport pistols were replaced with laser pistols. Another modification is to replace the equestrian event with an obstacle course: this is set to take effect following the 2024 Paris Olympics.

The sport's governing body is the Union Internationale de Pentathlon Moderne (UIPM). In addition to the Olympic Games, a Men's World Championship has been held since 1949, and a Women's World Championship since 1981. In 1999 a Modern Pentathlon World Cup was established, with four events taking place in the season, and the top 36 athletes for each gender qualifying to compete in the World Cup Final.

The UIPM is committed to ensuring that Modern Pentathlon continues to be relevant and engaging, ideally staying true to its roots but still evolving to meet the expectations of contemporary sport.

As the Modern Pentathlon consists of five different events, this case study could be completed individually, or as a group activity, with each member focusing on a single sport. It could be done primarily using secondary research, or students could make contact with Modern Pentathlon Australia and/or individual pentathletes for primary research.

There are many aspects of the syllabus that could be addressed when undertaking this depth study. If you were completing the depth study individually, you would probably focus on a few specific areas, although if it were a group activity you could take a broader approach. Aspects you consider could include:

- General background
  - Why were these five sports selected for the Modern Pentathlon?
  - What are the precise requirements for each component, and how have they changed over the history of Modern Pentathlon?
  - How does the scoring system work, and how well are the five sports balanced?
  - Is Modern Pentathlon popular in Australia, and do our pentathletes perform well internationally?

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- Personalising assessment and exercise prescription
  - What types of fitness testing would be appropriate for a pentathlete?
  - How might the results of a fitness test help them to develop a training program?
- Influence of training on movement and performance
  - For each of the five sports in the Modern Pentathlon, identify the relative importance of anaerobic, aerobic, flexibility and strength training. What are some exercises that pentathletes might find useful?
  - Of the five sports, which are more fitness dominant, and which are more skill dominant?
  - How do the principles of training apply to the sports in Modern Pentathlon?
  - What physiological adaptations can lead to improved performance in the sports in Modern Pentathlon?
  - What challenges might a pentathlete face in trying to balance these between the five sports, for overall improvement?
- Training for individual and group sports
  - For each of the five sports in Modern Pentathlon, what aspects need to be considered when designing a training session?
  - What challenges would a pentathlete face in training for five sports simultaneously? (You could look at the weekly training plan of pentathlete Genevieve Janse van Rensburg, on page 233 of this textbook.)
  - Consider the dates of the Modern Pentathlon World Cup events this year, as well as the World Championships/ Olympics. What might a yearly training program look like?
  - What psychological strategies might help improve performance in Modern Pentathlon? How might the strategies differ between the sports?
- Impact of sleep, nutrition and supplementation on movement and performance
  - For each of the five sports in Modern Pentathlon, what are some dietary aspects that need to be considered?
  - What challenges might a pentathlete face in trying to balance these between the five sports, for overall improvement?
  - What supplements might a pentathlete take to improve performance? How might this differ between the sports?
- Training for sustained movement and performance
  - For each of the five sports in Modern Pentathlon, what role would biomechanics play in developing efficient movements?
  - What challenges might a pentathlete face in trying to balance these between the five sports, for overall improvement?
  - What recovery strategies might a pentathlete use during training, or between sports at an event?
  - What effect have technological developments had in the sports in Modern Pentathlon, and on how the overall event is run?
  - For each of the five sports in Modern Pentathlon, what strategies can be used to prevent and manage sports injuries?
  - Have there been any cases of illegal drug use in Modern Pentathlon?



Figure 10.3 Australian Chloe Esposito won the Women's Modern Pentathlon at the 2016 Olympic Games in Rio de Janeiro, Brazil.

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Glossary

aerobic interval training alternating between periods of high-intensity **aerobic** activity and periods of low-intensity aerobic and active recovery (typically a work:rest ratio of between 1:0.5 to 1:1)

allied health a collective term used to describe a number of health professionals, including physiotherapists, dieticians/nutritionists, podiatrists, chiropractors and exercise physiologists, as well as others

anaerobic interval training alternating between periods of higher-intensity anaerobic activity and periods of rest and active recovery (typically a work:rest ratio of between 1:2 and 1:8)

artificial intelligence (AI) technology that enables machines to learn and perform tasks that generally require human intelligence, such as understanding language, recognising patterns, solving problems and making decisions based on gathered data and algorithms

atherosclerosis a condition where plaque forms on the inside of arteries

ATP-PCr system the anaerobic energy system that is responsible for providing energy in the first 10 seconds of maximal effort

benign localised and not cancerous

bulk bill where a GP charges the fee for a consultation directly to Medicare, enabling free access by the patient

Closing the Gap Australian Government targets to address Indigenous disadvantage in key areas

Coalition of Peaks a representative body of First Nations community organisations that negotiates with federal and state governments on Closing the Gap strategies

complementary healthcare approach a broad range of treatments and healing practices, used together with (and not instead of) evidence-based conventional Western medicine

Council of Australian Governments (COAG) Australian intergovernmental forum from 1992 to 2020, consisting of federal, state and territory governments, and the Australian Local Government Association. In 2020 it was replaced by a new structure.

DALYs disability-adjusted life years

diagnosis process of identifying the nature and extent of a particular health problem

elite athlete generally participates at a national, international or professional level

healthy ageing enhancing wellbeing in old age by developing and maintaining abilities

kinematics the study of the motion and forces acting on objects

malignant cancerous and has ability to spread to other parts of the body

maximum aerobic speed (MAS) the lowest speed an athlete can run where they have reached their maximal oxygen uptake (VO_2 max)

maximum heart rate (MHR) the highest level to which an individual is able to raise their heart rate, commonly measured as 220 – age (see Chapter 6 of *Cambridge Health and Movement Science Year 11* textbook)

means test a way to check how much money a person earns or owns, in order to qualify for government help or support

Medicare the publicly funded healthcare insurance scheme, available to all Australian citizens and permanent residents, which provides subsidised treatments for some medical practitioners, including GPs, and free treatment from public hospitals

mental rehearsal practising a skill in the mind

metastasis the spread of cancer cells from the place where they first formed to another part of the body

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National Disability Insurance Scheme (NDIS) an Australian Government scheme that provides support and funding to those with a permanent and significant disability

nowcasting a 'forecast' for today. It is the use of real-time data and statistical analysis to estimate the current state of a health-related event or condition.

osteopenia loss of bone density

osteoporosis a disease that causes the bones to become weaker and easily broken

peak body the leading organization that represents and advocates for a specific industry, profession, or group

periodisation the manipulation of training loads over time in order to bring about optimal gains in performance

Pharmaceutical Benefits Scheme (PBS) a government scheme that subsidises the cost of certain medicines

physiological adaptation a training stimulus causes stress on human body systems, signalling biochemical changes, leading to an improved ability to tolerate the stress of exercise

pre-hab actions taken to proactively avoid injury

pre-screening a tool used to identify people who may have medical conditions that put them at risk of an adverse event during physical activity/exercise

primary care medical treatment provided by local doctors or other health workers, rather than special treatment in a hospital

principle of training a fundamental guideline applied to ensure training programs are safe, effective and tailored to meet the specific requirements of a sport

prognosis estimating the likely outcome or course of a disease, and the chance of recovery or recurrence

progressive overload the gradual increase in training stimulus above the current level of adaptation in order to improve components of fitness

public health government and other programs aimed at the prevention of disease, the prolonging of life and the promotion of health

QQRT the four sleep fundamentals: quantity, quality, regularity and timing

RAMP protocol a protocol for the phases of a warm-up: raise, activate and mobilise, potentiate/perform

range of motion (ROM) the extent to which a body part can be moved around a joint

recreational participant participates in sport primarily for fun, physical fitness and social involvement

Sport Integrity Australia (SIA) the national organisation responsible for compliance with WADA and safeguards the integrity of sports to protect athletes and prevent doping

state anxiety feelings of anxiety related to a specific game or event

strategy a plan of action developed before beginning a task or activity to successfully achieve a goal or outcome; a long-term objective to achieve

sustainability the ability to continue at a particular level for a period of time

tactic a short-term move or combination of moves to achieve a short-term objective

technological integration investment in digital health systems, such as electronic health records and AI-driven diagnostic tools, to improve efficiency and patient outcomes

training threshold the minimum level of intensity or effort that a person must reach during exercise to achieve specific fitness improvements (when an upper limit is set, this is called a training zone)

trait anxiety the genetic predisposition and proclivity an athlete has towards increased anxiety and nervousness

urbanisation movement of people from rural areas to live in cities

visualisation creating and focusing on a range of positive mental images and experiences to achieve specific psychological benefits

VO_2 max the maximum (max) volume (V) of oxygen (O_2) the body is able to absorb during exercise, measured in mL/kg/minute

World Anti-Doping Agency (WADA) globally promotes, coordinates and monitors anti-doping in sports, ensuring fair, level, drug-free sports

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Index

Numbers
3D bioprinting 124–5

A
Aboriginal and Torres Strait Islander peoples
  access to health data by 32
  age distribution of 19
  burden of disease of 20–2
  causes of death among 20–1
  culture of 33
  development of 32
  factors determining health of 23–6
  geographic distribution of 15–17
  health inequalities and 15–34
  health status of 22, 29–34
  healthcare and 31–2, 87, 88–90
  injustice and 144
  life expectancy of 18–19
  partnerships with 31
  socio-economic targets and 30
access
  to education 143
  to health data 32
  to healthcare 32, 38–40, 86–7, 104, 130
  to social services in general 145
acupuncture 109
aerobic glycolysis 186
aerobic interval training 174, 189
aerobic lipolysis 186
aerobic threshold 187
aerobic training 186–90, 204, 205, 206, 207, 208
  anaerobic training and 174–5
age distributions, population 19, 65, 66
aged care 132–3
  facilities for 82
  workforce for 71
Aged Care Data and Digital Strategy 70–1
ageing, active *see* healthy ageing
ageing populations 142
  challenges of 68–9, 71–2
  coping with 70–1
  opportunities from 69
  as proportion of whole populations 65–6
agility training, post-injury 330
AI *see* artificial intelligence (AI) technology
allied health 81
amortisation 181
anabolism 306
anaerobic interval training 174, 175, 178
anaerobic tests 160
anaerobic threshold 178, 189
anaerobic training 175–85
  aerobic training and 174–5
analysis, epidemiological 130
anxiety 248
aromatherapy 109
arousal, optimal 246–7
artificial intelligence (AI) technology 125, 129, 130
assistive technology 126
atherosclerosis 51
athletes 157, 251
ATP-PCr energy system 180
attributes, athletic 251
augmented reality 126
Australian Institute of Sport 260
awareness, health 130
Ayurvedic medicine 109

B
balance training, post-injury 330
ballistic flexibility training 194
barriers to health 13
benign tumours 54
Better Life Index 47
big data 131–34
bioelectronic devices 127
biomechanics 298–304
bioprinting, 3D 126–7
birth rates 65
body composition tests 160
body-weight training 198
bone injuries 321, 322
bounce stretching 194
bowel cancer 57
Bowen therapy 109
breast cancer 56–7, 59
breath control 243
bulk billing 86
burden of disease
  for Aboriginal and Torres Strait Islander peoples 20–2
  geographic remoteness and 35, 37
  ranking of diseases adding to 7
bush medicines 90

C
caffeine 287–9
calcium, dietary 282–3
calisthenics 198
Canada, health lessons from 49–50

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cancer 54–9
morbidity rates for 54, 58, 59
mortality rates for 55, 58, 59
protective and risk factors for 56
screening for 85
various types of 56–7, 59
carbohydrate intake 263–4
cardiac output 210–11
cardiovascular disease 51–3
morbidity rates for 51–2, 62
mortality rates for 52–3
protective and risk factors for 53
cardiovascular fitness tests 159
catabolism 306
chiropractic 109
chronic health conditions 8–9, 62, 134, 322
circuit training 190
climate, training and 223
Closing the Gap strategy 29–30
coaching, sports 225, 229, 254
COAG *see* Council of Australian Governments
Coalition of Peaks 29–32
cold, application of 331
colonisation 15, 18, 26–7
colorectal cancer 57, 59
communication technology 89
community healthcare 81, 82–3
community-controlled health sector 89–91
competition phase of training programs 233
complementary healthcare 109–111
concentration, mental 239–40
concentric muscle contractions 181
concussion 333–4
conditioning in training sessions 227
confidentiality of patient information 134
continuous training 187
cool-downs 208, 226, 307
coordination training, post-injury 330
core training 183
Council of Australian Governments (COAG) 29–30
creatine 300–301
cricket 312–16
culture 28, 33

D

DALYs *see* disability-adjusted life years
data
big 131–34
demographic 5
genomic 50
health 4–5, 32
personal 130
death
among Aboriginal and Torres Strait Islander peoples 20–1
by age group 68
geographic remoteness and 36, 37
leading causes of 9
Decade of Healthy Ageing: Plan of Action 2021–2030 (UN) 71
decision-making, sports 228
delayed-onset muscle soreness 182
demography 19, 65, 66, 146
detraining 205
development, socio-economic 32
see also Sustainable Development Goals
diabetes
diseases occurring with 63
gestational 60
morbidity rates for 61–2
type 1 (insulin-dependent diabetes mellitus) 60
type 2 (non-insulin diabetes) 60, 61–2, 63, 91
diagnosis, medical 121, 123
dialysis 34
diet *see* nutrition
digital health information 113, 129
digital health records 83, 129
digital healthcare 50, 84, 88–9, 126, 129–30
digital sports technology 254, 310–17
direct sports injuries 319
disability, persons with 92, 107, 126
disability-adjusted life years (DALYs) 6
distress 249
doping *see* drug use in sports, illegal
drills, practice (for athletes) 200
drug use in sports
ethics and 338–42
health implications of 338
illegal 336–7
legal 336, 342
testing for 339–41, 343
duty of care 157
dynamic flexibility training 192

E

eccentric muscle contractions 181
education 48
access to 143
challenges relating to 144
health and 24
infrastructure for 144
targets relating to 143
elastics-based training 198
electrolytes 266
elite athletes 157
employment 24, 48
empowerment 140, 143, 144, 145
endurance training, post-injury 330
environment 146, 147, 223, 252
epidemiology 130, 134, 141
epigenetic testing 123–4
equipment advances 304, 311

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equity 104
see also access
Estonia, health lessons from 50
ethics 310, 338–42
eustress 249
evaluation, coach 229
exercise
health and safety during 156–7, 158, 166, 223–4
questionnaires before 156–7
recovery after 306–9
risk factors affecting 156
see also training
exertion, rate of perceived 175–6

F
facilities, sports 224
family structure, impact on health due to 24
fartlek training 188
fast twitch muscle fibres 212–13
fat as fuel source 186
fatigue 271, 273, 276
FIFA 11+ Injury Prevention Protocol 193
first aid 325
First Nations peoples *see* Aboriginal and Torres Strait Islander peoples
fitness 156, 161–63, 165–6, 252
fixed weights training 196–7
flexibility
in game strategies and tactics 254
tests for bodily 160
training for bodily 191–94, 329
fluid intake *see* hydration
focusing 239–40
force plate tests 161, 310
force-velocity curve 184
forecasting, health 5
free weights training 196–7
fuel sources 186
functional movements, biomechanics and 303
functional threshold power 175

G
gender 5
gene editing technology 127
general medical practitioners (GPs) 82
genetic testing 123
genomic data 50
geography, impact on health due to 25
glucose as fuel source 186
glycogen sparing 187
glycolysis, aerobic 186
goal setting in exercise or sports 162, 166, 244–5
good health and wellbeing 141–42
government funded and/or provided healthcare 94
GPs *see* general medical practitioners
ground contact times (in plyometric training) 181

H
haemoglobin levels, blood 212
hard tissue injuries 321–22, 325
health
apps relating to 110, 126
of Australians 4–13
challenges relating to 142
data about 4–5, 45
determinants of 4–5, 23–6
during exercise or training 159, 223–4
factors protecting 53, 56
factors risking 12, 42, 53, 56
information on 112–14, 129
insurance relating to 105–6
pre-exercise screening of 156–7, 158
promotion of 140–48, 150
targets relating to 141
see also healthcare; wellbeing
health expenditure 130
impact of 98–107
services enabled by 98, 99–100
sources of funds for 99–100
Health Plan 2021–2031, National Aboriginal and Torres Strait Islander 33
healthcare 48
access to 32, 38–40, 86–7, 104, 130
ageing and 68–9, 71–2
barriers to uptake of 86–7
categories of 81
complementary 109–11
control over 31, 89–91
cost-effectiveness of 130, 134
government funded and/or provided 94
information about 112–14
non-government funded and/or provided 95
person-centred 96–7
plans or programs for 102–3, 104–7
vs prevention 98, 101
healthcare system
challenges to 115
changing views within 78
effectiveness of 78–92
funding for 93
opportunities for 88–92
responsibility for 93–5
role of 81–85
HealthDirect Australia 84
healthy ageing 49, 67, 69
heart rate 210
heat, application of 331
herbalism 109
high-intensity interval training 175, 179
homeopathy 109
hospitals 81–82
housing, impact on health due to 24
hydration 265, 267, 276–7

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hydrotherapy 308
hypertrophy, muscle 195, 212
hyponatraemia 267

I
imaging technology *see* medical imaging technology
immunisation 85
implants, smart 127
income 145
  ageing and 69
  health and 23
Indigenous peoples *see* Aboriginal and Torres Strait Islander peoples
indirect sports injuries 319
inequalities, health 13, 15–34, 38–41, 78, 86–7, 120, 140, 141
  causes of 26–8, 41
inequalities, social
  challenges relating to 146
  targets relating to 145
inflammatory response 325–7
information, health 112–14, 129
infrastructure 147, 148
injuries
  assessment of 323–4
  biomechanics and 301
  classification of 319
  game strategies and tactics and 252
  of hard tissues 321–22, 325
  life-threatening 325
  management of 325–8
  from overuse 322
  prevention of 156, 157, 193, 224, 271, 273, 276
  rehabilitation and training after 328–31
  return to play after 331–32
  of soft tissues 320, 322, 325–8, 333–4
  training reversals and 205
in-performance nutrition 266–7
in-season training 233
intergenerational trauma 27, 28
interval training 174, 175, 178, 179, 180, 189
iron, dietary 283–4
Italy, health lessons from 49

J
Japan, health lessons from 48
jumping 161
justice system 24–5

K
kinematics 300

L
lactate levels, blood 175
lactate threshold 178
life expectancy
  of Aboriginal and Torres Strait Islander peoples 18–19
  by sex 10–11
  years of ill health and 11
lifestyle 69
ligament injuries 320, 322
lipolysis, aerobic 186
local health districts 96–7
longevity 65, 121
lung cancer 57, 59
lung capacity 211

M
macrocycles, training 233
  malignant tumours 54
  see also cancer
maximum aerobic speed 189
maximum heart rate 175
meals 265, 268
medical imaging technology 123
Medicare 48, 78, 104
Medicare Safety Net 104
medication technology 124
meditation 243
mental healthcare 83
mental rehearsals 240–41
mental training 222
mesocycles, training 232, 233, 234
metabolic recovery, post-exercise 306
metastases (sing. metastasis) 54
microcycles, training 232, 233, 234
micronutrients 280–85
minerals, dietary 282–4
mobile phones *see* smart phones
mobilisation, post-injury 328–9
modified games 200–201
monitoring of health, remote or wireless 126
morbidity 6–9
  see also burden of disease
mortality *see* death
motivation, training 166
movement
  biomechanics and 300–303
  enhanced 271, 273, 276
multivitamin supplements 285
muscle
  contraction of 181
  fibres comprising 212–13
  hypertrophy of 195, 212
  injuries to 320, 326
  post-exercise recovery of 306
  proprioception by 194
  relaxation of 243
  soreness in 182
  strength of 212

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muscle spindles 194
music, relaxing 243
My Aged Care 107
My Health Record 83, 130

N
nanotechnology 127
National Agreement on Closing the Gap 29–32
National Disability Insurance Scheme (NDIS) 92, 107
National Preventive Health Strategy 101
National Strategy for an Ageing Australia 69
naturopathy 109
NDIS *see* National Disability Insurance Scheme
neuromuscular recovery, post-exercise 306
New Zealand, health lessons from 49
non-government funded and/or provided healthcare 95
Nordic countries, health lessons from 48
not-for-profit healthcare organisations 95
nowcasting 5
nursing homes *see* aged care, facilities for
nutrition 260–69, 273–5
  carbohydrates 186, 263–4
  electrolytes and minerals 266, 282–4
  fats 186
  protein 285–6
  supplements 279–81, 290–91
  water 265, 267, 276–7

O
officiating, sports 310
off-season training 233
Organisation for Economic Co-operation and Development (OECD)
  health in member countries of 45, 48
  member countries of 44
osteopathy 110
osteopenia 282
osteoporosis 282
over-hydration 267
overtraining 205
overuse injuries 322
oxygen uptake 211

P
participation, sports 157, 162–3
partnerships, Closing the Gap 31
pathology technology 123
PBS *see* Pharmaceutical Benefits Scheme
peaking, performance 236
pentathlons 235, 351–52
perceived exertion, rate of 175–6
performance, sports 162–3, 236
periodisation, training 205, 231–33
peripheral vascular disease 51
person-centred healthcare 96–7
Pharmaceutical Benefits Scheme (PBS) 86
pharmaceutical technology 124
phones, smart 126, 129
phosphocreatine 180
physiological adaptations to training 209–13
physiological recovery, post-exercise 307
plyometric training 181–82
POLICE protocol 327
post-performance nutrition 268
poverty 147
power, training for 182–5
pre-event meals 265
pre-exercise questionnaires 156–7
pre-hab, training 224
preparation phase of training programs 231–32
pre-performance nutrition 263–5
pre-screening, exercise or training 156–7, 158
prescriptions, electronic 84, 129
pre-season testing, Aussie Rules 163
pre-season training 231–32
preventive healthcare 98, 101, 133
primary care 81, 82–3
principles of training 203–8
privacy of patient information 134
private health insurance 105–6
private healthcare organisations 95
private hospitals 81, 82
prognosis 121
progress, training 166
progressive overload 203–4
proprioceptive neuromuscular facilitation flexibility training 194
prostate cancer 57, 59
prostheses 127
protective equipment in training 223
protein intake 285–6
protocols
  FIFA 11+ Injury Prevention 193
  POLICE 327
  QQRT 271–72
  RAMP 185, 191, 206–7
  RICER 327
  TOTAPS 323–4
psychological recovery, post-exercise 308–9
psychology, sports 239–49, 252, 308–9
public health 48, 49–50, 81, 85
public hospitals 81, 82
Purple House 36

Q
QQRT protocol 271–72

R
racism 15, 18
RAMP protocol 185, 191, 206–7

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range of motion 191
rate of perceived exertion 175–6
records
  health 83, 129
  training and performance 317
recovery, post-exercise 306–9
recovery meals 268
recreational athletes or sports participants 157
referees, sports 311
referrals, health 129
reflection, training 229
regenerative medical technology 126
regional areas *see* rural and remote residents
Registry of Senior Australians 132–3
relaxation, post-exercise 308–9
relaxation techniques 243
remoteness, geographic *see* rural and remote area residents
resistance training (for power and speed) 182–5
return to play (RTP) 331–32
reversibility, training 205
RICER protocol 327
risk factors, exercise 156
risk factors, health 12, 42, 53, 56
RTP *see* return to play
rules, sports 253
rural and remote area residents 35–43, 41
  actions to improve health of 43
  burden of disease among 35, 37
  causes of death among 36
  health inequalities and 38–41
  health risk factors for 42
  healthcare system and 88–9
  rates of death among 37

S

safety, exercise and sports 156–7, 158, 166, 223–4
screening
  for cancer 85
  before exercise or training 156–7, 158
SDGs *see* Sustainable Development Goals
services, health *see* healthcare
SIA *see* Sport Integrity Australia
skills, sports 199–201, 227, 251
skin cancer 56
skin injuries 328
skinfold testing 160
sleep 271–73
slow twitch muscle fibres 212
SMART goals 162, 166, 245
smart implants 127
smart phones 126, 129
socio-economic disadvantage 13
socio-economic targets (in National Agreement) 30
sociological factors, impact on health due to 25, 28
sodium levels, blood 267
soft tissue injuries 320, 325–8
  see also concussion
specialised healthcare 81, 83
specificity, training 205
speed, training for 182–5
Sport Integrity Australia (SIA) 336
sprint interval training 175, 180
standard of living 48
state anxiety 248
static flexibility training 192
Stolen Generations 27, 28
strategies, sports 228, 251–54
strength tests 160
strength training 195–8, 204, 205, 206, 207, 208, 329–30
stress 248–9
stretching 192, 194
stretch-shortening cycle (muscle action) 181
stroke 51
stroke volume 210–11
structural recovery, post-exercise 306
sub-phases, training 233–7
supercompensation 203
supplements, dietary 279–80
support staff, sports 254
surgical interventions 124
sustainability
  challenges relating to 148
  of healthcare programs 102–3
  in sports 298
  targets relating to 147–8
Sustainable Development Goals (SDGs) 140
  good health and wellbeing (SDG 3) 141–42
  quality education (SDG 4) 143–4
  reduced inequalities (SDG 10) 145–6
  sustainable cities and communities (SDG 11) 147–8
Switzerland, health lessons from 48

T

Tabata-style training 179
tactics, sports 199–201, 228, 251–54
tapering, performance 236
teamwork in sports 222, 254
technological integration 71
technology, healthcare-related 120–21
  artificial intelligence (AI) and 125, 129, 130
  assistive 126
  for communication 89
  for diagnosis, measurement and monitoring 123–4, 125
  future 126–7
  for health treatments 124
  integration of 71
technology, sports-related 254, 310–17
telehealth 84, 88, 126, 129
tendon injuries 322

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thresholds
aerobic 187
anaerobic 178, 189
functional 175
lactate 178
training 204
TOTAPS protocol 323–4
training
adaptations from 209–13
aerobic 174–5, 186–90, 204, 205, 206, 207, 208
anaerobic 174–85
for bodily flexibility 191–94
de- 205
design of 223–9
environment and 223
evaluation of 225, 229
for game flexibility 254
grounds used for 224
health and safety during 156–7, 158, 166, 223–4
heaviness of 204
innovations in 310
mental 222
motivation for 166
over- 205
periodisation of 205, 231–33
post-injury 328–31
principles of 203–8
programs of 165–6, 231–37
for strength 195–8, 204, 205, 206, 207, 208, 329–30
thresholds in 204
see also specific types of training
trait anxiety 248
transition phase of training programs 233
transportation, impact on health due to 24
trauma, intergenerational 27, 28
tumours 54

U
urbanisation 147
urine colour 277

V
videoconferencing 129
virtual healthcare 91
virtual reality 126
visualisation 242
vitamins 280–81
VO_2 max 159, 175

W
WADA *see* World Anti-Doping Authority
warm-ups 206–7, 225
water intake *see* hydration
water-based recovery, post-exercise 308
weather, training and 223
wellbeing 46–7, 141–42
see also health
workforce 69
World Anti-Doping Authority (WADA) 336

Y
years lived with disability (YLDs) 6
years of life lost (YLLs) 6

Z
zinc, dietary 284
zone 2 training 187

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