Australian Government
Australian Institute of Health and Welfare

Impact of physical inactivity as a risk factor for chronic conditions

Australian Burden of Disease Study

Australian Government
Australian Institute of Health and Welfare

AUSTRALIAN BURDEN OF DISEASE STUDY SERIES
Number 15

Impact of physical inactivity as a risk factor for chronic conditions

Australian Burden of Disease Study

Australian Institute of Health and Welfare
Canberra
Cat. No. BOD 16

The Australian Institute of Health and Welfare is a major national agency whose purpose is to create authoritative and accessible information and statistics that inform decisions and improve the health and welfare of all Australians.

This publication is part of the Australian Institute of Health and Welfare's Australian Burden of Disease Study series. A complete list of the Institute's publications is available from the Institute's website <www.aihw.gov.au>.

ISBN 978-1-76054-230-6 (PDF)
ISBN 978-1-76054-231-3 (Print)
ISSN 2204-4108 (PDF)
ISSN 2006-4508 (Print)

Suggested citation

Australian Institute of Health and Welfare 2017. Impact of physical inactivity as a risk factor for chronic conditions: Australian Burden of Disease Study. Australian Burden of Disease Study series no. 15 Cat. no. BOD 16. Canberra: AIHW.

Any enquiries relating to copyright or comments on this publication should be directed to:
Australian Institute of Health and Welfare
GPO Box 570
Canberra ACT 2601
Tel: (02) 6244 1000
Email: info@aihw.gov.au

Published by the Australian Institute of Health and Welfare

This publication is printed in accordance with ISO 14001 (Environmental Management Systems) and ISO 9001 (Quality Management Systems). The paper is sourced from sustainably managed certified forests.

MIX
From responsible sources
FSC® C017269

Please note that there is the potential for minor revisions of data in this report. Please check the online version at <www.aihw.gov.au> for any amendments.

Contents

Acknowledgments ..... **v**
Abbreviations ..... **vi**
Symbols ..... **vi**
Summary ..... **vii**
1 Introduction **1**
1.1 Study aims and scope 2
What is burden of disease? 2
1.2 Structure of this report 3
2 Methods **5**
2.1 Select linked diseases and increased risk 6
2.2 Determine physical activity levels 8
2.3 Theoretical minimum risk exposure distribution 10
2.4 Quantify physical inactivity burden 10
2.5 Estimate the joint effect 10
2.6 Socioeconomic group analysis 11
2.7 Comparison with attributable burden in 2003 11
2.8 Scenario modelling 11
3 Burden due to physical inactivity **12**
3.1 Physical activity prevalence in 2011 12
3.2 Physical activity attributable burden 12
3.3 Physical inactivity burden by linked disease 13
3.4 Fatal and non-fatal attributable burden by linked disease 15
3.5 Physical inactivity burden by linked disease, age and sex 16
3.6 Proportion of burden due to physical inactivity for each linked disease 17
3.7 Attributable burden by activity level 18
3.8 Comparison using all physical activity domains 19
3.9 Combined impact of physical inactivity and overweight and obesity 20
4 Variation across socioeconomic groups **22**
4.1 Inequalities in attributable burden 22
5 Changes between 2003 and 2011 ..... **25**
5.1 Comparison of physical activity in 2011 and 2003 25
5.2 Overall change in attributable burden 25

6 Scenario modelling 29
6.1 Predicted prevalence of physical activity levels in 2020 30
6.2 Physical inactivity burden in 2020 32
6.3 Scenario differences in 2020 by age 33
7 Discussion 35
7.1 Major findings 35
7.2 Potential to reduce disease burden 36
7.3 Strengths 36
7.4 Limitations 37
7.5 Future directions 38
7.6 Conclusion 40
Appendix A: Detailed methods 41
Selection of linked diseases 41
Population exposure: prevalence of physical activity in each level 42
Theoretical minimum risk exposure distribution 43
Calculation of population attributable fractions 43
Estimating the joint effect 44
Socioeconomic group analysis 44
Scenario modelling 45
Appendix B: Selection of relative risks 46
Appendix C: Additional tables 49
Glossary 51
References 52
List of tables 55
List of figures 56
Related publications 57

Acknowledgments

This report was authored by Melanie Dunford and Vanessa Prescott of the Burden of Disease and Mortality Unit at the Australian Institute of Health and Welfare (AIHW), under the guidance of Michelle Gourley, Sushma Mathur and Lynelle Moon.

Justin Harvey, Geoff Neideck, Claire Sparke, David Whitelaw and Louise York from the AIHW provided constructive comments and review. Their contributions are gratefully acknowledged.

The report was prepared under the guidance of the National Vascular Diseases Monitoring Advisory Group (NVDMAG), chaired by Erin Lalor. The following NVDMAG expert advisory groups reviewed this report:

Cardiovascular Disease Expert Advisory Group: Andrew Tonkin (Chair), Tom Briffa, Derek Chew, Annette Dobson, Mark Nelson and Mandy Thrift.

Diabetes Expert Advisory Group: Jonathan Shaw (Chair), Maria Craig, Wendy Davis, Mark Harris, Greg Johnson, Glynis Ross and Sophia Zoungas.

The authors would like to acknowledge the methodological advice provided by Professor Tim Driscoll from the University of Sydney.

The Australian Government Department of Health funded this report. The authors acknowledge the valuable comments from individual staff members at the Department of Health.

Abbreviations

ABDS	Australian Burden of Disease Study
ABS	Australian Bureau of Statistics
AHS	Australian Health Survey
AIHW	Australian Institute of Health and Welfare
ASR	age-standardised rate
BMI	body mass index
DALY	disability-adjusted life years
GBD	Global Burden of Disease
MET	metabolic equivalent of task
PAF	population attributable fraction
TMRED	theoretical minimum risk exposure distribution
YLD	years lived with disability
YLL	years of life lost

Symbols

. .	not applicable
>	greater than
<	less than
%	per cent
+	plus

Summary

Physical inactivity increases the risk of a range of diseases, such as cardiovascular disease, type 2 diabetes and some cancers. More than half of Australian adults are either not active at all or do not meet the recommended guidelines (ABS 2013). The impact of both these factors was quantified in the Australian Burden of Disease Study (ABDS) 2011 which showed that physical inactivity is one of the leading risk factors of disease burden (AIHW 2016a). Disease burden measures the health loss from living with, or dying prematurely from, a disease or injury.

This report provides further information on physical inactivity as a risk factor for disease burden in Australia. It updates and extends the findings from the ABDS 2011 to include a revised list of diseases linked to physical inactivity, updated estimates of their association, and a broader definition of physical activity. Scenario modelling is used to show the potential benefits of increasing physical activity across Australia.

Health impact of physical inactivity

The enhanced analysis in this report indicates that 2.6% of the total disease burden in 2011 was due to physical inactivity. This finding, similar for both men and women, has been revised downwards from the 5.0% estimate reported in ABDS 2011 due to updated methods.

When physical inactivity is combined with overweight and obesity, the burden increases to 9%—equal with tobacco smoking, the leading risk factor for disease burden in Australia.

Health benefits from an extra 15–30 minute long brisk walk, 5 days per week

An extra 15 minutes of brisk walking, 5 days each week, could reduce disease burden due to physical inactivity by an estimated 13%. If this time increased to 30 minutes, the burden could be reduced by 26%. All ages would benefit, particularly people aged 65 and over.

The report suggests that small sustained increases in daily exercise, particularly for those who are sedentary, could produce sizeable future health gains for the population. Leisure and transport are the main ways people are physically active, making them best placed for targeted interventions to increase physical activity in the population.

Physical inactivity responsible for 10%–20% of disease burden for related diseases

Physical inactivity was linked to 7 diseases in this study, and found to contribute to substantial proportions of the disease burden:

- 19% for diabetes
- 16% for bowel cancer and 16% for uterine cancer
- 14% for dementia
- 11% for breast cancer and 11% for coronary heart disease
- 10% for stroke.

Decreasing burden with increasing socioeconomic position

People in the lowest socioeconomic group experienced rates of disease burden due to physical inactivity at 1.7 times that of the highest socioeconomic group. There was a clear pattern of decreasing burden with increasing socioeconomic position.

Slight reduction in physical inactivity burden over time

The rate of disease burden due to physical inactivity reduced by 12% between 2003 and 2011, after accounting for population increase and ageing.

1 Introduction

Physical inactivity is a major risk factor for ill health in Australia, with over half (56%) of adults not meeting current Australian physical activity guidelines (ABS 2013). Physical activity is also an important factor in preventing or reducing overweight and obesity, a leading contributor to disease in Australia (AIHW 2017a). Health conditions associated with physical inactivity—such as cancer, cardiovascular disease, dementia and diabetes—are among the leading causes of morbidity and mortality in Australia (AIHW 2016a).

Regular exercise is important not only in preventing disease, but also in treating and managing disease (Pedersen & Saltin 2015). It can also increase overall quality of life through improved mental and social wellbeing, particularly by reducing stress, anxiety and depressive symptoms (Hoegh Poulsen et al. 2016; Sanchez-Villegas et al. 2008; Teychenne et al. 2008).

The Australian Physical Activity and Sedentary Behaviour Guidelines recommend the amount of physical activity to be undertaken each week to maintain good health. These recommendations are outlined in Box 1.1.

Box 1.1: Australian Physical Activity and Sedentary Behaviour Guidelines

The Australian Physical Activity and Sedentary Behaviour Guidelines recommend the amount of exercise to be undertaken in leisure- or transport-related activities. These recommendations vary by age.

People aged 18–64 are recommended to accumulate 150 to 300 minutes of moderate intensity physical activity or 75 to 150 minutes of vigorous intensity physical activity, or an equivalent combination of both moderate and vigorous activities, each week (Department of Health 2014). The guidelines advise to be active most, preferable all, days every week and to avoid prolonged sitting.

People aged 65 and over should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days (Department of Health 2014). They are recommended to do a range of physical activities that incorporate fitness, strength, balance and flexibility.

People who do not meet these guidelines are considered insufficiently active, or physically inactive. This differs from the definition of physical inactivity used in this report.

Physical inactivity rates increase with age, as well as with level of socioeconomic disadvantage. The proportion of people in 2014–15 who were not meeting physical activity guidelines increased from 48% in men and women aged 18–24, to 75% in men and women aged 65 and over (ABS 2013; AIHW 2017b). Furthermore, 60% of men and 66% of women living in the most disadvantaged areas did not meet physical activity guidelines, compared with 38% of men and 43% of women living in the least disadvantaged areas (AIHW 2017b).

Overall, physical activity levels have increased over recent years, but not for all age groups. The total proportion of people who did at least 150 minutes of physical activity per week increased by 0.5% each year between 2002 and 2012; however, for people aged 65 and over, this proportion decreased—and for people aged 65 and over, the proportion undertaking no physical activity increased (Devonshire-Gill & Norton 2017). Increasing activity levels were also seen across all socioeconomic groups in this 10-year period (Devonshire-Gill & Norton 2017).

1.1 Study aims and scope

This report provides detailed information on the health impact of physical inactivity in Australia; it also updates and extends the estimates of disease burden attributable to physical inactivity reported in the Australian Burden of Disease Study (ABDS) 2011. This includes:

- revised linked diseases and relative risks based on recent evidence
- an updated physical activity definition to include activity from all domains (including occupational activity and activity from household chores, which were not included in the ABDS 2011), and comparison of results from these definitions
- comparison of results by level of activity
- inclusion of, and reporting on, those aged 20 and over
- disaggregation by socioeconomic group
- examination of differing levels of physical inactivity in Australia, and how this affects chronic disease burden in the future, using scenario modelling
- estimation of the joint effect of physical inactivity and overweight and obesity on disease burden in Australia.

This study focuses on the health impact of physical inactivity in Australia, as a risk factor for disease. Reduced physical inactivity levels may also be a consequence of a range of diseases that restrict people's ability to exercise; however, this relationship could not be quantified in this study.

Seven (7) chronic diseases were included in this study that were found to have sufficient evidence of increased risk of development in adults who do not undertake enough physical activity (Blondell et al. 2014; Kyu et al. 2016; Schmid et al. 2015). These diseases were breast cancer, bowel cancer, coronary heart disease, dementia, diabetes, stroke, and uterine cancer. Only type 2 diabetes was found to be causally associated with physical inactivity; however, as the ABDS 2011 did not estimate diabetes burden by type, the total diabetes burden was used in estimates of the proportion of diabetes burden due to physical inactivity. This is further discussed in Chapter 2.

What is burden of disease?

Burden of disease analysis is used to assess and compare the impact of different diseases, conditions or injuries ('diseases' for simplicity) and risk factors on a population.

The ABDS 2011 quantified the fatal and non-fatal effects of these diseases in a consistent manner so that they could then be combined into a summary measure of health called the **DALY**— or **disability-adjusted life year**. The DALY combines the estimates of years of life lost due to premature death (YLL) and years lived in ill health or with disability (YLD) to count the total years of healthy life lost from diseases. These and other key terms are defined in Box 1.2.

This health loss represents the difference between the current health status of the population and the ideal situation where everyone lived a long life, free of disease. Burden of disease estimates capture both the quantity and quality of life, and reflect the magnitude, severity and impact of disease and injury within a population in the given year. The analysis also estimates the contribution of various risk factors to health loss, known as the attributable burden. It is important to note that burden as described in burden of disease studies is solely the health loss experienced by the individual with the disease.

Attributable burden reflects the direct relationship between a risk factor—physical inactivity in this report—and a disease outcome. It is the amount by which disease burden would be reduced if exposure to the risk factor had been avoided or reduced to the lowest possible exposure.

Burden of disease estimates can be used to inform population health monitoring, health policy formulation, health service planning and health promotion and management strategies.

For detailed information about the ABDS 2011, and further information on the methods used to calculate disease burden, see *Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011* (AIHW 2016d) and *Australian Burden of Disease Study: methods and supplementary material* (AIHW 2016b).

1.2 Structure of this report

This report quantifies the disease burden due to physical inactivity in Australia in 2011. This chapter provides background information on physical inactivity and chronic disease in Australia, and burden of disease analysis.

- Chapter 2 summarises the methods used in this report to estimate the burden attributable to physical inactivity.
- Chapter 3 summarises the results of analyses to estimate the impact of physical inactivity on disease burden in Australia in 2011, by sex, age group and by linked diseases.
- Chapter 4 summarises the results by socioeconomic group.
- Chapter 5 compares estimates for 2003 and 2011.
- Chapter 6 presents results from scenario modelling, which shows the impact on disease burden of reducing physical inactivity in the population.
- Chapter 7 discusses the results, strengths and limitations of this study, as well as future directions.
- Appendix A provides more detailed information on the methods used in this report.
- Appendix B details the relative risks used in this report, and the selection criteria used to assess an association between physical inactivity and linked diseases.
- Appendix C provides additional tables of results.

Box 1.2: Important terms used in this report

attributable burden: The disease burden attributed to a particular risk factor. It is the reduction in burden that would have occurred if exposure to the risk factor had been avoided or had been reduced to its **theoretical minimum risk exposure distribution**.

chronic disease: A disease that tends to be long lasting and persistent in its symptoms or development.

comparative risk assessment: The process for estimating the burden of disease attributable to selected risk factors. It involves five key steps: selection of risk-outcome pairs; estimation of exposure distribution; estimation of effect sizes; choice of theoretical minimum risk exposure distribution; and finally, calculation of attributable burden.

confounding: A situation when an observed association is due, in whole or in part, to a third factor that is associated both with the exposure and with the outcome of interest.

Disability-adjusted life years (DALY): A year of healthy life lost, either through premature death or equivalently through living with disability due to illness or injury.

linked disease: A disease or condition on the causal pathway of the risk factor, and therefore more likely to develop if exposed to the risk.

population attributable fraction (PAF): For a particular risk factor and causally linked disease or injury, the percentage reduction in burden that would occur for a population if exposure to the risk factor were avoided or reduced to its theoretical minimum.

relative risk (RR): The risk of an event relative to exposure, calculated as the ratio of the probability of the event's occurring in the exposed group to the probability of its occurring in the non-exposed group. A relative risk of 1 implies no difference in risk; RR <1 implies the event is less likely to occur in the exposed group; and RR >1 implies the event is more likely to occur in the exposed group.

risk factor: Any factor that causes or increases the likelihood of a health disorder or other unwanted condition or event.

theoretical minimum risk exposure distribution (TMRED): The risk factor exposure distribution that will lead to the lowest conceivable disease burden.

Years lived with disability (YLD): A measure of the years of what could have been a healthy life that were instead spent in states of less than full health. This is also referred to as non-fatal burden.

Years of life lost (YLL): A measure of years of life lost due to premature mortality. This is also referred to as fatal burden.

2 Methods

This chapter provides an overview of the steps used to calculate the burden attributable to physical inactivity.

Burden due to physical inactivity was estimated using the comparative risk assessment methodology—a standard approach used in burden of disease risk factor analysis globally (Forouzanfar et al. 2013; Murray et al. 2003).

In this study, the steps followed to quantify the burden due to physical inactivity were:

- select linked diseases and relative risks
- determine prevalence of total physical activity levels in the population
- define the theoretical minimum risk exposure distribution (TMRED)
- calculate the population attributable fractions (PAF)
- quantify the disease burden due to physical inactivity.

The ABDS 2011, which used methods from the Global Burden of Disease Study (GBD) 2010, estimated that 5% of the total health burden in Australia was due to physical inactivity. With increased evidence and revised methods, the disease burden due to physical inactivity was revised downwards in this study, compared with that reported in the ABDS 2011. The updated methods used are further explained in Box 2.2.

A more detailed methods description is in Appendix A. The methodological developments in this study, which have occurred since the ABDS 2011 and the impact of these changes are described in Box 2.1 and in Appendix B.

Box 2.1: Key developments since the Australian Burden of Disease Study 2011

Several methodological developments have occurred since the release of the ABDS 2011. The updated methods used in this report, and the potential impact on the final results, are discussed here.

1. Expanded exposure definition for physical inactivity

The ABDS 2011 excluded physical activity during work and from household chores. Excluding exercise in these domains may have over-represented sedentary and low levels of activity categories in the ABDS 2011, particularly for people with physically demanding occupations. Therefore, physical activity in this report is not just limited to leisure activity and active transportation; it includes other activities that involve bodily movement undertaken as part of work and household chores. This is consistent with the most recent editions of the GBD study, which also included physical activity from occupational exposure and household chores. In this study, the impact of this expanded exposure definition for physical activity resulted in a reduction of 11,254 attributable DALY.

2. Additional linked diseases

The ABDS 2011 included 5 diseases linked to physical inactivity (breast cancer, bowel cancer, coronary heart disease, diabetes and stroke) based on evidence used in the GBD 2010. In this report, diseases were reviewed and updated based on the latest evidence, which resulted in 2 extra diseases being included as being linked to physical inactivity—dementia and uterine cancer. The impact of including dementia and uterine cancer as linked diseases resulted in an extra 21,978 DALY.

(continued)

Box 2.1 (continued): Key developments since the Australian Burden of Disease Study 2011

3. Revised relative risks

The ABDS 2011 used relative risks that were based on the GBD 2010. In this study, these were updated to be based on those used in the GBD 2015, which were lower for all linked diseases. See Box 2.2 for the differences in relative risks between the GBD 2010 and 2015.

The impact of these revised relative risks resulted in the attributable burden estimates being revised downwards by 129,852 DALY. These changes had the greatest impact on the resulting estimates reported in this study since the ABDS 2011.

4. Extended age groups

The burden due to physical inactivity reported in the ABDS 2011 was limited to adults aged 25 and over. In this report, this age group was extended to include those aged 20 and over. Those aged under 20 were not included as there was insufficient evidence for causal association in this age group. The impact of the extended age groups resulted in an extra 352 DALY.

2.1 Select linked diseases and increased risk

Select diseases for inclusion in analysis

In this study, diseases that were identified as having a causal association with physical inactivity are referred to as linked diseases. A disease was included in the analysis if it was considered to have a 'convincing' or 'probable' level of evidence supporting a causal association (based on review of the literature at the time of the study) according to criteria set by the World Cancer Research Fund.

In total, 7 linked diseases were included: breast cancer, bowel cancer, coronary heart disease, dementia, diabetes, stroke and uterine cancer (Blondell et al. 2014; Kyu et al. 2016; Schmid et al. 2015). Dementia and uterine cancer were previously not included in the GBD 2015 or the ABDS 2011.

As the ABDS 2011 did not disaggregate diabetes by type, the total diabetes burden estimates were used in the analysis. This will overestimate the attributable diabetes burden due to physical inactivity, as only type 2 diabetes is causally associated with physical inactivity. Future burden of disease studies will benefit from disaggregating diabetes burden by type.

Physical inactivity is causally associated with a range of other conditions that were not included in this study. These were excluded from the study if they were not captured as a disease in the ABDS 2011 or they did not meet the level of evidence criteria used in this study. The omitted diseases include back pain, depression, heart failure, metabolic syndrome, obesity, osteoarthritis and osteoporosis.

It is important to note that excluding these conditions does not disregard the current evidence, and does not indicate that physical inactivity does not play a role in development of some of these conditions. For some conditions, it indicates that further evidence is required to describe the causal association.

See Appendix A for further information on the criteria for assessing evidence, and why certain conditions were excluded from this report.

Selection of relative risks

Relative risks for linked diseases included in other burden of disease studies were sourced directly from the GBD 2015. With increased evidence and revised methods, the risk for each of these disease outcomes has reduced in the latest GBD, compared with the relative risks used in the ABDS 2011 (which were obtained from the GBD 2010). Therefore, the disease burden due to physical inactivity has been revised downwards in this report, compared with that reported in the ABDS 2011. See Box 2.2 for the differences between the relative risk inputs used in each study; see Appendix B for further detail on the differences in inputs used to estimate the proportion of disease burden due to physical inactivity, and how this contributes to the changes in estimates since the ABDS 2011.

Attributable burden was estimated in adults aged 20 and over, except for dementia, which was estimated in people aged 65 and over. Relative risks for these diseases were sourced directly from selected studies. Age- or sex-specific relative risks for all linked diseases were applied where possible. See Appendix B for a review of the linked diseases and relative risks selected.

For detailed information about the ABDS 2011, see *Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011* (AIHW 2016d) and *Australian Burden of Disease Study 2011: methods and supplementary material* (AIHW 2016b).

Box 2.2: Reason for attributable burden revised downwards in this study compared with ABDS 2011: relative risks updated

Relative risks are used to quantify the increased risk for an individual exposed to the risk factor—which for this report is physical inactivity—and the associated disease outcome. The ABDS 2011 used relative risks that were used in the GBD 2010. This study used relative risks from the GBD 2015.

The systematic review and meta-analysis used in the GBD 2010 to derive relative risks was based on physical inactivity as a categorical risk, with risk associated with being inactive or insufficiently active (defined as the proportion of the population not reaching the recommended 150 minutes of moderate activity each week).

By comparison, the relative risks used in the GBD 2015 were based on the systematic review and meta-analysis by Kyu et al. 2016. This study included 3 to 5 times more prospective studies for each disease outcome; it also based estimates on total physical activity across all domains, and produced continuous risk curves for each of the 5 disease outcomes used in the GBD (breast cancer, bowel cancer, coronary heart disease, type 2 diabetes and stroke). The results from each outcome indicated the associated increased risk is lower than that reported in the GBD 2010, with the greatest reductions in risk seen in the sedentary group for all disease outcomes. For example, the age-dependent relative risk of coronary heart disease reduced from 1.1–2.9 in the GBD 2010 to 1.1–1.6 in the GBD 2015 in the most inactive group.

Therefore, the risk association for each disease outcome has decreased compared with the relative risks used in the GBD 2010, resulting in attributable burden estimates that have been revised downwards in this study.

2.2 Determine physical activity levels

Physical activity definition and measures

Physical activity is any bodily movement produced by skeletal muscles that expends energy (World Health Organization 2017). During people's daily activities, this exercise may occur in a number of domains, such as during leisure time or for transport.

In this study, physical activity in the population encompasses the following domains: leisure (moderate or vigorous activity and walking for exercise), transport-related, occupational, and activity due to household chores. The ABDS 2011 excluded the domains of occupational activity and activity due to household chores.

Physical activity measures are based on the frequency and intensity of activity. In this study, physical activity is measured using the metabolic equivalent of task (MET), which quantifies the rate of energy expenditure. One (1) MET is equivalent to the rate of energy expended at rest in 1 minute, whereas 5 METs indicates that the energy expended is 5 times that at rest. The greater the MET, the more the energy that is exerted. This MET intensity score is multiplied by the minutes spent at each activity intensity to give the total MET score for that activity (Jette M, Sidney K & Blümchen G 1990).

Moderate exercise, such as brisk walking, recreational swimming, dancing or social tennis, have a MET intensity between 3.5 and 5. Vigorous activity requires more effort and includes running, fast cycling and many organised sports. These activities have a MET intensity of around 7 and above.

The MET scores in each activity domain were mostly calculated by the duration of exercise per week in minutes, and the activity intensity from the National Nutrition and Physical Activity Survey as part of the Australian Health Survey (AHS) 2011–12. The estimation of MET scores from each of these domains is detailed in Appendix A.

The MET scores from all activities undertaken are summed and then used to group people into physical activity categories. An example of how the MET score is calculated is shown in Box 2.3.

Physical activity categories

Physical inactivity in this report is defined as collectively undertaking fewer than 8,000 METs each week from the following domains: leisure activity, transport-related activity (such as cycling to work), occupational activity, and activity due to household chores.

Prevalence of physical activity was estimated in four categories. The categories used in this report are based on those from the GBD 2015. The categories are:

- **Sedentary:** total MET score between 1–599
- **Low:** total MET score between 600–3,999
- **Moderate:** total MET score between 4,000–7,999
- **High:** total MET score of 8,000 and above.

Age- and sex-specific data were extracted for each category in the finest possible increments. Prevalence was obtained from age 20 and over, to align with relative risks. The level of granularity was limited to keep the relative standard error to 25% or less where possible. Further details on estimating physical activity levels in this study is in Appendix A.

Box 2.3: An example—calculating physical activity levels

Sally, aged 45, works in an office full time and drives to work each day. She finds it hard to find time to exercise during the working week, but manages to take a 30-minute brisk walk around the block, every Sunday morning.

To calculate how much physical activity Sally undertakes each week, the time spent in each activity and the intensity of the activity are needed. This information is required for leisure activity, transport-related activity (such as cycling to work), occupational activity, and activity due to household chores.

In Sally's case, she takes a brisk walk (MET intensity score for moderate activity is 5.0) for 30 minutes, 1 day per week. So, her total leisure activity MET score is 150 (5.0 x [30 minutes x 1]).

For Sally's transport MET score, driving is not considered to be physically intensive and therefore has a MET intensity score of 0. Working in an office and sitting at a desk during work hours is also not considered to be physically intensive and also has a MET intensity score of 0. So, Sally's total transport and occupational activity MET score for the week is 0.

She also undertakes 2 hours of household chores each week (MET intensity score of 3.0). So, her total household chores activity MET score is 360 (3.0 x [60 minutes x 2]).

Therefore, Sally's total activity MET score is 510 (150 + 0 + 0 + 360).

This MET score places Sally in the sedentary activity category. People within this category are at highest risk of disease development due to physical inactivity. The extra risk of developing diseases linked to physical inactivity for people in this category ranges between 14% and 67%, depending on the disease.

Physical inactivity definition in this study

In this study, physical inactivity is defined as undertaking fewer than a combined total of 8,000 METs per week through leisure, transport-related and occupational physical activity or activity due to household chores. Therefore, people in the sedentary, low and moderate activity levels in this study are considered to have some extra risk of developing diseases associated with physical inactivity. The level of additional risk is highest for people in the sedentary category and lowest for people in the moderate category. People in the high activity category have no extra risk of developing disease associated with physical inactivity.

This aligns with the definitions and methodologies used in the GBD studies and in the ABDS 2011. The categories from the GBD 2015 were chosen for comparability across burden of disease studies, and for applicability in estimating attributable burden. It is important to note that the categories in this study are for the purpose of burden of disease analysis only and do not align with Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults. Table 2.1 outlines the differences between the physical activity categories used in this study and those in Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults.

Table 2.1: Comparison of physical activity components in this study and components in Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults

Component	Burden of disease analysis	Physical activity guidelines
Purpose	Quantify the disease burden due to physical inactivity	Provide recommendations to the population on the amount of exercise to undertake for good health
Measure	Total MET score from all domains each week	Time spent in moderate or vigorous activity each week

(continued)

Table 2.1 (continued): Comparison of physical activity components in this study and components in Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults

Component	Burden of disease analysis	Physical activity guidelines
Categories	Sedentary: total MET score between 1–599 Low: total MET score between 600–3,999 Moderate: total MET score between 4,000–7,999 High: total MET score of 8,000 and above	Sufficient (aged 18–64): At least 150 minutes of moderate intensity physical activity or 75 minutes of vigorous activity, or an equivalent combination each week. Sufficient (aged 65+): At least 30 minutes of moderate intensity physical activity on most, preferably all, days, which should include a range of physical activities that incorporate fitness, strength, balance and flexibility. Insufficient: Not meeting the recommendations
Age range	20+ years	18+ years

2.3 Theoretical minimum risk exposure distribution

The estimated contribution of a risk factor to disease burden is calculated by comparing the observed risk factor distribution with an alternative hypothetical distribution (the counterfactual scenario). In the ABDS 2011, a TMRED scenario was adopted, that is the hypothetical exposure distribution that would lead to the lowest conceivable disease burden.

In this study, the TMRED for the risk factor 'physical inactivity' was 8,000 METs, which equates to the category of high physical activity. This is the exposure level for which, if achieved, there is no extra risk of developing disease associated with physical inactivity.

2.4 Quantify physical inactivity burden

The burden attributable to physical inactivity was estimated using calculated PAFs for each linked disease and the total burden estimated in the ABDS 2011. PAFs are estimates for the proportion of a particular disease that could have potentially been avoided if the population had never been exposed to a risk factor (Box 1.2). These were calculated using relative risks and exposure information from the previous steps. The formulae used to calculate PAFs and attributable burden are detailed in Appendix A.

As it is possible to develop more than one linked disease, the underlying DALY estimates (as calculated in the ABDS 2011) were adjusted for the probability of an individual having more than one condition (for more information, see AIHW 2016b). The relative risks used were also typically adjusted for confounding (age, sex, body mass index [BMI], smoking status, alcohol use, and other chronic conditions).

2.5 Estimate the joint effect

In the ABDS 2011 and in this study, physical inactivity was assessed as an independent risk factor. Therefore, the attributable burden estimates in this report, and other attributable burden estimates for various risk factors in the ABDS 2011, cannot be added together. This is due to the complex relationships and interactions between risk factors.

To overcome this issue, the joint effect of selected risk factors can be estimated. In this study, the joint effect of physical inactivity and overweight and obesity was estimated (see Appendix B for details on the methods used).

2.6 Socioeconomic group analysis

Estimates of attributable burden by socioeconomic group were calculated using data on population exposure to physical inactivity by socioeconomic group, applied to estimates of disease burden by equivalent socioeconomic group from the ABDS 2011.

In this report, socioeconomic groups are based on an index of relative socioeconomic disadvantage, developed as part of the Socio-Economic Indexes for Areas by the ABS (ABS 2010). This index relates to a particular geographic area and is based on a number of characteristics, including household income, employment and education level. In this analysis, the index is allocated based on the individual's residential area. The actual socioeconomic properties of individuals can vary within the same area.

Socioeconomic groups are presented as quintiles in this analysis. Quintile 1 (Q1) represents the 20% of the population with the lowest socioeconomic characteristics (least advantaged). The level of socioeconomic position increases with each quintile, through to the 20% of the population with the highest socioeconomic characteristics (Q5) (most advantaged).

Each quintile has a similar number of people. However, the lower socioeconomic groups have a larger proportion of people aged 65 and over than the higher groups. A greater proportion of Aboriginal and Torres Strait Islander people and people with disability are also found in the lowest socioeconomic group (ABS 2010).

2.7 Comparison with attributable burden in 2003

Burden due to physical inactivity was also estimated for the year 2003. For this comparison, population exposure for the year 2003 was obtained from trends in ABS National Health Surveys, and linked disease burden in 2003 was obtained from the ABDS 2011.

2.8 Scenario modelling

Scenario modelling was used to investigate changes in the health impacts from physical inactivity if the levels of physical activity in Australia differed. To estimate the health impacts from different levels of physical activity in the population, burden due to physical inactivity was estimated under different scenarios in the year 2020:

- *Trend rate scenario:* the estimated attributable burden in the year 2020 if the prevalence rate of physical inactivity continued according to current trends observed in the 2001, 2004–5, 2007–08, 2011–12 and 2014–15 ABS National Health Surveys.
- *Stable rate scenario:* the estimated attributable burden in the year 2020 if the prevalence rate of physical inactivity were to remain as it was in the year 2011.
- *Targeted daily activity scenario:* the estimated attributable burden in the year 2020 if everyone in the population 'at risk' increased the time spent doing moderate activity, such as going for a brisk walk. A varying range of times of extra activity were analysed:
    - 15 minutes of moderate activity, 5 days per week
    - 30 minutes of moderate activity, 5 days per week
    - 60 minutes of moderate activity, 5 days per week.

The attributable burden estimates from these scenarios were compared to determine the impact, and differences between the scenarios. Detailed information on the methods used for scenario modelling is in Appendix B.

3 Burden due to physical inactivity

This chapter presents estimates of the burden due to physical inactivity in Australia in 2011, including total, non-fatal and fatal burden by sex, age group and linked disease. The list of linked diseases included in this analysis can be found in Appendix Table B1.

3.1 Physical activity prevalence in 2011

In this report, physical activity levels were classified as being either sedentary, low, moderate or high. The activity levels in each group are a summation of activities from each domain: leisure, transport, occupational and household chores. Individuals with high physical activity levels (8,000 METs or higher) were not considered to be at additional risk of disease development due to physical inactivity (see Chapter 2). As physical activity levels decrease—from moderate activity levels to sedentary—the risk of developing disease due to physical inactivity increases.

Table 3.1 shows the proportion of people in Australia in 2011 in each of the activity categories. The majority of the population were either sedentary (31%) or undertook low levels (49%) of activity across all activity domains. By comparison, only 11% of the population achieved high levels of activity, and were not at risk of developing diseases associated with physical inactivity.

A higher proportion of males were in the moderate and high activity categories (10% in moderate and 15% in high) compared with females (7% in both moderate and high).

Table 3.1: Proportion of population in each activity category and sex, 2011

	Physical activity category (%)			
	Sedentary	**Low**	**Moderate**	**High**
Males	29.5	45.8	10.0	14.7
Females	33.3	52.1	7.2	7.3
Persons	**31.4**	**49.0**	**8.6**	**10.9**

Note: Numbers for men, women and persons may not sum to 100 due to rounding.

3.2 Physical activity attributable burden

Physical inactivity, when assessed independently for this study, was responsible for 2.6% of the total burden of disease and injuries in Australia in 2011, equivalent to 116,676 DALY (Table 3.2). This is less than the attributable burden reported in the ABDS 2011 (5.0%; 224,198 DALY). This difference is largely due to reduced relative risks across most linked diseases (sourced from the GBD 2015), compared with those used in the ABDS 2011 (sourced from the GBD 2010). See Box 2.1 for information on developments since the ABDS 2011 and their impact.

The 2.6% estimate reported here does not include the burden due to related risk factors, such as obesity (to which physical inactivity can contribute). The combined impact of physical inactivity and of overweight and obesity on disease burden is discussed at the end of this chapter.

The attributable burden due to physical inactivity was slightly higher in males (59,765 DALY) than in females (56,911 DALY). However, the proportion of total disease burden due to physical inactivity was slightly greater in females (2.7%) than in males (2.5%).

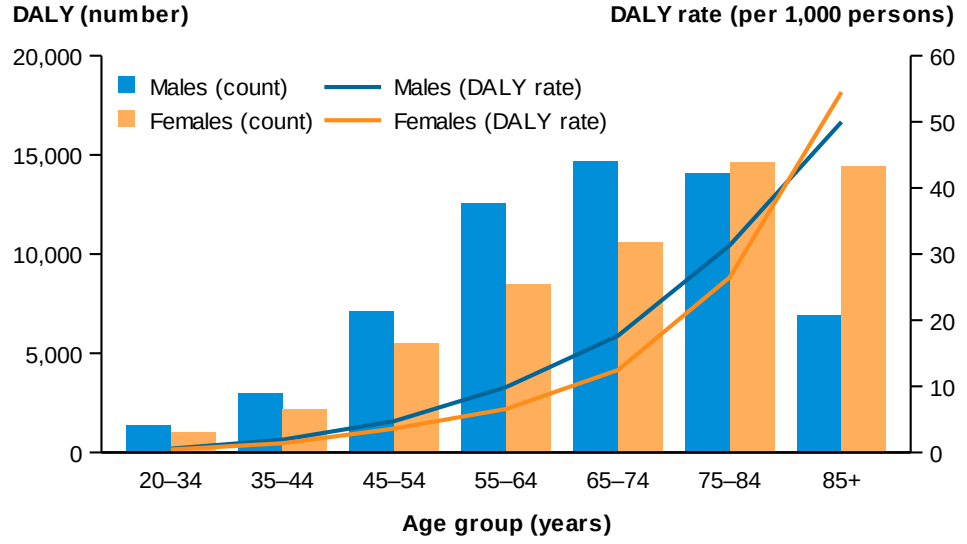
Figure 3.1 shows the burden due to physical inactivity (DALY counts and rates per 1,000 persons) in males and females. The burden due to physical inactivity increased with age in men up to age 74, with most of the burden experienced between ages 55 and 84. In women, the attributable burden increased with age, with most of the burden experienced in ages 75 and over.

More burden due to physical inactivity was experienced by males than females up to age 74, as reflected in the higher DALY rates. For age groups aged 75 and over, women contributed a greater amount of burden due to physical inactivity, due to more females than males living to older ages.

Table 3.2: Burden (DALY) attributable to physical inactivity, by sex, 2011

	Attributable DALY	
	Number	**% of total DALY**
Males	59,765	2.5
Females	56,911	2.7
Persons	**116,676**	**2.6**

Source: AIHW analysis of burden of disease database, 2011.



Source: AIHW analysis of burden of disease database, 2011.

Figure 3.1: Burden (DALY and DALY rate per 1,000 persons) attributable to physical inactivity, by age and sex, 2011

3.3 Physical inactivity burden by linked disease

One-third of the burden due to physical inactivity in Australia in 2011 was due to coronary heart disease (39,262 DALY) (Figure 3.2; Table 3.3). This was followed by dementia (18% of total physical inactivity burden), diabetes (16%), bowel cancer (13%) and stroke (12%).

Males had more attributable burden due to coronary heart disease (26,415 DALY), diabetes (10,760) and bowel cancer (8,363) then females (12,848 DALY from coronary heart disease, 8,305 from diabetes and 6,640 from bowel cancer). This is because males experience more underlying disease burden from these diseases.

Females contributed a greater amount of attributable burden due to dementia (13,152 DALY) than males (7,600 DALY). Females also experienced more underlying disease burden due to dementia.

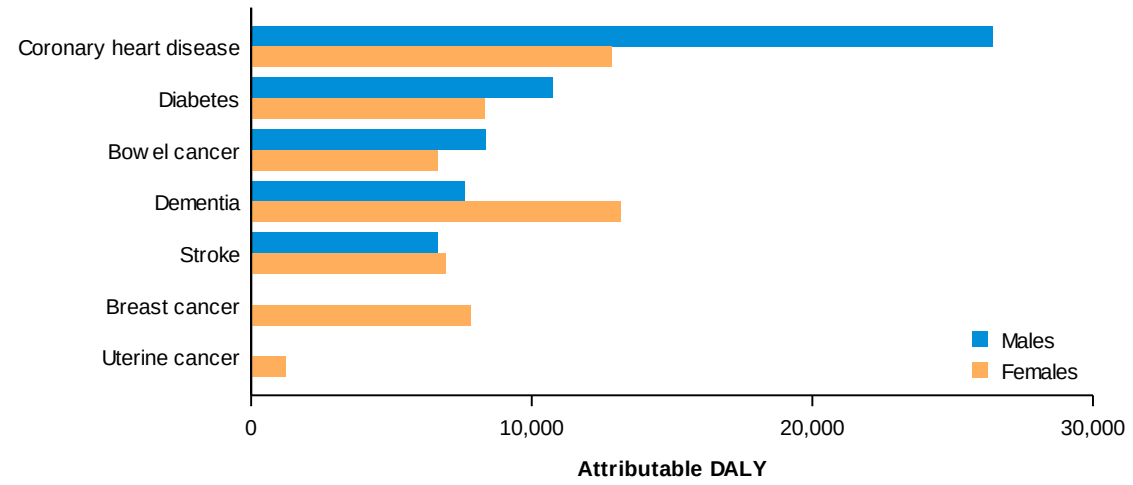
In females, breast cancer was responsible for a greater proportion of attributable burden (14% of total physical inactivity burden in females) than stroke (12%), bowel cancer (12%), and uterine cancer (2.2%).

Table 3.3: Burden (DALY) due to physical inactivity, by linked disease and sex, 2011

	Males		Females		Persons	
Linked disease	**Number**	**%**	**Number**	**%**	**Number**	**%**
Coronary heart disease	26,415	44.2	12,848	22.6	39,262	33.6
Dementia	7,600	12.7	13,152	23.1	20,752	17.8
Diabetes	10,760	18.0	8,305	14.6	19,065	16.3
Bowel cancer	8,363	14.0	6,640	11.7	15,003	12.9
Stroke	6,628	11.1	6,926	12.2	13,555	11.6
Breast cancer	. .	. .	7,813	13.7	7,813	6.7
Uterine cancer	. .	. .	1,226	2.2	1,226	1.1
Total	**59,765**	**100.0**	**56,911**	**100.0**	**116,676**	**100.0**

Note: Numbers in the % column for males, females and persons may not sum to 100 due to rounding.

Source: AIHW analysis of burden of disease database, 2011.



Source: AIHW analysis of burden of disease database, 2011.

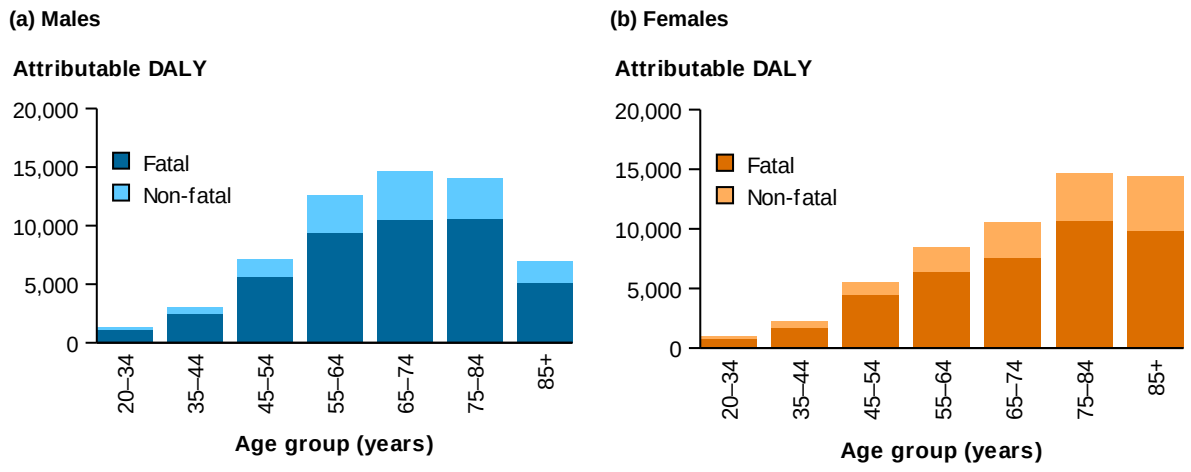
Figure 3.2: Burden (DALY) due to physical inactivity, by sex and linked disease, 2011

3.4 Fatal and non-fatal attributable burden by linked disease

Fatal burden contributed to almost three-quarters (74%) of the disease burden due to physical inactivity and was the main contributor in all age groups for both males and females (Figure 3.3). The contribution of non-fatal burden increased with increasing age, up to age 74 in men and 85+ in females.

Attributable burden from breast cancer, bowel cancer, coronary heart disease, stroke and uterine cancer were mostly due to fatal burden (Table 3.4). Males had a slightly greater proportion of fatal burden from bowel cancer and coronary heart disease. Fatal and non-fatal attributable burden contributed similar amounts for dementia and diabetes.

For female specific linked diseases, the burden due to physical inactivity was mostly due to fatal burden (92% fatal burden for breast cancer and 91% fatal burden for uterine cancer).



Source: AIHW analysis of burden of disease database, 2011.

Figure 3.3: Burden attributable to physical inactivity due to fatal and non-fatal burden, by age, males (a) and females (b), 2011

Table 3.4: Burden (DALY) attributable to physical inactivity due to fatal and non-fatal burden, by sex, 2011

	Males (%)		Females (%)		Persons (%)	
Linked disease	**Fatal**	**Non-fatal**	**Fatal**	**Non-fatal**	**Fatal**	**Non-fatal**
Coronary heart disease	80.7	19.3	76.8	23.2	79.4	20.6
Dementia	56.1	43.9	51.4	48.6	53.1	46.9
Diabetes	53.1	46.9	55.0	45.0	53.9	46.1
Bowel cancer	93.1	6.9	92.4	7.6	92.8	7.2
Stroke	85.9	14.1	88.3	11.7	87.1	12.9
Breast cancer	. .	. .	92.4	7.6	92.4	7.6
Uterine cancer	. .	. .	90.9	9.1	90.9	9.1
Total	**74.9**	**25.1**	**73.0**	**27.0**	**74.0**	**26.0**

Source: AIHW analysis of burden of disease database, 2011.

3.5 Physical inactivity burden by linked disease, age and sex

Burden due to physical inactivity increased with age, particularly due to the increased occurrence of chronic conditions in later life (Figure 3.4). The occurrence and amount of chronic disease burden also varied by sex at different life stages. Note that there were no diseases linked to physical inactivity that met the study's inclusion criteria in infants or children.

Adults aged 20–44

This age group has much lower levels of burden due to the linked chronic diseases, and the highest levels of total physical activity, compared with other age groups. Dementia was the only linked disease not examined in this age group.

Adults aged 20–34 contributed 2.1% of the burden due to physical inactivity (2,411 DALY). Attributable burden was higher in adults aged 35–44. This age group contributed 4.5% of the overall physical inactivity burden (5,224 DALY).

Males contributed a greater proportion of the disease burden due to physical inactivity. This is primarily due to coronary heart disease being more prevalent in men in this age group.

Adults aged 45–64

In total, 11% of the burden due to physical inactivity was from adults aged 45–54 (12,643 DALY). Adults aged 55–64 contributed 18.0% of the physical inactivity burden (21,046 DALY). This is due to increases in underlying chronic disease burden with increasing age. Males contributed a greater proportion of disease burden, particularly for those aged 55–64.

In males, coronary heart disease was the leading cause of attributable burden in this age group, followed by diabetes and bowel cancer. In females, breast cancer, coronary heart disease, diabetes and bowel cancer were the leading causes of attributable burden.

Adults aged 65–84

Adults aged 65–74 contributed 22% of the overall physical inactivity burden (25,263 DALY). This increased to one-quarter of the total physical activity attributable burden in ages 75–84 (28,719). This is due to the increases in underlying chronic disease burden with increasing age, particularly the increase in dementia burden. Dementia and stroke became an increasing contribution of attributable burden in these age groups.

Adults aged 85+

Older Australians accounted for 18% of the burden due to physical inactivity, with dementia contributing the greatest attributable burden, followed by coronary heart disease, stroke and diabetes. The attributable burden was higher in females than in males in this age group, due to a greater number of women living to older ages.

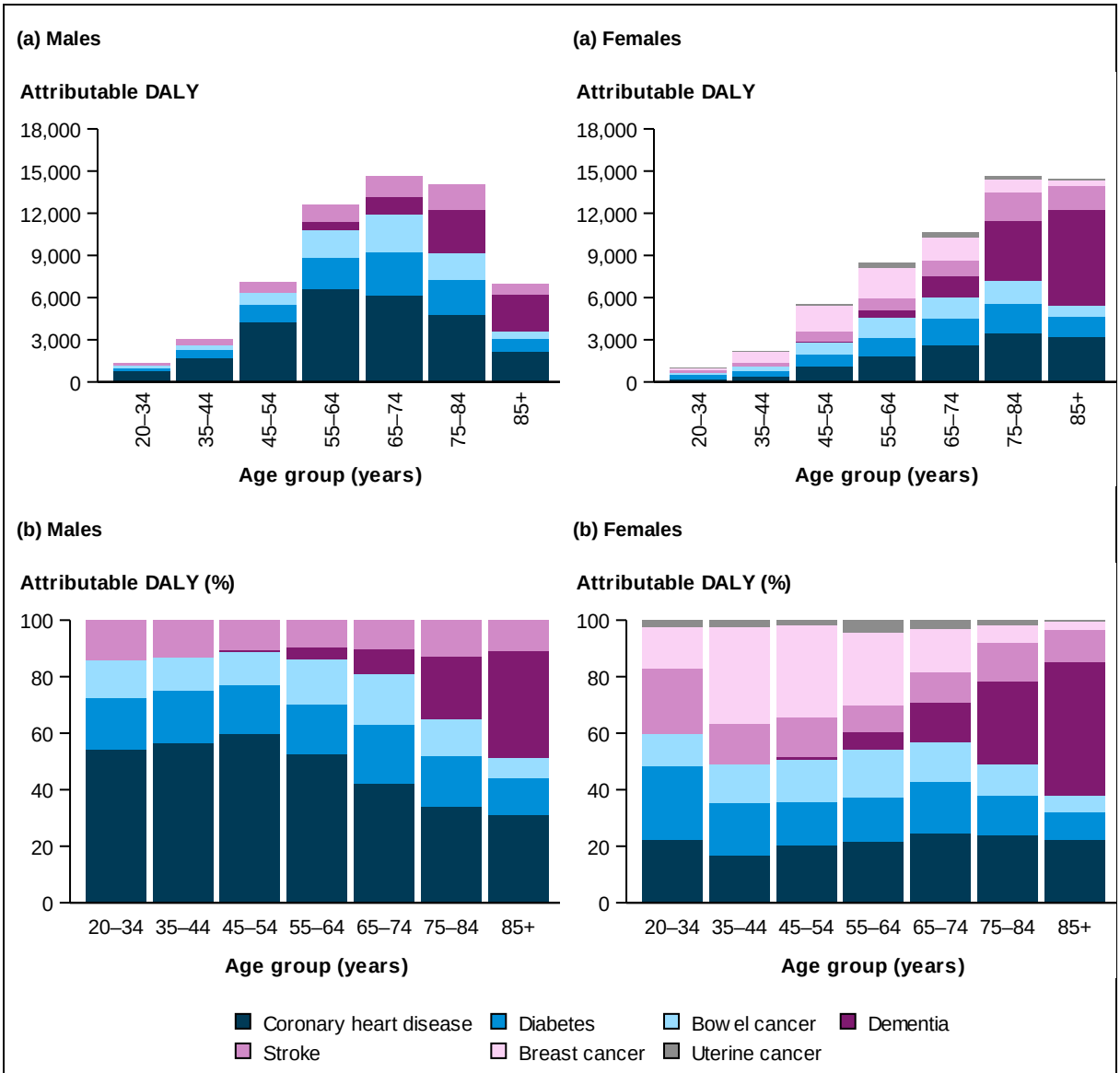


Figure 3.4: Burden attributable to physical inactivity, by age, sex and linked disease, DALY (a) and proportion within each age group DALY (b), 2011

3.6 Proportion of burden due to physical inactivity for each linked disease

Physical inactivity was responsible for 19% of the diabetes burden, 16% of the bowel cancer burden, 16% of the uterine cancer burden, 14% of the dementia burden, and 11% of both the coronary heart disease burden and the breast cancer burden (Table 3.5). The proportion of disease burden due to physical inactivity varied by sex (Appendix Table C1). The proportion was slightly higher in males for cardiovascular diseases (coronary heart disease and stroke) than in females. The proportion was slightly lower in males for bowel cancer and diabetes than in females. The proportion of dementia burden due to physical inactivity did not vary by sex.

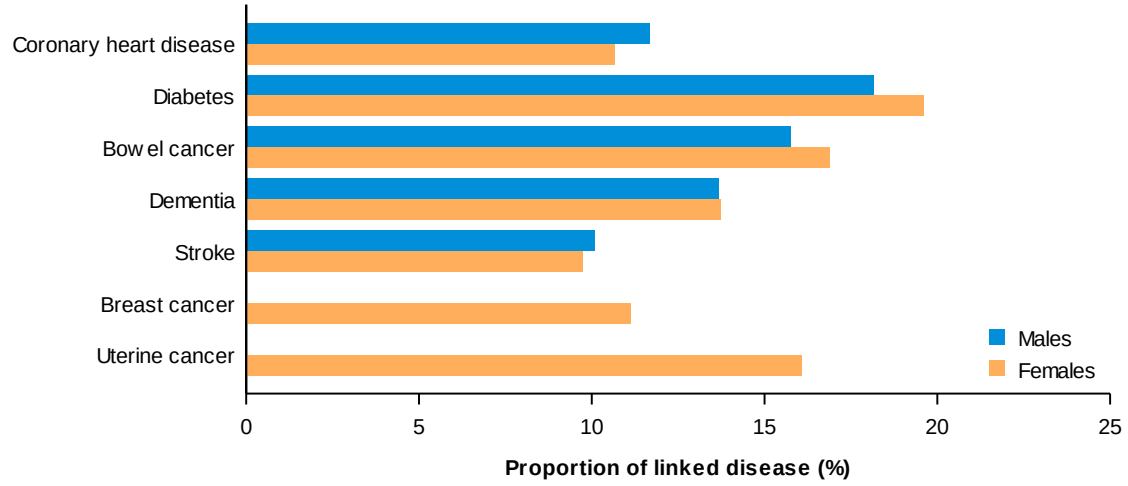
Table 3.5: Number and proportion of disease burden due to physical inactivity (attributable DALY), by linked disease, 2011

Linked disease	Total DALY	DALY attributable to physical inactivity	% of linked disease burden due to physical inactivity
Coronary heart disease	346,651	39,262	11.3
Dementia	151,308	20,752	13.7
Diabetes	101,653	19,065	18.8
Bowel cancer	92,422	15,003	16.2
Stroke	136,771	13,555	9.9
Breast cancer	70,675	7,813	11.1
Uterine cancer	7,622	1,226	16.1
Total	**4,494,427**	**116,676**	**2.6**

Note: The right-hand column is the attributable DALY divided by the linked disease total DALY in 2011 of that row.

Source: AIHW analysis of burden of disease database, 2011.

The proportion of disease burden due to physical inactivity also varied by sex and linked disease (Figure 3.5). Females contributed to a slightly greater proportion of disease burden due to physical inactivity from all linked diseases, except for coronary heart disease and stroke.



Source: AIHW analysis of burden of disease database, 2011.

Figure 3.5: Proportion of linked disease burden (DALY) due to physical inactivity, by sex, 2011

3.7 Attributable burden by activity level

In this report, physical activity was grouped into four levels of total activity: sedentary, low, moderate and high. People who have high activity levels are not considered at additional risk of the diseases linked to physical inactivity, with the remaining categories counted in the burden due to physical inactivity. Note that this differs from the definition of physical inactivity in Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults.

Table 3.6 shows the proportion of burden due to physical inactivity, by level of activity. Being sedentary—which in this report, includes individuals with desk-bound jobs who walk fewer than 30 minutes in total most days of the week for exercise—was responsible for 55% of the burden due to physical inactivity, followed by those who undertake low levels of activity

(42%). Moderate physical activity had a very low risk of associated disease and was responsible for around 3% of the total burden due to physical inactivity. Males had a slightly greater proportion of attributable burden due to being sedentary (58%), than females (54%) but females had a slightly greater proportion of burden due to low levels of activity (42%). These proportions were similar across all age groups.

Table 3.6: Proportion (%) of attributable burden (DALY), by activity level and sex, 2011

	Sedentary	Low	Moderate	High	All activity levels
Males	58.3	38.7	3.0	. .	100.0
Females	54.3	42.3	3.4	. .	100.0
Persons	**54.7**	**42.0**	**3.4**	**. .**	**100.0**

Source: AIHW analysis of burden of disease database, 2011.

3.8 Comparison using all physical activity domains

In this study, national physical activity estimates include all physical activity domains: leisure, transport, occupational and household chores. There are many definitions of physical activity. This section incorporates estimates using two different prevalence definitions:

- *leisure only*—physical activity due to walking for leisure and transport, moderate exercise, vigorous exercise, stretching and vigorous gardening
- *all domains*—physical activity listed in the leisure only definition, as well as occupational activity and household chores.

The methods used to estimate each domain are described in Appendix A.

Comparison of results

Using the leisure only definition, physical inactivity is responsible for 2.8% of the total burden in Australia in 2011 (127,930 DALY) (Table 3.7). When occupational activity and household chores are included as forms of activity, this decreases to 2.6% (116,676 DALY).

The decrease in attributable DALY was greater for males (11% reduction) than females (8.5% reduction), when including occupational activity and household chores in the definition of physical activity. This may be due to a greater proportion of men reporting that they do vigorous activity at work.

Table 3.7: Comparison of burden (DALY) attributable to physical inactivity, using different exposure definitions, by sex, 2011

	DALY count		Change in DALY (%)	Total DALY in Australia	% of total DALY	
	Leisure only	All domains			Leisure only	All domains
Males	66,178	59,765	–11.0	2,412,531	2.7	2.5
Females	61,752	56,911	–8.5	2,081,896	3.0	2.7
Persons	**127,930**	**116,676**	**–9.6**	**4,494,427**	**2.8**	**2.6**

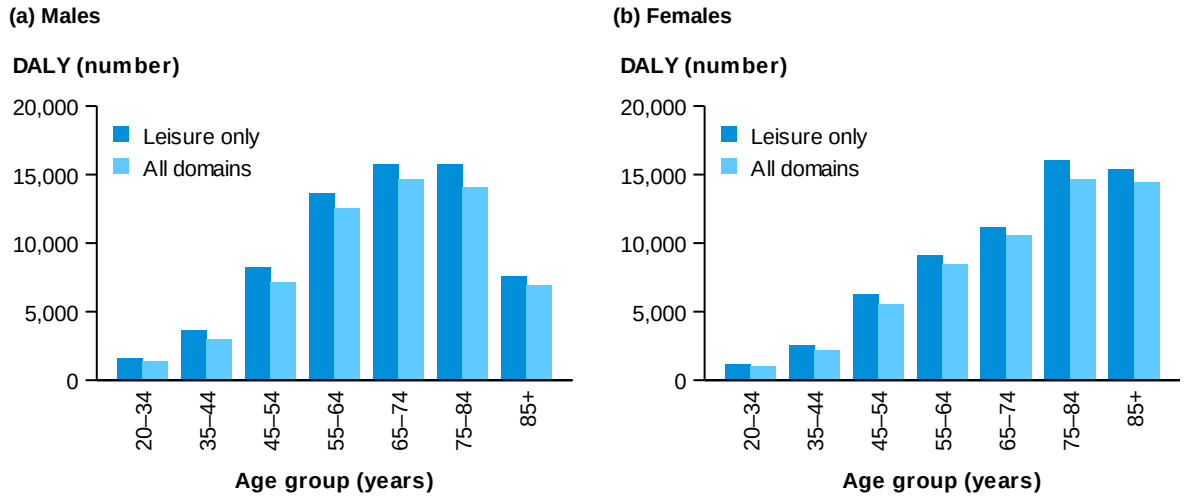
Note: The '% of total DALY' column is the DALY count divided by the total DALY in Australia of that row.

Source: AIHW analysis of burden of disease database, 2011.

Burden due to physical inactivity under each prevalence definition increased with age up to age 84 (Figure 3.6). Attributable burden was higher across most age groups when only

leisure activity was included, due to the exclusion of both occupational activity among the working age population and the impact of activity due to household chores (which tended to increase in duration with increasing age).

The greatest difference in attributable DALY was seen in men aged 35–44, where attributable burden was 1.2 times higher when occupational activity and activity due to household chores are excluded (leisure only). This reflects a greater proportion of men in this age group obtaining physical activity through their employment.



Source: AIHW analysis of burden of disease database, 2011.

Figure 3.6: Comparison of burden attributable to physical inactivity under different definitions, by age, males (a) and females (b), 2011

3.9 Combined impact of physical inactivity and overweight and obesity

Physical inactivity is a known risk for overweight and obesity.

An analysis of the joint effect of the attributable burden due to these two closely related risk factors—physical inactivity, and overweight and obesity—was undertaken. This analysis used the estimates in this study for physical inactivity together with enhanced estimates for overweight and obesity from a recent report that also extended the ABDS 2011 data, which estimated that overweight and obesity was responsible for 7.0% of the disease burden in Australia in 2011 (AIHW 2017a).

This analysis found that physical inactivity and overweight and obesity combined were responsible for 8.9% of the total burden of disease and injuries in Australia in 2011, equivalent to 400,009 DALY (Table 3.8).

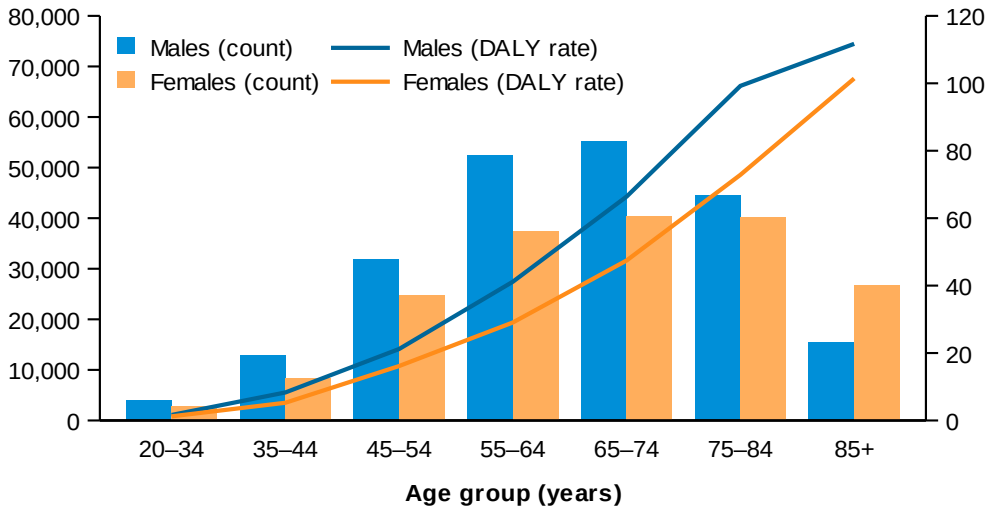
The DALY due to the joint effect of physical inactivity and overweight and obesity was higher in males (218,097 DALY) than in females (181,912 DALY). The proportion of total attributable burden was also greater in males (9.0%) than in females (8.7%) (Table 3.8).

Table 3.8: Burden (DALY) attributable to physical inactivity and overweight and obesity combined, by sex, 2011

	Total DALY in Australia	Attributable DALY	
		Number	% of total DALY
Males	2,412,531	218,097	9.0
Females	2,081,896	181,912	8.7
Persons	**4,494,427**	**400,009**	**8.9**

Source: AIHW analysis of burden of disease database, 2011.

The rate of burden attributed to physical inactivity and overweight and obesity combined increased with age in both males and females (Figure 3.7). The rate of burden due to the joint effect of these two risks was higher in males than in females, across all ages. The burden due to the combined effect of physical inactivity and overweight and obesity increased with age in males up to age 74 and in females up to age 84. Most of the burden in both males and females was experienced between ages 55 and 84.



Source: AIHW analysis of burden of disease database, 2011.

Figure 3.7: Burden (DALY, and DALY rate per 1,000 persons) attributable to physical inactivity and overweight and obesity combined, by age and sex, 2011

4 Variation across socioeconomic groups

This chapter presents estimates of the burden attributable to physical inactivity in Australia in 2011, by socioeconomic group.

4.1 Inequalities in attributable burden

Table 4.1 shows the total burden attributable to physical inactivity by socioeconomic group. The lowest socioeconomic group (Q1) experienced the greatest amount of burden attributable to physical inactivity (29,883 DALY), compared with 18,665 DALY in the highest socioeconomic group (Q5).

After taking account of the different age structures of the socioeconomic groups (using age-standardised rates—ASRs—per 1,000 people), the lowest socioeconomic group (Q1) experienced a rate of burden due to physical inactivity that was 1.7 times that of the highest socioeconomic group (Q5) (Table 4.1). The difference across socioeconomic groups was greater for men (Q1:Q5 rate ratio of 1.9) than for women (Q1:Q5 rate ratio of 1.6) (Appendix Table C2).

Table 4.1: Burden (DALY) attributable to physical inactivity, by socioeconomic group, 2011

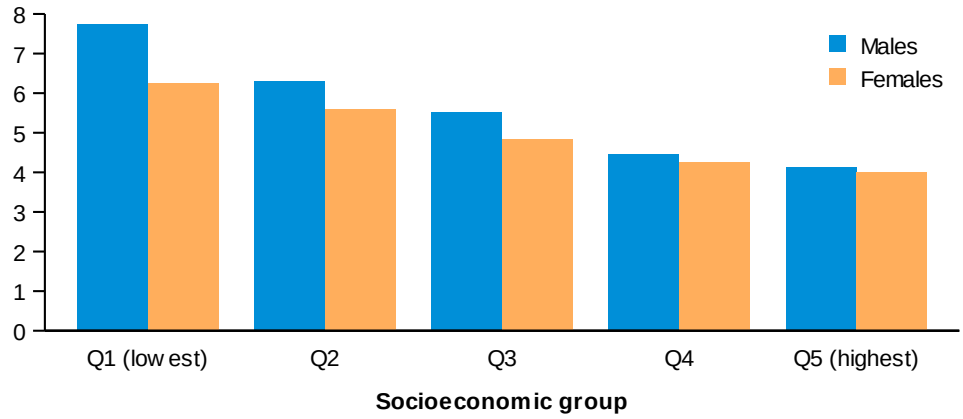
Socioeconomic group (quintile, or Q)	Total DALY ('000)	Attributable DALY ('000)	ASR per 1,000 persons	Rate ratio
Q1 (lowest)	1,067	30	7.0	1.7
Q2	1,020	26	6.0	1.5
Q3	922	23	5.2	1.3
Q4	800	20	4.3	1.1
Q5 (highest)	708	19	4.1	1.0
Total	**4,494**	**116**	. .	. .

Notes

1. Columns may not add to the total shown due to rounding.
2. Rates were age standardised to the 2001 Australian Standard Population, and are expressed per 1,000 persons.
3. Rate ratios divide the Q1 ASR by the Q5 ASR.

Source: AIHW analysis of burden of disease database, 2011.

There was a clear pattern of decreasing burden with increasing socioeconomic position for both males and females (Figure 4.1). The greatest difference in the rate of attributable burden due to physical inactivity was in the lowest socioeconomic group (7.7 per 1,000 people in males compared with 6.2 in females). As socioeconomic position increased, the difference in ASRs of attributable burden between males and females decreased.



Notes

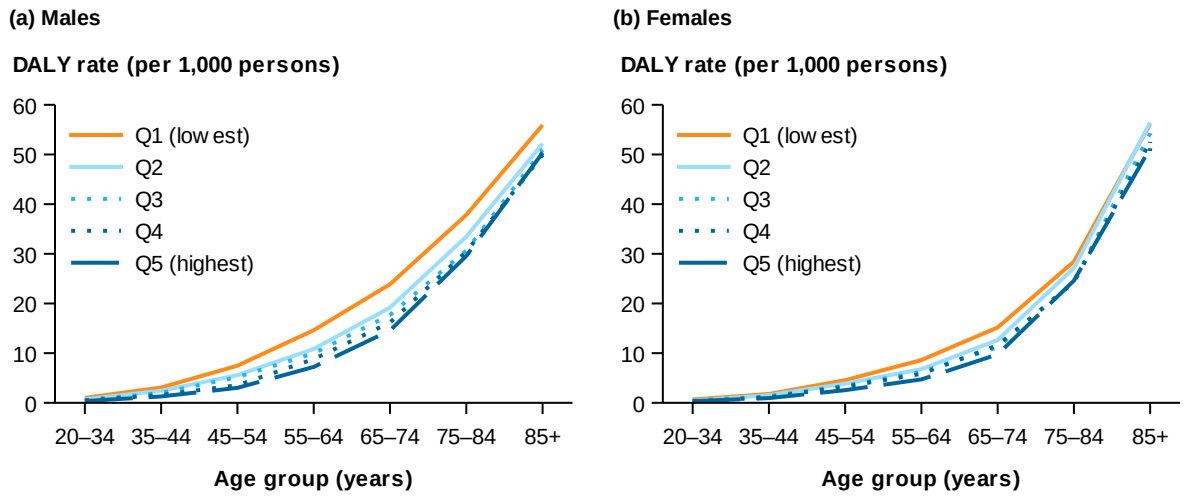
1. Rates were age standardised to the 2001 Australian Standard Population, and are expressed per 1,000 persons.
2. Q1 refers to the lowest socioeconomic group. This increases to Q5 which is the highest socioeconomic group.

Source: AIHW analysis of burden of disease database, 2011.

Figure 4.1: Age-standardised DALY rate (per 1,000 persons) due to physical inactivity, by socioeconomic group and sex, 2011

There was an increasing rate of burden due to physical inactivity with increasing age across all socioeconomic groups, with the greatest increase in the lowest socioeconomic group (Figure 4.2). The greatest relative disparity in attributable burden by socioeconomic group was seen in the youngest age group (20–34 years), where the rate of burden due to physical inactivity in the lowest socioeconomic group was 2.0 times that of the highest socioeconomic group (Appendix Table C3).

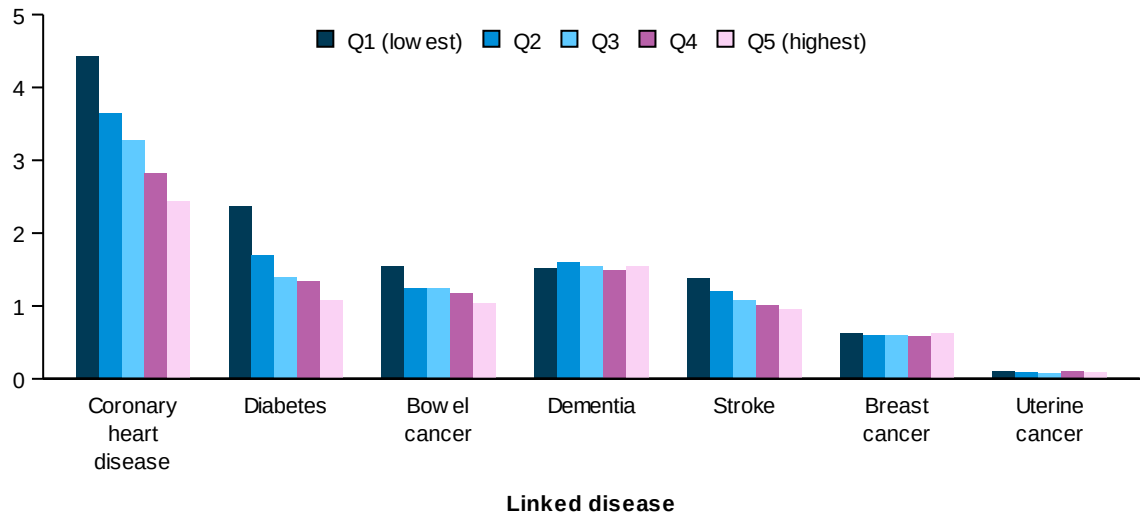
The rate of attributable burden in males was higher across all socioeconomic groups compared with females, except for older ages where the rate was similar (Figure 4.2). The disparity between the highest socioeconomic group and the lowest was greater in males for all age groups compared with females.



Source: AIHW analysis of burden of disease database, 2011.

Figure 4.2: Age-specific DALY rate (per 1,000 persons) due to physical inactivity, by socioeconomic group and age, males (a) and females (b), 2011

Figure 4.3 shows the age-standardised DALY rate per 1,000 persons for the diseases linked to physical inactivity. Most diseases showed decreasing burden due to physical inactivity with increasing socioeconomic group, except for dementia, breast cancer and uterine cancer. The strongest gradient was seen in diabetes (Q1:Q5 rate ratio of 2.8).



Note: Rates were age standardised to the 2001 Australian Standard Population, and are expressed per 1,000 persons.

Source: AIHW analysis of burden of disease database, 2011.

Figure 4.3: Age-standardised DALY rate (per 1,000 persons) of linked diseases attributable to physical inactivity, by socioeconomic group, 2011

5 Changes between 2003 and 2011

This chapter compares the level of physical activity, and burden attributable to physical inactivity, between 2003 and 2011.

This study based physical activity exposure estimates for 2003 on trends in physical activity over time from Australian Bureau of Statistics (ABS) National Health Surveys between the years 2001 and 2014. These surveys provided comparable estimates of activity across years for leisure and transport activity only. This study used exposure estimates based on trend data for the year 2003 to reduce the effects of variability across survey years. By comparison, the ABDS 2011 based the 2003 prevalence estimates on findings of the National Health Survey 2004–5. As there is limited information to determine trends in occupational activity and activity due to household chores in Australia, this was assumed to be the same in 2003, as in 2011.

5.1 Comparison of physical activity in 2011 and 2003

Physical activity, in this report, was grouped into four levels of total activity: sedentary, low, moderate and high. Table 5.1 compares the proportion of people in Australia in 2003 and 2011 in each of these activity categories.

There was little difference in the proportion of people estimated to be in each physical activity category in 2003 and 2011.

Table 5.1: Proportion (%) of population, by activity level and sex, 2011

Levels of total activity	Males		Females		Persons	
	2003	2011	2003	2011	2003	2011
Sedentary	30.0	29.5	33.7	33.3	31.9	31.4
Low	46.1	45.8	51.6	52.1	48.9	49.0
Moderate	9.4	10.0	7.4	7.2	8.4	8.6
High	14.4	14.7	7.3	7.3	10.8	10.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Note: Numbers may not add due to rounding.

Source: AIHW analysis of burden of disease database, 2011.

Slight improvements in physical inactivity over time were observed in results from a trend analysis of the Active Australia Survey, which showed that the proportion of people who undertake at least 150 minutes of physical activity each week increased by 0.5% each year between 2002 and 2012 (Devonshire-Gill & Norton 2017).

5.2 Overall change in attributable burden

The total burden due to physical inactivity was 2.8% higher in 2011 compared with 2003 (116,676 DALY in 2011 compared with 113,414 DALY in 2003—Table 5.2). This was likely due to population increases and ageing, and increases in the total burden for the linked diseases between 2003 and 2011. Females had a greater increase in burden due to physical inactivity (5.5%) than males (0.2%).

Table 5.2: Comparison of burden (DALY) attributable to physical inactivity, 2003 and 2011

	DALY count		Change in DALY (%)	Total DALY in Australia		% of total DALY	
	2003	2011		2003	2011	2003	2011
Males	59,643	59,765	0.2	2,279,854	2,412,531	2.6	2.5
Females	53,772	56,911	5.5	1,925,369	2,081,896	2.8	2.7
Persons	**113,414**	**116,676**	**2.8**	**4,205,223**	**4,494,427**	**2.7**	**2.6**

Note: The '% of total DALY' column is the DALY count divided by the total DALY in Australia of that row.

Source: AIHW analysis of burden of disease database, 2011.

However, when taking into account differences in the 2011 and 2003 population size and age structure, the age-standardised attributable DALY rate was slightly lower in 2011 than in 2003 (rate ratio of 0.9; Table 5.3). This suggests that the burden due to physical inactivity has decreased slightly over time. This trend is similar to that reported in the ABDS 2011.

Table 5.3: Comparison of age-standardised DALY rates attributable to physical inactivity, 2003 and 2011

	DALY ASR		ASR rate ratio 2011:2003
	2003	2011	
Males	6.1	5.4	0.9
Females	5.4	5.1	0.9
Persons	**5.8**	**5.2**	**0.9**

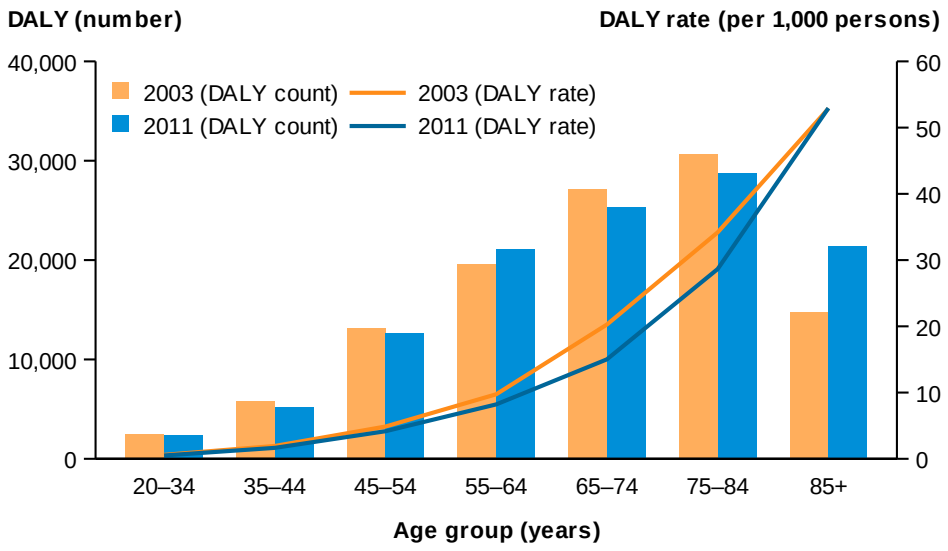
Note: Rates were age standardised to the 2001 Australian Standard Population, and are expressed per 1,000 persons.

Source: AIHW analysis of burden of disease database, 2011.

The attributable burden was higher in most age groups in 2011 than in 2003, except for people aged 55–64 and 85 and over (Figure 5.1). Age-specific DALY rates in 2011 were lower than in 2003 for ages 55–84.

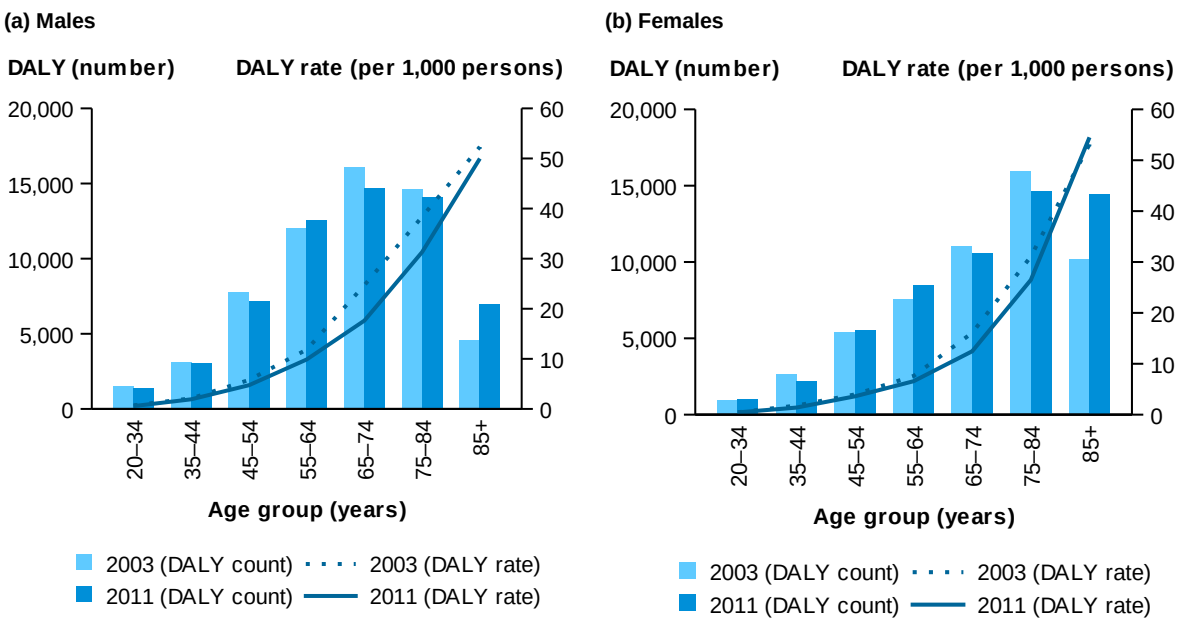
The burden due to physical inactivity varied by age for males and females (Figure 5.2). Males experienced a greater amount of attributable burden in 2003 than in 2011, in all age groups, except for ages 65–74 and 85 and over. This pattern was similar in females. In males the burden in ages 35–44 was similar in 2003 and 2011. In females this occurred in ages 45–54.

The rate of attributable burden increased with age, for both males and females in 2003 and 2011 (Figure 5.2). Males experienced a greater decrease in the rate of burden due to physical inactivity between 2003 and 2011 than females. This could be due to increases in physical activity (particularly in age groups with a higher prevalence of chronic diseases) or to decreases in the underlying linked diseases burden.



Source: AIHW analysis of burden of disease database, 2011.

Figure 5.1: Burden (Daly number and DALY rates per 1,000 persons) attributable to physical inactivity, by age, 2003 and 2011

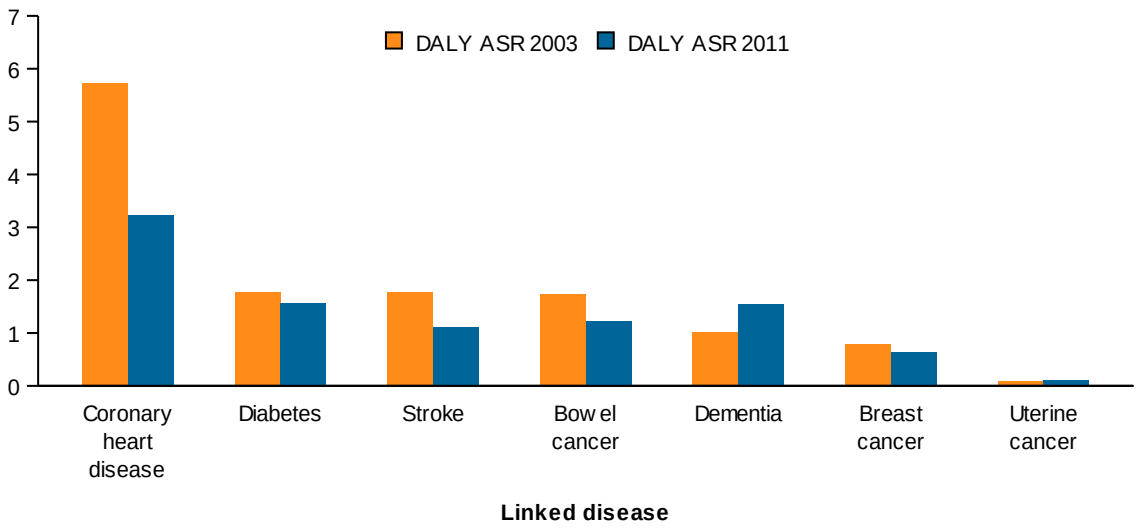


Source: AIHW analysis of burden of disease database, 2011.

Figure 5.2: Comparison of attributable burden (DALY and age-specific DALY rate) in 2011 and 2003, males (a) and females (b), 2011

Between 2003 and 2011, the age-standardised DALY rates of all linked diseases attributable to physical inactivity decreased except for dementia, which was 1.5 times as high in 2011 as in 2003 (Figure 5.3). This is consistent with the large increases observed in overall dementia burden between 2011 and 2003 that were reported in the ABDS 2011, which was mainly due to an increase in deaths coded to dementia between these years (AIHW 2016d).

The greatest decrease in attributable burden was seen in coronary heart disease, which decreased from 5.7 per 1,000 persons in 2003 to 3.2 in 2011.



Note: Rates were age standardised to the 2001 Australian Standard Population, and are expressed per 1,000 persons.

Source: AIHW analysis of burden of disease database, 2011.

Figure 5.3: Age-standardised attributable DALY rate per 1,000 persons for diseases linked to physical inactivity, 2003 and 2011

6 Scenario modelling

This chapter presents the outcomes of scenario modelling used to assess the impact of physical inactivity on potential disease burden in the year 2020. The scenarios used to compare potential attributable burden in 2020 were as described here:

- *Trend rate scenario:* the estimated attributable burden in future years if the prevalence rate of physical inactivity continues at its current trend, based on estimates in the 2001, 2004–05, 2007–08, 2011–12 and 2014–15 ABS National Health Surveys.
- *Stable rate scenario:* the estimated attributable burden in future years if the prevalence rate of physical inactivity remained the same as in the year 2011 (as estimated in the ABDS 2011).
- *Targeted daily activity scenario:* the estimated attributable burden in the year 2020, if everyone in the population 'at risk' increased the time spent doing moderate activity, such as going for a brisk walk. Those 'at risk' include people who fall in the sedentary, low and moderate activity categories (89% of the population). Three amounts of time spent undertaking extra physical activity were analysed:
    - 15 minutes of moderate activity, 5 days per week
    - 30 minutes of moderate activity, 5 days per week
    - 60 minutes of moderate activity, 5 days per week.

Determining associations between chronic diseases and associated disease burden in the future is complex. Hence, it was assumed for linked disease burden estimates in the scenario modelling analysis that disease prevalence rates from the ABDS 2011 would remain the same to 2020, with increases due to population growth and ageing alone. While this assumption is simplistic, it provides a consistent baseline for each scenario in order to estimate the difference in physical inactivity attributable burden between the scenarios.

As there is limited information to determine trends in occupational activity and activity due to household chores in Australia, this was also assumed to be the same in 2020. Therefore, variations in physical inactivity in the scenario modelling chapter are due to differences in leisure activity and active transportations only, even though total activity levels include activity from all domains.

Further detail on the methods used in the scenario modelling analysis are in Appendix A.

Box 6.1: An example—how does increasing physical activity reduce the risk of linked disease?

In the previous example (see Box 2.3), Sally's total activity MET score was estimated to be 510. This was achieved by doing a brisk 30-minute walk once per week, as well as doing, on average, 2 hours of household chores per week. A MET score of 510 for the week puts Sally in the sedentary category.

If Sally increased her physical activity, by going for an extra 15-minute brisk walk in her lunch time each day during the working week, this would add an extra 375 METs to her total activity levels (5.0 MET intensity score x [15 minutes x 5]).

This extra activity would give Sally a total MET score of 885. Now she would be considered to be in the low activity category, and her risk of developing diseases linked to physical inactivity would have reduced by between 25%–61%. The greatest health benefits are experienced when a person goes from being sedentary to being active most days of the week.

6.1 Predicted prevalence of physical activity levels in 2020

The proportion of Australians estimated to be in each physical activity category in 2020 under each scenario is shown in Table 6.1. Note that, under the *Stable rate scenario*, the estimated attributable burden (DALY number) will be higher in 2020 than in 2011 as the population is estimated to be larger for the year 2020.

If current trends in prevalence of physical inactivity continued (*Trend rate scenario* in Table 6.1), 31% of the population is expected to be in the sedentary activity category, 49% in the low activity category, 9% in the moderate activity category and 11% in the high activity category. This is very similar to the proportions estimated under the *Stable rate scenario* (if physical inactivity levels were maintained at 2011 levels).

If everyone in the population 'at risk' of additional disease due to physical inactivity (those with sedentary, low and moderate physical inactivity levels) did an extra 15 minutes of moderate exercise (for example, a brisk walk) 5 days per week, the proportion of the population expected to be in the sedentary category in 2020 would reduce by half, to 15% (compared with the scenario if current trends continued), with many moving into the low activity category.

If everyone in the population at risk did an extra 30 minutes of exercise 5 days per week, around three-quarters of the population would be expected to be in the low activity category in 2020, with 12% in each of the moderate and high activity categories. An extra 60 minutes of exercise 5 days per week would result in a more notable shift from people in the low to moderate activity category (with 70% expected to be in the low activity category and 17% in the moderate activity category in 2020).

Table 6.1: Comparison of the proportion in each activity category, under the *Stable rate* and *Targeted activity scenarios,* compared with the *Trend rate scenario,* 2020

	Estimated prevalence 2020 (%)					% difference between 2020 Trend rate scenario[(a)]			
			Targeted activity (5 days/week)				Targeted activity (5 days/week)		
	Trend rate	Stable rate	15 mins	30 mins	60 mins	Stable rate	15 mins	30 mins	60 mins
Sedentary	31.0	31.4	14.7	0.0	0.0	1.3	–52.6	–100.0	–100.0
Low	49.1	49.0	63.7	76.1	70.2	–0.2	29.7	55.0	43.0
Moderate	9.0	8.6	10.0	12.0	16.8	–4.4	11.1	33.3	86.7
High	11.0	10.9	11.5	12.0	13.0	–0.9	4.5	9.1	18.2

(a) The estimated proportion of the population in each physical activity category in the year 2020 if the prevalence rate of trends in physical activity continues as observed in self-reported physical activity measures from the 2001, 2004–05, 2007–08, 2011–12 and 2014–15 ABS National Health Surveys.

The same physical activity distribution patterns as described earlier in this section were evident in both men and women for each scenario (Appendix Table C1). There were, however, some differences by age (Table 6.2).

Changes in physical activity in adults aged 20–39

By the year 2020, if physical activity rates remain the same as in 2011 (*Stable rate scenario*), the proportion of sedentary adults aged 20–39 is expected to increase by 3.7%, compared

with the scenario if current trends continued (*Trend rate scenario*) (Table 6.2). The proportion is expected to stay relatively similar between current trends continuing in 2020 and rates in 2011 for those who have low activity levels, but is estimated to decrease by 7.4% for moderate levels of activity in 2020 if rates remained the same as in 2011. This shows that physical activity levels are expected to improve slightly among younger adults based on current trends.

In 2020, if adults then aged 20–39 did an extra 15 minutes of activity a day, 5 days per week (*Targeted activity scenario*), it is estimated that the proportion who were sedentary would reduce by 50%, that the proportion with low levels of activity would increase by 24%, and that the proportion with moderate activity levels would increase by 13%.

Increasing this level of activity to an extra 30 minutes a day in 2020 would, compared with continuing trends, eliminate the proportion of people in this age group considered sedentary, increase the proportion with low activity levels by 45% and increase the proportion with moderate activity levels by 35%.

If the amount of activity is increased to an extra 60 minutes a day in 2020—the proportion of adults in this age group with moderate and high levels of activity would increase.

Changes in physical activity in adults aged 40–59

For adults aged 40–59, the proportion who are sedentary and who have low and moderate activity levels is expected to stay relatively similar between current trends continuing to 2020 compared with rates in 2011. This shows that physical activity levels in this age group are not improving over time.

In 2020, if adults then aged 40–59 did an extra 15 minutes of activity a day, 5 days per week, it is estimated that the proportion who were sedentary would reduce by 45%, that the proportion with low activity levels would increase by 25%, and that the proportion with moderate activity levels would increase by 6.1%.

Increasing this to an extra 30 minutes of activity a day in 2020 would, compared with continuing trends, eliminate the proportion of people in this age group considered sedentary, increase the proportion with low activity levels by 54%, and increase the proportion with moderate activity levels by 26%.

If the amount of activity is increased to an extra 60 minutes a day in 2020, the proportion of adults in this age group with moderate activity levels would increase by 65%, and by 21% for those with high levels of activity.

Changes in physical activity in adults aged 60+

Physical activity levels in those aged 60 and over are not expected to improve in future years; the proportions in each physical activity category are expected to stay relatively similar between current trends continuing to 2020 compared with rates in 2011.

In 2020, if adults then aged 60 and over did an extra 15 minutes of activity a day, 5 days per week, it is estimated that the proportion who were sedentary would reduce by 63%, that the proportion with low activity levels would increase by 46% and that the proportion with moderate activity levels would increase by 26%.

Increasing this to an extra 30 minutes of activity a day in 2020 would, compared with continuing trends, eliminate the proportion of people in this age group considered sedentary, increase the proportion with low activity levels by 72%, and increase the proportion with moderate activity levels by 49%. If this amount of activity is increased to an extra 60 minutes

a day in 2020, the proportion of adults in this age group with moderate and high levels of activity would increase.

Table 6.2: Comparison of the proportion in each activity category, under the *Stable rate* and *Targeted activity scenarios,* compared with the *Trend rate scenario,* by broad age group, 2020

Age group (years)/ Activity group	Estimated prevalence 2020 (%)					% difference between 2020 Trend rate scenario			
			Targeted activity (5 days/week)				Targeted activity[b] (5 days/week)		
	Trend rate	Stable rate	15 mins	30 mins	60 mins	Stable rate[a]	15 mins	30 mins	60 mins
20–39									
Sedentary	27.0	28.0	13.6	0.0	0.0	3.7	–49.6	–100.0	–100.0
Low	50.3	50.3	62.1	73.0	66.0	0.0	23.5	45.1	31.2
Moderate	9.4	8.7	10.6	12.7	19.0	–7.4	12.8	35.1	102.1
High	13.3	13.0	13.7	14.3	15.0	–2.3	3.0	7.5	12.8
40–59									
Sedentary	29.3	29.7	16.0	0.0	0.0	1.4	–45.4	–100.0	–100.0
Low	47.8	47.7	59.9	73.5	68.2	–0.2	25.3	53.8	42.7
Moderate	9.8	9.7	10.4	12.3	16.2	–1.0	6.1	25.5	65.3
High	13.0	12.9	13.8	14.2	15.7	–0.8	6.2	9.2	20.8
60+									
Sedentary	39.2	39.1	14.7	0.0	0.0	–0.3	–62.5	–100.0	–100.0
Low	49.0	49.0	71.7	84.4	79.5	0.0	46.3	72.2	62.2
Moderate	7.0	6.9	8.8	10.4	14.4	–1.4	25.7	48.6	105.7
High	4.8	4.9	4.9	5.2	6.1	2.1	2.1	8.3	27.1

(a) Refers to the per cent difference between future prevalence of the population within each activity category if, in 2020, the proportion of people in each activity category was the same as in 2011—*Stable rate scenario* compared with the expected prevalence under current trends *Trend rate scenario*.

(b) Refers to the per cent difference between future prevalence of the population within each activity category if, in 2020, everyone at risk had undertaken moderate exercise 5 days per week, in addition to their current activity levels, by 15 minutes, 30 minutes and 60 minutes compared with the expected prevalence under current trends *Trend rate scenario*.

6.2 Physical inactivity burden in 2020

In this scenario modelling analysis, the difference between the scenarios is the difference in the projected prevalence of each physical activity category in 2020. It is important to note that the trends over time in this report rely on changes in leisure physical activity only. See Chapter 2 and Appendix A for a detailed description of the methods used to calculate disease risk.

Table 6.3 shows the estimated burden due to physical inactivity in 2020 under each of the hypothetical scenarios.

If the level of physical activity in the population remained the same in 2020 as it was in 2011 (*Stable rate scenario*), the disease burden due to physical inactivity remains relatively similar compared with if current trends continued (*Trend rate scenario*). Overall, this shows that there has been little improvement in physical activity in Australia required to reduce the additional risk of associated disease burden.

If everyone in the population 'at risk' did an extra 15 minutes of moderate activity 5 days per week, 13.0% of the potential disease burden due to physical inactivity could be avoided in 2020 compared with what would be the case if current trends continued. Females showed the greatest improvement in this scenario, with 24.0% of the burden due to physical inactivity potentially avoided in 2020. By comparison, for males, 1.6% of the burden due to physical inactivity could be avoided under this scenario. This is likely to be due to differences in the distribution of people in each activity category by sex. For example, in females, it is likely there is a greater proportion who need only a small increase in activity to move from the sedentary to low activity category.

If physical activity increased by an extra 30 minutes, 5 days per week, 26% of future disease burden could be avoided (23% for males and 28% for females). If the amount of extra activity increased to 60 minutes, only a further 2% of future disease burden could be avoided. Therefore, substantial health benefits would follow if females aimed to undertake an extra 15 minutes—and men an extra 30 minutes—of moderate exercise (5 days per week), with only marginal improvements beyond these activity levels.

Table 6.3: Comparison of projected burden due to physical inactivity in 2020

	Attributable DALY under scenarios in 2020					% of attributable DALY avoided under scenarios in 2020			
			Targeted activity (5 days/week)				Targeted activity[(b)] (5 days/week)		
	Trend rate	Stable rate	15 mins	30 mins	60 mins	Stable rate[(a)]	15 mins	30 mins	60 mins
Males	71,685	71,216	70,568	55,048	52,954	0.7	1.6	23.2	26.1
Females	78,300	76,980	59,200	56,548	55,485	1.7	24.4	27.8	29.1
Persons	**149,986**	**148,196**	**129,768**	**111,597**	**108,440**	**1.2**	**13.5**	**25.6**	**27.7**

(a) % of attributable DALY avoided refers to the per cent difference between future attributable burden for each sex if, in 2020, the proportion of people in each activity category was the same as in 2011—*Stable rate scenario* compared with the expected attributable burden under current trends *Trend rate scenario*.

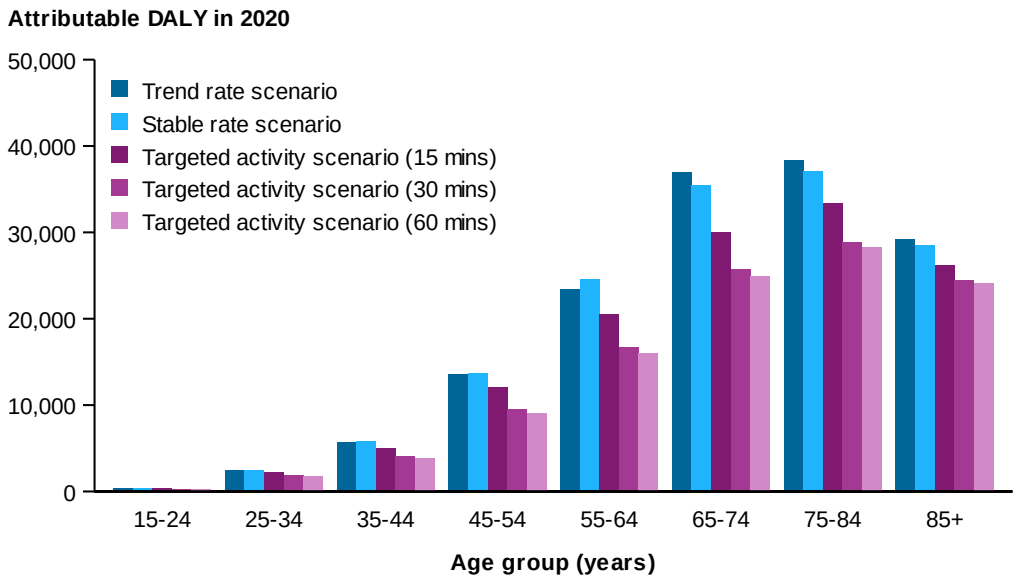
(b) % of attributable DALY avoided refers to the per cent difference between future attributable burden for each sex if, in 2020, everyone had undertaken moderate exercise 5 days per week, in addition to their current activity levels, by 15 minutes, 30 minutes and 60 minutes compared with the expected attributable burden under current trends *Trend rate scenario*.

Source: AIHW analysis of burden of disease database, 2011.

6.3 Scenario differences in 2020 by age

The estimated burden due to physical inactivity in 2020 varied by age under the different scenarios (Figure 6.1). The attributable burden in 2020 increased with increasing age up to age 84 under all scenarios, with the greatest amount of burden due to physical inactivity in people aged 65–84. A comparison of the *Stable rate* and *Trend rate scenarios* suggests that the burden due to physical inactivity is decreasing (improving) in those aged 55–64 and increasing (getting worse) in those aged 65 and over.

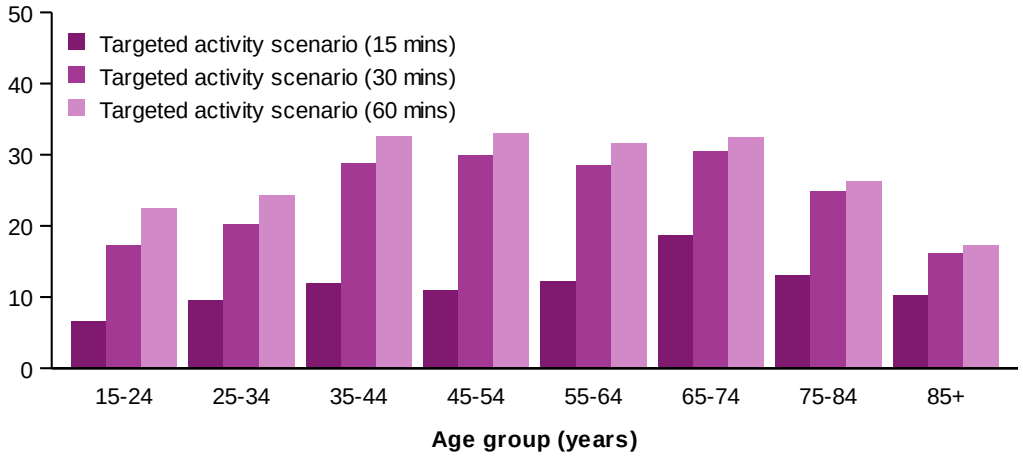
In terms of the absolute number of DALY avoided, the largest gains could be made in increasing physical activity in ages 65 and over. The largest DALY difference was in ages 65–74, where 6,920 DALY could be avoided in 2020 if those at risk did an extra 15 minutes a day of moderate activity, 5 days per week (11,240 and 12,012 DALY avoided if this increases to 30 and 60 minutes, respectively), compared with what would be the case if current trends continued (*Trend rate scenario*).



Source: AIHW analysis of burden of disease database, 2011.

Figure 6.1: Burden (DALY) due to physical inactivity by age, under the *Trend rate, Stable rate* and *Targeted activity scenarios*, 2020

In terms of the relative proportion of DALY avoided within each age group, this analysis suggests that the largest gains could be made in those aged 65–74, where 19% of potential disease burden due to physical inactivity could be avoided in 2020 if those 'at risk' did an extra 15 minutes of moderate activity, 5 days per week, compared with if current trends continued (*Trend rate scenario*) (Figure 6.2). If those at risk did an extra 30 minutes of moderate activity, 5 days per week, around 30% of potential disease burden due to physical inactivity could be avoided in those aged 35–74. The additional disease burden that could be avoided by increasing activity from 30 to 60 minutes, 5 days per week, is minimal across all age groups; however, it was greatest for the younger age groups.



Source: AIHW analysis of burden of disease database, 2011.

Figure 6.2: Burden (DALY) due to physical inactivity that could be avoided under the *Targeted activity scenarios* (extra 15, 30 and 60 minutes of brisk walking), by age, 2020

7 Discussion

This report describes the impact of physical inactivity on the disease burden in Australia in 2011. It updates and extends the estimates reported in the ABDS 2011 by including:

- revised linked diseases that have a causal association with physical inactivity, and updated relative risks based on the latest evidence
- an extended definition of physical activity to include activity from work and household chores (as well as leisure and transport)
- estimates by socioeconomic group.

In total, 7 linked diseases were included in this study: breast cancer, bowel cancer, coronary heart disease, dementia, diabetes, uterine cancer, and stroke. Dementia and uterine cancer were not included in the ABDS 2011 or the GBD 2015 study.

Results from scenario modelling are also presented, which estimate the impact that increases in physical activity may have on future disease burden in the Australian population.

7.1 Major findings

Physical inactivity was responsible for 2.6% of the total burden of disease and injuries in Australia in 2011, equivalent to 116,676 DALY (Table 3.2). This is less than that reported in the ABDS 2011 (5.0%; 224,198 DALY). This difference is largely due to smaller relative risks applied for five of the linked disease outcomes, based on the latest evidence from a larger meta-analysis from the GBD 2015.

Including measures of occupational activity and activity due to household chores in measuring total MET scores in this study accounted for about 10% of the difference in reported attributable burden due to physical inactivity between this study and the ABDS 2011. This suggests that the majority of physical activity in the Australian population is obtained through leisure time or active transportation.

The relative burden due to physical inactivity was larger in females (2.7% of all disease burden) than in males (2.5%), with almost three-quarters (74.0%) of the physical inactivity burden being fatal.

Almost two-thirds (65%) of the burden due to physical inactivity was in people aged 65 and over. Coronary heart disease accounted for about one-third (34%) of the total attributable physical inactivity burden (39,262 DALY). This was followed by dementia (18%), diabetes (16%), bowel cancer (13%) and stroke (12%).

About 19% of the total diabetes burden was due to physical inactivity. For each remaining linked disease, 10%–16% of the linked disease burden was attributable to physical inactivity: bowel and uterine cancer (16% each), dementia (14%), coronary heart disease and breast cancer (11% each) and stroke (10%).

Large inequalities were found across socioeconomic groups, with the lowest socioeconomic group experiencing a rate of burden due to physical inactivity that was 1.7 times that of the highest socioeconomic group. Most diseases showed decreasing burden due to physical inactivity with increasing socioeconomic group, except for dementia and breast cancer. The strongest gradient was seen in diabetes (Q1:Q5 rate ratio of 2.8).

The burden due to physical inactivity was slightly lower in 2011 than in 2003 (2003:2011 rate ratio:0.9). This shows that burden due to physical inactivity overall has decreased only slightly over time.

When combined, the joint effect of physical inactivity and overweight and obesity were responsible for 9% of the disease burden in Australia in 2011.

7.2 Potential to reduce disease burden

Physical activity is beneficial in preventing disease, as well as in reducing disease severity for some conditions, and in improving recovery from adverse outcomes or treatments (Pedersen & Saltin 2015). Physical activity has a positive impact on the physiological functioning, psychological wellbeing and/or recovery of patients with early-stage and advanced cancer, cardiovascular disease, chronic obstructive pulmonary disease, diabetes, various musculoskeletal disorders (Bennell et al. 2014; Fransen et al. 2015), multiple sclerosis (Kjolhede et al. 2012) and Parkinson's disease (Lauzé et al. 2016). There is also evidence that increased physical fitness is associated with decreased depressive symptoms in those with depression (Sui et al. 2009).

The analysis in this report suggests that notable reductions in disease burden could be achieved with small increases in physical activity in the population at risk.

If those 'at risk' (which was 89% of the Australian population in 2011) did an extra 15 minutes of moderate exercise (such as brisk walking) 5 days each week, 13% of the potential future disease burden due to physical inactivity burden could be avoided (equivalent to 20,218 DALY avoided). An extra 30 minutes of moderate exercise 5 days each week could result in 26% of future disease burden avoided (38,289 DALY avoided); this increases to 28% if an extra 60 minutes of moderate exercise is done (41,546 DALY avoided).

For females, around one-quarter (24%) of future disease burden due to physical inactivity could potentially be avoided if those at risk added a 15-minute brisk walk, 5 days each week to their current activity levels. Males needed to do an extra 30 minutes of exercise 5 days each week for an equivalent level of future disease burden to be avoided. Therefore, substantial health benefits would follow if women aimed to undertake an extra 15 minutes of daily exercise (5 days per week), and men an extra 30 minutes of daily exercise (5 days per week).

As this study modelled only physical inactivity associated with increased risk of disease incidence and mortality, the full extent to which physical activity contributes to disease burden through decreasing disease severity, and improving disease management, is not known.

7.3 Strengths

This study enhances the analyses undertaken in the ABDS 2011. It is the first study to quantify disease burden in Australia due to physical inactivity in all activity domains (leisure, transport, occupational and household chores) in adults aged 20 and over, and to disaggregate by socioeconomic group. It is also the first study to report the combined contribution of physical inactivity and overweight and obesity to disease burden in Australia.

The analysis in this report indicates that the physical inactivity attributable burden is overestimated by about 11.0% in men and 8.5% in women if occupational activity and household chores are excluded in the exposure definition. Therefore, the ABDS 2011 would have overestimated the attributable burden by excluding these activity types.

The analysis also highlights that the majority of physical activity is acquired through leisure and active transportation. This indicates that these activity domains are critical areas for targeted interventions aimed at increasing physical activity in the population.

The estimates of attributable burden due to physical inactivity reported in this study rely on the best available evidence from recent studies and meta-analyses relevant to the Australian population. This study included an additional 2 diseases—dementia and uterine cancer, each having suitable levels of evidence of a causal association with physical inactivity according to the World Cancer Fund criteria for causal associations used in this study. These were not estimated in the GBD 2015 or the ABDS 2011.

This study relied on the underlying disease burden data from the ABDS 2011, and the quality of these estimates was high for most diseases. Fatal burden estimates for all diseases are considered to be of high quality; however, there were some variations in the quality of non-fatal estimates by disease, which ranged from medium to high quality. For more information on the quality of the disease burden estimates in the ABDS 2011, see *Australian Burden of Disease Study 2011: methods and supplementary material* (AIHW 2016b).

This study illustrates the use of burden of disease data to undertake scenario modelling in looking at how changes in the population's physical activity levels affect disease burden. The results of the scenario analyses not only highlighted the potential benefits (at the population level) of reducing physical inactivity in preventing or delaying associated chronic diseases, but also demonstrated that large health benefits could be achieved with relatively small increases in daily exercise.

7.4 Limitations

National physical activity data

Due to data limitations, trends in physical activity could be estimated only for selected domains included in the study. Trends could be estimated only for leisure activity (walking, moderate and vigorous activity) and transport-related activity. Estimates for occupational activity and selected leisure activities were based on specific questions in the National Nutrition and Physical Activity Survey, as part of the AHS 2011–12. As these questions were not included in previous National Health Surveys, trends over time could not be estimated. However, it is not expected that excluding these domains would have had a great impact on the trend estimates, as the majority of physical activity was due to leisure and transport-related activity.

Self-reported data on the time spent per week on physical activity were used to estimate exposure. Self-reported data are not as reliable as objectively measured data, and therefore may not provide an accurate representation of an individual's level of physical activity. A study by Garriquet et al. (2015) found that the proportion of people meeting physical activity levels specified in the Canadian Physical Activity Guidelines was 90% when using the International Physical Activity Questionnaire, compared with 70% when based on all accelerometer data. However, self-reported physical activity data were chosen for use in this report as these were readily available at a population level for the years investigated.

Method for combining risk factors

The joint effect calculation is standard methodology in burden of disease analyses to account for multiple risk factors on the same causal pathways. At present, most risk factors in burden of disease analyses are presented individually, with the joint effect estimate calculated only

for all risk factors combined and all dietary risks combined in the ABDS 2011, and for other selected risk factors in the GBD. In the absence of a risk estimate specific for the combined impact of physical inactivity and overweight and obesity and disease development—as well as its applicability to estimating attributable burden—the standard joint effect formula was used. Further work is required to develop a more robust method to accurately account for the interactions between two or more specific risk factors. The ability to accurately quantify the combined contribution of physical inactivity, diet and overweight and obesity is necessary to determine the overall impact of these leading risks on disease burden in Australia.

Global burden of disease methods

This study adopted global burden of disease methods to estimate the disease burden due to physical inactivity, which has some known limitations.

Firstly, it categorises population physical activity levels into four groups (sedentary, low, moderate and high) estimated from the total MET scores from leisure, travel, occupational and household related activity combined in the year for which disease burden is measured. The MET score ranges were based on global activity MET scores which may not be realistic for everyone to achieve in Australia, due to the relatively low levels of occupational physical activity in Australia compared with that in other countries. As well, this method does not take into account an individual's previous activity levels or the magnitude of changes in activity over time (such as moving from moderate activity levels to sedentary over a certain period of time).

Secondly, a uniform distribution for increased risk of disease is assumed within each of the four categories of physical inactivity levels. However, there is evidence to suggest that associated risk of disease is on more of a continuum, decreasing with increases in physical activity. Methods would be improved if this risk factor was treated as a continuous risk, as opposed to a categorical risk. The results of this study do, however, indicate that substantial health benefits from physical activity could be achieved through small increases in moderate activity—particularly for people who are considered sedentary.

Linked diseases

In this study, 7 diseases were included as outcomes of physical inactivity. At the time of the study, these were considered to have a 'convincing' or 'probable' level of evidence supporting a causal association, according to criteria set by the World Cancer Research Fund. By comparison, overweight and obesity was found to be linked to 22 diseases using the same level of evidence criteria. The increased number of studies, and study quality in overweight and obesity research, contributed to some of these diseases being included in the analysis of burden due to overweight and obesity, but not for physical inactivity. With increasing evidence, diseases associated with overweight and obesity may be included as diseases linked to physical inactivity in the future.

Furthermore, the study did not quantify the amount of physical activity that is reduced due to specific chronic diseases that restrict people's ability to exercise. This would be a beneficial analysis to determine the spectrum of disease affecting physical inactivity levels, and how this has an impact on disease burden.

7.5 Future directions

As part of the ABDS 2011, the Australian Institute of Health and Welfare (AIHW) has developed a system that will allow estimates of disease burden in Australia to be updated,

and remain current with emerging information. This offers potential to monitor and update the estimates included in this study as new evidence emerges about the association between physical inactivity and linked diseases, and as physical inactivity in the population changes over time.

Sedentary behaviour (such as viewing television or sitting for prolonged periods) could be explored as a risk factor in the future, but its relationship with physical activity is not completely understood. Some studies suggest excessive periods of sedentary behaviour increases the risk of cardiovascular disease, cancer and type 2 diabetes—independent of the individual's level of physical activity, while findings for other meta-analyses provide evidence that the impact of sedentary behaviours can be reduced through increased moderate and vigorous activity (Biswas et al. 2015; Ekelund et al. 2016; Schmid & Leitzmann 2014). Further evidence in this area would be required before it is used in burden of disease analyses.

Physical inactivity is also prevalent among Aboriginal and Torres Strait Islander people. In 2012–13, 62% of Indigenous adults in non-remote areas did not undertake sufficient levels of physical activity in the last week according to Australian Physical Activity Guidelines (AIHW 2015). Estimates reported from the ABDS 2011 indicated that Indigenous Australians had rates of attributable burden due to physical inactivity at 3.3 times the rate of non-Indigenous Australians in 2011 (AIHW 2016c). An analysis of the impact of physical inactivity in the Indigenous population would be an important area of work to progress in future burden of disease studies. This could use available data from the ABDS 2011 database, and Indigenous-specific physical activity levels from ABS Indigenous health survey data, and apply relative risks used in this report.

Age-period-cohort analyses could not be done in this study due to the lack of longitudinal Australian burden of disease data. In a recent international study, Leijon et. al (2015) examined the age and birth cohort trends in a 24-year follow-up study of regular exercise among Swedish adults. The authors suggested that although physical activity declined with age, in men this varied, depending on the decade of birth. Physical activity increased for those in the earliest generations (born between 1920 and 1930), but decreased for those in the later generations (born between 1960 and 1970). Furthermore, findings from the National FINRISK Study, a large Finnish longitudinal health survey, showed prevalence of physical activity was higher in the oldest cohorts (those born between 1910 and 1930) compared with the youngest cohorts (those born between 1940 and 1970). There were also notable changes in the source of physical activity across birth cohorts. The proportion of leisure time activity increased, and occupational and transport related activity decreased, in the older cohorts (born between 1910 and 1930) more so than for the younger cohorts (born between 1940 and 1970). Age-period-cohort analyses of physical activity and associated disease burden would be valuable to explore with longitudinal data and comparable physical activity data from successive National Health Surveys in Australia in the future.

This report does not include the economic cost of physical inactivity burden on the Australian health-care system. It has been estimated that the total cost of physical inactivity in Australia in 2013 was $805 million (Ding et al. 2016). About 80% of this cost was made up of direct costs, with the remaining due to productivity losses. This study by Ding et al. (2016) did not include the burden due to physical inactivity from the additional linked diseases in this study (dementia and uterine cancer). Further analyses linking disease burden to health expenditure would provide further insight into the impact of physical inactivity on the Australian health-care system.

7.6 Conclusion

This study provides details of the impact of physical inactivity on disease burden in the Australian population and highlights that small increases in daily exercise can have substantial benefits in reducing associated chronic disease burden. It also points out that health inequalities exist in disease burden due to physical inactivity, with lower socioeconomic groups experiencing larger rates of attributable burden. Results from this study suggest that prevention and intervention efforts may best be focused on sustained increases in physical activity in the population by as little as 15 minutes each day, to avoid disease burden from physical inactivity.

Appendix A: Detailed methods

Diseases with a strong causal association with physical inactivity ('linked diseases') were included in the study after review of the literature. The quantified associated extra risk for each linked disease—known as relative risks—were selected in this process. The degree of additional risk was combined with categorical physical activity prevalence data to determine the proportion of each disease due to physical inactivity. These proportions were then combined with disease burden estimates from the ABDS 2011 to quantify the disease burden due to physical inactivity in the population.

Selection of linked diseases

Linked diseases were included in the analysis if there was evidence of an association based on high-quality epidemiological studies—preferably from a meta-analysis or prospective studies. Evidence was rated based on the World Cancer Research Fund criteria to judge the level of association, and only included if there was a convincing or probable level of evidence for an association with physical inactivity. An insufficient level of evidence included linked diseases where there were inconsistent findings from studies, or where reverse causality presented an issue.

Linked disease was categorised as convincing or probable based on the robustness and volume of studies showing a relationship. Convincing evidence describes a causal relationship that is 'robust enough to be highly unlikely to be modified in the foreseeable future as new evidence accumulates' (WCRF/AICR 2007). Probable evidence suggests a causal relationship is often described and is unlikely to change with increased knowledge. The main reason for classifying as probable evidence was that a meta-analysis had not been conducted, or only a few high-quality studies were available from which to select.

The diseases included in the analysis also had to have burden estimated, or burden that could be estimated appropriately from the ABDS 2011.

Each relative risk was applied to both fatal and non-fatal burden. See Appendix B for a detailed description of the selection of linked diseases.

Linked diseases and associated risk factors not included in analysis

There are several conditions associated with physical inactivity that were not included in this report either because the study's selection criteria were not met or because attributable burden could not be quantified (as they were not captured as a disease in the ABDS 2011).

Conditions that were excluded as they were not captured as a disease in the ABDS 2011 include heart failure, metabolic syndrome, obesity, osteoporosis and sarcopenia. Metabolic syndrome is defined as a group of risk factors rather than a disease. High BMI, fasting plasma glucose levels, blood pressure and cholesterol were instead included as separate risk factors in the ABDS 2011, rather than estimating this combined effect experienced in metabolic syndrome. Overweight and obesity was also estimated separately as a risk factor in the ABDS 2011.

Heart failure is a recognised cardiovascular outcome that increases in risk with decreases in physical activity levels. Heart failure burden was not estimated in the ABDS 2011, but was included in the burden estimates of numerous cardiovascular diseases. Therefore, it was not possible to individually calculate heart failure burden due to physical inactivity. Heart failure, however, is captured in the burden estimates for coronary heart disease and stroke.

Depression was identified in the literature as having some association with physical inactivity, but the evidence for causal association was limited due to inconsistent methodologies and definitions. Two prospective cohort studies provided evidence of an association between depression and physical inactivity. Both studies were only within the female population, and in one study the outcome comprised depressive symptoms as opposed to medically diagnosed depression. Reduced depressive symptoms and other mental health outcomes due to increased physical activity levels were also commonly observed, but this does not indicate the required level of evidence to demonstrate causality, a requirement for inclusion in this study.

Various musculoskeletal conditions (osteoarthritis, osteoporosis and low back pain) were examined for inclusion in the report; however, these did not meet the criteria for inclusion as there was not enough evidence suggesting a causal relationship. As mentioned, osteoporosis was also not a disease in the ABDS 2011 (but was included as a risk factor—low bone mineral density), and therefore could not be included as a disease outcome to measure attributable burden. Evidence was also conflicting for back pain and osteoarthritis, as physical activity can be beneficial, as well as detrimental, depending on the frequency and type of activity undertaken.

Population exposure: prevalence of physical activity in each level

Population exposure to the risk factor—which in this report is physical inactivity—was treated as a categorical variable. The categories describe the range of total activity per week, as measured by the total MET. This measure encompasses the rate of energy expenditure, with 1 Met equivalent to 1 kcal/kg/hour, which is about the energy expended sitting. The higher the MET, the greater the energy expended. The calculation of METs requires the input of:

- time spent undertaking the activity in 1 week (*T*)
- intensity score for that specific activity (*I*).

The total MET for each activity is calculated as:

$$\mathrm{MET} = T \times I$$

In this study, the total MET score describes the total rate of energy expended across four activity domains: leisure, transportation, occupational, and household. The categories included:

- Sedentary: fewer than 600 METs per week.
- Low levels of activity: 600–3,999 METs per week.
- Moderate levels of activity: 4,000–7,999 METs per week.
- High levels of activity: 8,000 METs and over per week.

These categories align with relative risks provided by the GBD 2015 and these categories were used in the ABDS 2011.

The National Nutrition and Physical Activity Survey (as part of the AHS 2011–12) was used to obtain the inputs required to calculate METs for leisure, occupational and transport activity. The number of self-reported minutes spent in each activity per week was multiplied by the intensity scores as provided by the AHS to calculate the total MET for each individual in the survey. The intensity factor for each activity level are shown in Table A1.

Table A1: Intensity factors used to calculate METs

Physical activity domain	Intensity factor
Leisure	
Walking for fitness, recreation or sport for at least 10 mins	3.5
Walking for transport for at least 10 mins	3.5
Strength and toning	3.0
Moderate physical activity[(a)]	5.0
Vigorous gardening	5.0
Vigorous physical activity[(b)]	7.5
Transport	
Walking for transport for at least 10 mins	3.5
Occupational	
Work involves mostly walking	3.5
Work involves mostly heavy labour	5.5
Household chores	3.0

(a) Moderate intensity physical activity/exercise was defined as activities that caused a moderate increase in the heart rate or breathing of the respondent.

(b) Vigorous intensity physical activity/exercise was defined as activities that caused a large increase in the respondent's heart rate or breathing.

The AHS 2011–12 does not provide information on the time spent and the intensity of activity due to household chores, so this was obtained from alternative data sources. The time taken on specific household chores was obtained from the ABS Time Use Survey 2006. This survey provides detailed information on daily activity patterns of people in Australia and the time allocated to different activities. The time spent undertaking household chores (excluding meal and drink preparation) by sex in 10-year age groups was extracted, and multiplied by the conservative intensity of 3.0. The calculated METs by age and sex were added to the calculated METs from remaining domains to provide the total MET.

Age- and sex-specific data for the proportion of people within each activity category, once the METs from each domain were summed, was extracted in the finest possible increments. The level of granularity was limited to keep the relative standard error to 25% or less, where possible.

Theoretical minimum risk exposure distribution

The TMRED for the risk factor 'physical inactivity' was 8,000 METs per week across all domains (leisure, transport, occupational, and household chores)—defined as the high-activity category in this study. Anyone achieving this level is not considered to be at risk of disease associated with physical inactivity.

Calculation of population attributable fractions

PAFs determine the proportion of a particular disease that could have potentially been avoided if the population had never been exposed to a risk factor (Box 1.3).

The calculation of PAFs requires the input of:

- effect size, or the relative risk (*RR*), of the risk factor on the outcome of interest
- prevalence of exposure in the population (*P*).

The **PAF** is calculated as:

$$\mathrm{PAF} = \frac{P(RR-1)}{P(RR-1)+1}$$

The burden attributable to physical inactivity can be estimated using the calculated PAFs for each linked disease and the total burden estimated in the ABDS 2011.

Attributable burden (*AB*) is calculated as:

$$\mathrm{AB} = PAF \times C$$

where:

C is the total burden (DALY) of a specific outcome (for example, stroke).

For detailed information about the most recent ABDS, and further information on the methods used to calculated disease burden, see *Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011* (AIHW 2016d) and *Australian Burden of Disease Study: methods and supplementary material* (AIHW 2016b).

Estimating the joint effect

Attributable burden due to physical inactivity and overweight and obesity was estimated by calculating the joint effect.

The PAFs for overweight and obesity were derived from analysis of estimates produced in a recent AIHW study (AIHW 2017a). This study identified 22 linked diseases associated with overweight and obesity, including 7 linked diseases, which this study identified as having sufficient evidence of a casual association with physical inactivity.

The **PAF for the joint effect** is calculated as:

$$\mathrm{PAF} = 1 - \prod (1 - PAF_{\mathrm{r}})$$

where:

PAF is the population attributable fraction of burden attributable to a disease from the risk factors combined

PAF_r is the population attributable fraction for risk factor '*r*' and linked disease

the product Π runs over all risk factors within the cluster.

This formula has been used in several other burden of disease studies. Desirably, it caps the estimated combined attributable burden, therefore avoiding the possibility of the proportion's exceeding the total disease burden.

Socioeconomic group analysis

Analysis by socioeconomic group was based on the burden estimates by this disaggregation from the ABDS 2011, and the prevalence of physical activity in each level by the equivalent socioeconomic groups.

In this report, socioeconomic groups are based on an index of relative socioeconomic disadvantage—known as SEIFA (Socio-Economic Indexes for Areas). SEIFA is a ranking defined by an individual's residential area and measured on socioeconomic indicators including household income, employment and education levels. Note that this disadvantage

refers to the statistical area's disadvantage and not the individual's disadvantage, which may differ.

Scenario modelling

The estimated burden due to physical activity in the year 2020 was calculated for various hypothetical scenarios. The difference between these scenarios indicates potential burden that may be avoided, due to population changes in physical activity levels.

The year 2020 was chosen because it aligns with the World Health Organization's Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013–2020 (WHO 2013).

The scenarios that aimed to investigate the impact of changes in physical activity levels on future burden were:

- *Trend scenario:* the estimated attributable burden in future years if the prevalence rate of physical inactivity continues at its current trend based on estimates in the 2001, 2004–05, 2007–08, 2011–12 and 2014–15 ABS National Health Surveys.
- *Stable rate scenario:* the estimated attributable burden in future years if the prevalence rate of physical inactivity remained the same as it is in the year 2011–12 (as estimated in the ABDS 2011–12). This scenario used the age- and sex-specific rates of physical activity in each activity category in 2011.
- *Targeted daily activity scenario:* the estimated attributable burden in the year 2020 if everyone in the population 'at risk' under current trends increased the time spent doing moderate activity, such as going for a brisk walk. People who fall in the sedentary, low and moderate activity categories are considered 'at risk'. A varying range of times undertaking extra activity were analysed:
  - 15 minutes of moderate activity, 5 days per week
  - 30 minutes of moderate activity, 5 days per week
  - 60 minutes of moderate activity, 5 days per week.

Physical activity levels and linked disease burden in 2020

Variations in physical inactivity for the year 2020 were based on changes in leisure and transport activity only. This was due to the limited information on trends in occupational activity and on activity due to household chores over time in Australia.

For the *Trend scenario*, the age- and sex-specific proportion of people within each physical activity category were projected using the linear trends of actual prevalence in Australia as noted in successive ABS AHSs between 2001–2014.

For the *Stable rate scenario,* the age- and sex-specific proportion of people within each physical activity category in 2011 was used and maintained at 2011 levels to 2020. This provides an indication of the impact of halting current trends in physical activity.

The *Targeted daily activity scenario* was estimated by adding an extra 75,150 or 300 minutes of moderate activity to the people 'at risk' estimated for the year 2020 under the *Trend scenario*. The MET intensity score of 5.0 was used to indicate moderate activity, as described in Table A1. For these scenarios, it was assumed that the 2011 linked disease burden rates were the same in 2020, adjusting only for expected changes in population structure. Due to the complexity of possible associations between diseases, expected future changes in linked disease burden will need more consideration. This assumption was made for simplicity in this analysis.

Appendix B: Selection of relative risks

Physical inactivity is associated with excess mortality and an increased risk of developing a number of chronic conditions. However, the strength of association and quality of evidence supporting the level of risk varies for each disease.

Diseases associated with physical inactivity that were selected for this study are referred to as 'linked diseases'; they were identified for inclusion in the analysis after review of relevant literature. For a disease to be included it must have convincing or probable evidence—according to the World Cancer Research Fund criteria—for a causal association. Convincing evidence included diseases with a well-known causal relationship or where numerous high-quality studies applicable to Australia showed a causal relationship, after adjusting for confounders. A probable level of evidence is where a causal relationship was documented by high-quality studies, but supporting evidence was not as robust as for those identified as convincing.

Relative risks measure the strength of association between a risk factor and a linked disease. Disease risk was calculated in people aged 20 and over for all conditions except dementia, which was calculated in people aged 65 and over. Risk was categorised by the amount of physical activity regularly undertaken using the MET groupings in the GBD 2015.

Following review of current evidence, 7 diseases were included in the analysis (Table B1). The linked diseases are the same as those estimated in the ABDS 2011 and the GBD 2015, except for dementia and uterine cancer.

Relative risks were obtained from the GBD 2015 except for the additional linked diseases. Disease risk varied by level of physical activity for most linked diseases. Age-specific relative risks were available for coronary heart disease and stroke.

Table B1: Relative risks and sources for linked diseases

		Relative risk (95% confidence intervals)				
Linked disease	**Age (years)**	**<600 METs**	**600–3,999 METs**	**4,000–7,999 METs**	**Relative risk source**	**Level of evidence**
Breast cancer	20–100+	1.16 (1.11–1.21)	1.12 (1.08–1.16)	1.07 (1.00–1.18)	GBD 2015	Convincing
Bowel cancer	20–100+	1.29 (1.21–1.38)	1.17 (1.09–1.26)	1.09 (1.05–1.14)	GBD 2015	Convincing
Uterine cancer*	20–100+	1.20 (1.15–1.25)	1.20 (1.15–1.25)	1.20 (1.15–1.25)	Schmid et al. 2015	Probable
Coronary heart disease	20–100+	1.05–1.57 (1.04–1.63)	1.06–1.81 (1.02–1.31)	1.01–1.03 (1.00–1.21)	GBD 2015	Convincing
Stroke	20–100+	1.06–1.67 (1.04–1.99)	1.03–1.26 (1.01–1.51)	1.02–1.18 (1.00–1.53)	GBD 2015	Convincing
Diabetes	20–100+	1.39 (1.30–1.48)	1.19 (1.12–1.26)	1.04 (1.00–1.12)	GBD 2015	Convincing
Dementia*	45–100+	1.14 (1.04–1.32)	1.14 (1.04–1.32)	1.14 (1.04–1.32)	Blondell et al. 2014	Convincing

* Additional linked disease not included in the ABDS 2011.

The possible physiological mechanisms for disease development and selection of relative risks are now discussed further for each individual disease.

Cancers

There are numerous biological pathways through which physical activity may reduce cancer risk. This includes reducing levels of circulating sex hormones, improving insulin sensitivity, reducing adiposity and states of inflammation, and increasing immune function. The pathways, and level of association, vary by cancer types. Three cancers were determined to have sufficient evidence for inclusion in this study: breast, bowel and uterine cancer.

There is strong and convincing evidence supporting physical inactivity as a risk factor for development of bowel cancer (WCRF/AICR 2007). In a meta-analysis of over 52 case-control and cohort studies, there was a 24% risk reduction overall in the development of colon cancer in those undertaking the highest levels of recreational physical activity, compared with the least active group (Wolin et al. 2009).

A recent meta-analysis of 31 studies with over 63,000 breast cancer cases provided evidence for a 12% risk reduction in the development of breast cancer among those with high total activity levels compared with the least active group, with stronger associations found among those who were not overweight or obese, and pre-menopausal women (Wu et al. 2013). This meta-analysis included physical activity across all domains.

Uterine cancer has only recently been included as an outcome of physical inactivity, due to increasing evidence of a causal association. The level of evidence for uterine cancer was rated as 'probable', based on recommendations and reviews undertaken by the World Cancer Research Fund. In a recent systematic review and meta-analysis, which included nearly 20,000 uterine cancer cases, Schmid et al. 2015 reported a 20% decreased risk in uterine cancer among those in highest total activity group compared with the least active group.

The relative risks for breast and bowel cancer used in this study were from the GBD 2015 study. The relative risk for uterine cancer was derived from a systematic review and meta-analysis (Schmid et al. 2015). The studies included in these meta-analyses were mostly adjusted for the following confounders: age, family history of cancer outcome, smoking, alcohol consumption and BMI.

Cardiovascular diseases

There is a well-established inverse relationship between increasing physical activity levels and decreased incidence of cardiovascular disease. Buttar et al. 2005 summarised physical activity benefiting cardiovascular health through decreasing blood pressure, reducing total cholesterol and high density lipoproteins, increasing low density lipoproteins, vascular remodelling and reducing thrombus formation.

The relative risks for coronary heart disease and stroke used in this study were from the GBD 2015 study. The effect sizes used by the GBD 2015 were obtained from a systematic review and dose-response meta-analysis by Kyu et al. 2016 of studies of the association between physical activity levels and incidence of coronary heart disease (43 prospective studies) and stroke (26 prospective studies). The pooled relative risks showed an overall reduction in developing coronary heart disease, ranging from 16%–25% in those undertaking more than 600 METs per week. A similar level of risk reduction was observed for stroke. The studies included were adjusted for age, sex, smoking, alcohol consumption and BMI.

Dementia

Dementia was included in this study due to the accumulating evidence for an association between physical activity and dementia. It was previously not included as a disease outcome

in the ABDS 2011, or in the GBD studies (Beydoun et al. 2014; Blondell et al. 2014; de Bruijn et al. 2013; Guure et al. 2017). Physical activity is suggested to play a role in improving and/or preserving cognitive function through various neuroprotective mechanisms (such as an increased release of neurotrophins), as well as by mitigating vascular risk factors (Ahlskog et al. 2011; Pedersen & Saltin 2015).

The relative risks for dementia used in this study were obtained from a systematic review and meta-analysis by Blondell et al. 2014. These authors pooled estimates from 26 prospective studies to calculate the association between physical activity and reduced dementia incidence. The pooled relative risks showed a 14% reduction in the risk of developing dementia in those who undertook high levels of activity, compared with the low activity group. Sensitivity analyses were undertaken to assess heterogeneity; this provided the same or stronger associations. In this study, the relative risk was applied to the sedentary, low and moderate activity categories, as there is insufficient evidence of a dose response relationship between the MET categories used in this study and risk of dementia.

The relative risk used in this study for the association between physical activity and dementia was also used in a recent analysis by the AIHW (AIHW 2016e). In this report, the burden of dementia disease attributable to 8 vascular risk factors and diseases was quantified, and physical inactivity was responsible for 9.4% of the burden of dementia in 2011. Physical inactivity in that report was defined as people aged 45 or over who are inactive or insufficiently active according to the AHS 2011–12 definitions. Due to these differences, the estimates between these two reports are not comparable.

Diabetes

There is strong and consistent evidence supporting an increased risk for physical inactivity and the development of type 2 diabetes. Physical activity increases insulin sensitivity and glucose tolerance, reducing atherosclerotic risk and decreasing intra-abdominal adiposity.

In this study, the relative risks for diabetes were obtained from the GBD 2015 study, which was based on a systematic review and dose-response meta-analysis by Kyu et al. 2016. In total, the pooled relative risks from 55 prospective studies provides evidence for a 14%–28% increased risk of developing diabetes among those who undertook fewer than 8000 METs per week.

As the ABDS 2011 does not have separate burden estimates for type 1 and type 2 diabetes, the relative risks were applied to the entire diabetes burden.

Appendix C: Additional tables

Table C1: Number and proportion of disease burden due to physical inactivity (attributable DALY), by linked disease, by sex, 2011

	Males			Females		
Linked disease	**Total DALY**	**Attributable DALY**	**% due to physical inactivity**	**Total DALY**	**Attributable DALY**	**% due to physical inactivity**
Coronary heart disease	226,021	26,415	11.7	120,629	12,848	10.7
Diabetes	59,298	10,760	18.1	42,356	8,305	19.6
Bowel cancer	53,084	8,363	15.8	39,338	6,640	16.9
Dementia	55,593	7,600	13.7	95,716	13,152	13.7
Stroke	65,689	6,628	10.1	71,081	6,926	9.7
Breast cancer	407	. .	. .	70,268	7,813	11.1
Uterine cancer	0	. .	. .	7,622	1,226	16.1
Total	**2,412,531**	**59,765**	**2.5**	**2,081,896**	**56,911**	**2.7**

Note: The '%' column (for both Males and Females) is the attributable DALY divided by the linked disease burden in 2011 of that row.

Source: AIHW analysis of burden of disease database, 2011.

Table C2: Burden (DALY) due to physical inactivity by socioeconomic group, by sex, 2011

	Males				Females			
Socioeconomic group (quintile, or Q)	**Total DALY ('000)**	**Attributable DALY ('000)**	**ASR per 1,000 persons**	**Rate ratio**	**Total DALY ('000)**	**Attributable DALY ('000)**	**ASR per 1,000 persons**	**Rate ratio**
Q1 (lowest)	587	17	7.7	1.9	480	13	6.2	1.6
Q2	556	14	6.3	1.5	464	12	5.6	1.4
Q3	496	12	5.5	1.3	426	11	4.8	1.2
Q4	422	10	4.5	1.1	378	10	4.2	1.1
Q5 (highest)	366	9	4.1	. .	341	9	4.0	. .

Notes

1. Rates were age standardised to the 2001 Australian Standard Population, and are expressed per 1,000 persons.
2. Rate ratios divide the Q1 ASR by the Q5 ASR.

Source: AIHW analysis of burden of disease database, 2011.

Table C3: Changes in age-specific DALY rate (per 1,000 persons) by socioeconomic group and age, 2011

	Socioeconomic group (quintile, or Q)					
Age group (years)	Q1 (lowest)	Q2	Q3	Q4	Q5 (highest)	Rate ratio (Q1:Q5)
20–34	0.7	0.4	0.5	0.2	0.3	2.0
35–44	1.8	1.5	1.3	1.1	0.9	1.9
45–54	4.6	3.9	3.4	3.3	2.5	1.8
55–64	8.6	6.8	6.2	5.8	4.7	1.8
65–74	15.2	12.6	11.2	11.6	9.7	1.6
75–84	28.4	27.2	24.3	24.3	24.6	1.2
85+	56.1	56.4	54.3	52.5	51.3	1.1

Note: Rate ratios divide the Q1 ASR by the Q5 ASR.

Source: AIHW analysis of burden of disease database, 2011.

Glossary

attributable burden: The disease burden attributed to a particular risk factor. It is the reduction in burden that would have occurred if exposure to the risk factor had been avoided or had been reduced to its **theoretical minimum risk exposure distribution (TMRED)**.

chronic disease: A disease that tends to be long lasting and persistent in its symptoms or development.

comparative risk assessment: The process for estimating the burden of disease attributable to selected risk factors. It involves five key steps: selection of risk-outcome pairs; estimation of exposure distribution; estimation of effect sizes; choice of theoretical minimum risk exposure level; and, finally, calculation of attributable burden.

confounding: A situation when an observed association is due, in whole or part, to a third factor that is associated both with the exposure and with the outcome of interest.

disability-adjusted life years (DALY): A year of healthy life lost, either through premature death or, equivalently, through living with disability due to illness or injury.

effect size: A statistical measure of the strength of the relationship between two variables (in this context, between a risk exposure and a disease outcome), expressed, for example, as a relative risk or odds ratio.

linked disease: A disease or condition on the causal pathway of the risk factor, and therefore more likely to develop if exposed to the risk.

population attributable fraction (PAF): For a particular risk factor and causally linked disease or injury, the percentage reduction in burden that would occur for a population if exposure to the risk factor was avoided or reduced to its theoretical minimum.

relative risk (RR): The risk of an event relative to exposure, calculated as the ratio of the probability of the event's occurring in the exposed group to the probability of its occurring in the non-exposed group. A relative risk of 1 implies no difference in risk; RR <1 implies the event is less likely to occur in the exposed group; RR >1 implies the event is more likely to occur in the exposed group.

relative standard error: The standard error expressed as a percentage of the estimate. This indicates the percentage of errors likely to have occurred due to sampling.

risk factor: Any factor that causes or increases the likelihood of a health disorder or other unwanted condition or event.

theoretical minimum risk exposure level: The risk factor exposure distribution that will lead to the lowest conceivable disease burden.

YLD (years lived with disability): A measure of the years of what could have been a healthy life that were instead spent in states of less than full health. This is also referred to as non-fatal burden.

YLL (years of life lost): A measure of the years of life lost due to premature mortality. This is also referred to as fatal burden.

References

ABS (Australian Bureau of Statistics) 2013. ABS cat no. 4364.0. Australian Health Survey: physical activity, 2011–12. Canberra: ABS.

ABS 2010. Measure of Australia's progress, 2010. ABS cat no. 1370.0. Canberra: ABS. Viewed: 14 June 2017, <http://www.abs.gov.au/ausstats/abs@.nsf/cat/1370.0>.

Ahlskog JE, Geda YE, Graff-Radford NR & Petersen RC 2011. Physical exercise as a preventive or disease-modifying treatment of dementia and brain aging. Mayo Clinic Proceedings 86:876–84.

AIHW (Australian Institute of Health and Welfare) 2015. Aboriginal and Torres Strait Islander Health Performance Framework 2014 report: detailed analyses. Cat. no. IHW 167. Canberra: AIHW.

AIHW 2016a. Australia's health 2016. Australia's health series no. 15. Cat. no. AUS 199. Canberra: AIHW.

AIHW 2016b. Australian Burden of Disease Study 2011: methods and supplementary material. Australian Burden of Disease Study series no. 5. Cat. no. BOD 6. Canberra: AIHW.

AIHW 2016c. Australian Burden of Disease Study: impact and causes of illness and death in Aboriginal and Torres Strait Islander people 2011. Australian Burden of Disease Study series no. 6. Cat. no. BOD 7. Canberra: AIHW.

AIHW 2016d. Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011. Australian Burden of Disease Study series no. 3. Cat. no. BOD 4. Canberra: AIHW.

AIHW 2016e. Contribution of vascular diseases and risk factors to the burden of dementia in Australia: Australian Burden of Disease Study 2011. Australian Burden of Disease Study series no. 9. Cat. no. BOD 10. Canberra: AIHW.

AIHW 2017a. Impact of overweight and obesity as a risk factor for chronic conditions: Australian Burden of Disease Study. Australian Burden of Disease Study series no. 11. Cat. no. BOD 12. Canberra: AIHW.

AIHW 2017b. Insufficient physical activity. Canberra: AIHW. Viewed 27 September 2017, <https://www.aihw.gov.au/reports/biomedical-risk-factors/risk-factors-to health/contents/insufficient-physical-activity>.

Bennell KL, Dobson F & Hinman RS 2014. Exercise in osteoarthritis: moving from prescription to adherence. Best Practice and Research: Clinical Rheumatology 28:93–117.

Beydoun MA, Beydoun HA, Gamaldo AA, Teel A, Zonderman AB & Wang Y 2014. Epidemiologic studies of modifiable factors associated with cognition and dementia: systematic review and meta-analysis. BMC Public Health 14:643.

Biswas A, Oh PI, Faulkner GE, Bajaj RR, Silver MA, Mitchell MS et al. 2015. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. Annals of Internal Medicine 162:123–32.

Blondell SJ, Hammersley-Mather R & Veerman JL 2014. Does physical activity prevent cognitive decline and dementia?: a systematic review and meta-analysis of longitudinal studies. BMC Public Health 14:510.

Buttar HS, Li T & Ravi N 2005. Prevention of cardiovascular diseases: role of exercise, dietary interventions, obesity and smoking cessation. Experimental and Clinical Cardiology 10:229–49.

de Bruijn RF, Schrijvers EM, de Groot KA, Witteman JC, Hofman A, Franco OH et al. 2013. The association between physical activity and dementia in an elderly population: the Rotterdam Study. European Journal of Epidemiology 28:277–83.

Department of Health 2014. Australia's Physical Activity and Sedentary Behaviour Guidelines. Canberra: Department of Health.

Devonshire-Gill KR & Norton K 2017. Australian Adult Physical Activity Sufficiency Trend Data: Positive, Prevalent and Persistent Changes 2002–2012. Journal of Physical Activity and Health 3:1–31.

Ding D, Lawson KD, Kolbe-Alexander TL, Finkelstein EA, Katzmarzyk PT, van Mechelen W et al. 2016. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. Lancet 388:1311–24.

Ekelund U, Steene-Johannessen J, Brown WJ, Fagerland MW, Owen N, Powell KE et al. 2016. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. Lancet 388:1302–10.

Forouzanfar MH, Alexander L, Anderson HR, Bachman VF, Biryukov S, Brauer M et al. 2013. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013: supplementary appendix. Lancet:1–721.

Fransen M, McConnell S, Harmer AR, Van der Esch M, Simic M & Bennell KL 2015. Exercise for osteoarthritis of the knee: a Cochrane systematic review. British Journal of Sports Medicine 49:1554–7.

Guure CB, Ibrahim NA, Adam MB & Said SM 2017. Impact of physical activity on cognitive decline, dementia, and its subtypes: meta-analysis of prospective studies. Biomed Research International 2017. doi:10.1155/2017/9016924.

Garriguet D, Tremblay S & Colley RC 2015. Comparison of physical activity adult questionnaire results with accelerometer data. Health Reports 26:11–17.

Hoegh Poulsen P, Biering K & Andersen JH 2016. The association between leisure time physical activity in adolescence and poor mental health in early adulthood: a prospective cohort study. BMC Public Health 16:3.

Jette M, Sidney K & Blümchen G 1990. Metabolic equivalents (METS) in exercise testing, exercise prescription, and evaluation of functional capacity. Clinical Cardiology 13(8):555–565.

Kjolhede T, Vissing K & Dalgas U 2012. Multiple sclerosis and progressive resistance training: a systematic review. Multiple Sclerosis 18:1215–28.

Kyu HH, Bachman VF, Alexander LT, Mumford JE, Afshin A, Estep K et al. 2016. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose-response meta-analysis for the Global Burden of Disease Study 2013. BMJ 354:i3857.

Lauzé M, Daneault J-F & Duval C 2016. The effects of physical activity in Parkinson's Disease: a review. Journal of Parkinson's Disease 6:685–98.

Leijon M et al. 2015. The longitudinal age and birth cohort trends of regular exercise among adults aged 16–63 years in Sweden: a 24-year follow-up study. Population Health Metrics 13:18.

Murray CJ, Ezzati M, Lopez AD, Rodgers A & Vander Hoorn S 2003. Comparative quantification of health risks conceptual framework and methodological issues. Population Health Metrics 1:1.

Pedersen BK & Saltin B 2015. Exercise as medicine—evidence for prescribing exercise as therapy in 26 different chronic diseases. Scandinavian Journal of Medicine and Science in Sports 25(Suppl. 3):1–72.

Sanchez-Villegas A, Ara I, Guillen-Grima F, Bes-Rastrollo M, Varo-Cenarruzabeitia JJ & Martinez-Gonzalez MA 2008. Physical activity, sedentary index, and mental disorders in the SUN cohort study. Medicine and Science in Sports and Exercise 40:827–34.

Schmid D, Behrens G, Keimling M, Jochem C, Ricci C & Leitzmann M 2015. A systematic review and meta-analysis of physical activity and endometrial cancer risk. European Journal of Epidemiology 30:397–412.

Schmid D & Leitzmann MF 2014. Television viewing and time spent sedentary in relation to cancer risk: a meta-analysis. Journal of the National Cancer Institute 106:7.

Sui X, Laditka JN, Church TS, Hardin JW, Chase N, Davis K et al. 2009. Prospective study of cardiorespiratory fitness and depressive symptoms in women and men. Journal of Psychiatric Research 43:546–52.

Teychenne M, Ball K & Salmon J 2008. Physical activity and likelihood of depression in adults: a review. Preventive Medicine 46:397–411.

Wolin KY, Yan Y, Colditz GA & Lee IM 2009. Physical activity and colon cancer prevention: a meta-analysis. British Journal of Cancer 100:611–16.

WCRF/AICR (World Cancer Research Fund/American Institute for Cancer Research) 2007. Food, nutrition, physical activity, and the prevention of cancer: a global perspective. Washington DC: AICR.

WHO (World Health Organization) 2017. Physical activity. Geneva: World Health Organization. Viewed 23 May 2017, <http://www.who.int/dietphysicalactivity/pa/en/>.

WHO 2013. Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013–2020. Geneva: WHO.

Wu Y, Zhang D & Kang S 2013. Physical activity and risk of breast cancer: a meta-analysis of prospective studies. Breast Cancer Research and Treatment 137:869–82.

List of tables

Table 2.1: Comparison of physical activity components in this study and components in Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults 9

Table 3.1: Proportion of population in each activity category and sex, 2011 12

Table 3.2: Burden (DALY) attributable to physical inactivity, by sex, 2011 13

Table 3.3: Burden (DALY) due to physical inactivity, by linked disease and sex, 2011 14

Table 3.4: Burden (DALY) attributable to physical inactivity due to fatal and non-fatal burden, by sex, 2011 15

Table 3.5: Number and proportion of disease burden due to physical inactivity (attributable DALY), by linked disease, 2011..... 18

Table 3.6: Proportion (%) of attributable burden (DALY), by activity level and sex, 2011..... 19

Table 3.7: Comparison of burden (DALY) attributable to physical inactivity, using different exposure definitions, by sex, 2011..... 19

Table 3.8: Burden (DALY) attributable to physical inactivity and overweight and obesity combined, by sex, 2011 21

Table 4.1: Burden (DALY) attributable to physical inactivity, by socioeconomic group, 2011 22

Table 5.1: Proportion (%) of population, by activity level and sex, 2011 25

Table 5.2: Comparison of burden (DALY) attributable to physical inactivity, 2003 and 2011 . 26

Table 5.3: Comparison of age-standardised DALY rates attributable to physical inactivity, 2003 and 2011 26

Table 6.1: Comparison of the proportion in each activity category, under the *Stable rate* and *Targeted activity scenarios,* compared with the *Trend rate scenario,* 2020 30

Table 6.2: Comparison of the proportion in each activity category, under the *Stable rate* and *Targeted activity scenarios,* compared with the *Trend rate scenario,* by broad age group*,* 2020..... 32

Table 6.3: Comparison of projected burden due to physical inactivity in 2020..... 33

Table A1: Intensity factors used to calculate METs 43

Table B1: Relative risks and sources for linked diseases 46

Table C1: Number and proportion of disease burden due to physical inactivity (attributable DALY), by linked disease, by sex, 2011 49

Table C2: Burden (DALY) due to physical inactivity by socioeconomic group, by sex, 2011 49

Table C3: Changes in age-specific DALY rate (per 1,000 persons) by socioeconomic group and age, 2011..... 50

List of figures

Figure 3.1: Burden (DALY and DALY rate per 1,000 persons) attributable to physical inactivity, by age and sex, 2011 13

Figure 3.2: Burden (DALY) due to physical inactivity, by sex and linked disease, 2011 14

Figure 3.3: Burden attributable to physical inactivity due to fatal and non-fatal burden, by age, males (a) and females (b), 2011 15

Figure 3.4: Burden attributable to physical inactivity, by age, sex and linked disease, DALY (a) and proportion within each age group DALY (b), 2011 17

Figure 3.5: Proportion of linked disease burden (DALY) due to physical inactivity, by sex, 2011 18

Figure 3.6: Comparison of burden attributable to physical inactivity under different definitions, by age, males (a) and females (b), 2011 20

Figure 3.7: Burden (DALY, and DALY rate per 1,000 persons) attributable to physical inactivity and overweight and obesity combined, by age and sex, 2011 21

Figure 4.1: Age-standardised DALY rate (per 1,000 persons) due to physical inactivity, by socioeconomic group and sex, 2011 23

Figure 4.2: Age-specific DALY rate (per 1,000 persons) due to physical inactivity, by socioeconomic group and age, males (a) and females (b), 2011 24

Figure 4.3: Age-standardised DALY rate (per 1,000 persons) of linked diseases attributable to physical inactivity, by socioeconomic group, 2011 24

Figure 5.1: Burden (Daly number and DALY rates per 1,000 persons) attributable to physical inactivity, by age, 2003 and 2011 27

Figure 5.2: Comparison of attributable burden (DALY and age-specific DALY rate) in 2011 and 2003, males (a) and females (b), 2011 27

Figure 5.3: Age-standardised attributable DALY rate per 1,000 persons for diseases linked to physical inactivity, 2003 and 2011 28

Figure 6.1: Burden (DALY) due to physical inactivity by age, under the *Trend rate, Stable rate* and *Targeted activity scenarios*, 2020 34

Figure 6.2: Burden (DALY) due to physical inactivity that could be avoided under the *Targeted activity scenarios* (extra 15, 30 and 60 minutes of brisk walking), by age, 2020 34

Related publications

This report *Impact of physical inactivity as a risk factor for chronic conditions* and other AIHW publications can be downloaded for free from the AIHW website <http://www.aihw.gov.au>.

The website also includes information on ordering printed copies.

The following related AIHW publications might also be of interest:

- AIHW 2016. Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011. Australian Burden of Disease Study series no. 3. Cat. no. BOD 4. Canberra: AIHW.
- AIHW 2016. Australian Burden of Disease Study 2011: methods and supplementary material. Australian Burden of Disease Study series no. 5. Cat. no. BOD 6. Canberra: AIHW.
- AIHW 2017. Impact of overweight and obesity as a risk factor for chronic conditions: Australian Burden of Disease Study. Australian Burden of Disease Study series no. 11. Cat. no. BOD 12. Canberra: AIHW.

This report details the impact of physical inactivity on disease burden in the Australian population. Results from this study suggest that prevention and intervention efforts may best be focused on sustained population-level increases in physical activity, by as little as 15 minutes each day, to avoid associated disease burden. It also highlights that health inequalities exist, with lower socioeconomic groups experiencing larger rates of disease burden due to physical inactivity.

aihw.gov.au

AIHW

Stronger evidence,
better decisions,
improved health and welfare