




OBESITY: SEDENTARY BEHAVIOURS AND HEALTH

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This evidence brief forms part of the Australian National Preventive Health Agency's evidence brief series which aims to disseminate information and inform dialogue relating to high priority preventive health issues.

This evidence brief was prepared by The Boden Institute of Obesity, Nutrition, Exercise & Eating Disorders and the Menzies Centre for Health Policy, University of Sydney for the Australian National Preventive Health Agency.

This brief is written in plain English to appeal to a wide audience. A more detailed technical paper supports the evidence presented in this brief and is available upon request from ANPHA@anpha.gov.au

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EVIDENCE BRIEF

OBESITY:
SEDENTARY BEHAVIOURS
AND HEALTH

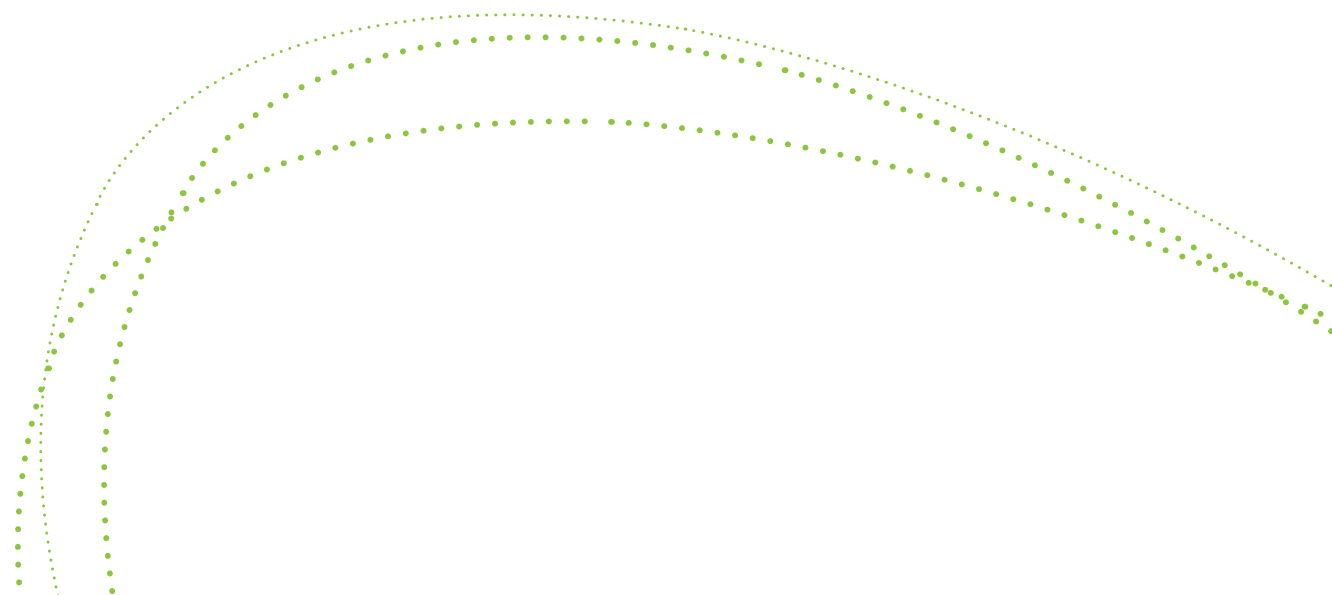
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CONTENTS

Summary	1
What is Sedentary Behaviour?	2
Sedentary, active or both?	2
How much time do we spend being sedentary?	3
Adults	3
Children	5
Trends	6
What are the health effects of being too sedentary?	7
Adults	7
Children	7
What influences how sedentary we are?	8
Adults	8
Children	8
Can we reduce sedentary time?	9
Adults	9
Children	9
What we need to understand better	10
Conclusion	11
References	12



SUMMARY

- Sedentary behaviour describes the behaviours of sitting or lying down while awake. This includes sitting while watching TV, driving a car, working at a desk, doing schoolwork, and sitting and using a computer or mobile device
- Sedentary behaviour is not the opposite of physical activity. Sitting and physical inactivity are independent risk factors for chronic disease. It is possible to be active and meet the 150-300 minutes/week guideline for moderate intensity activity, and still sit too much
- Australians are sedentary for 50-70% of their waking hours, or 8-12 hours per day
- Sitting for prolonged periods each day, no matter what else people do, impairs health. Too much sitting is associated with higher mortality rates and with developing diabetes and other chronic diseases
- Encouraging people to sit less is likely to reduce their risk of developing chronic diseases
- People who sit for prolonged periods are more likely to be overweight or obese. This may be because overweight people sit more, or whether sitting more leads to weight gain, or both
- For adults, evidence suggests it is appropriate to encourage less sedentary behaviour. Being sedentary for more than 11 hours a day impairs health, and that the cut-off point for risk may be as low as 7 or 8 hours a day
- For children, evidence supports that spending more than two hours a day in front of screens is damaging to health. Some of this negative health effect comes through prolonged sitting, and some through the poor diet that may be associated with watching TV
- Time spent in sitting/sedentary behaviours seems to be increasing due to changes in patterns of work and transport and to increases in the use of technology at work, in education and leisure
- There are two approaches to reducing sedentary time – being sedentary for less total time each day or interrupting sedentary time. It is not yet clear whether one approach is better than the other
- Research is in the early stage of understanding the importance for health of sedentary behaviour and knowing how best to address it

**BEING
SEIDENTARY
MORE THAN
11 HOURS
IMPARES
HEALTH**

An illustration of a grey office chair with a black seat and backrest, positioned to the right of the text. Below the chair, there is a small clock face with a white background and black hands, integrated into the letter 'O' of '11 HOURS'.

WHAT IS SEDENTARY BEHAVIOUR?

Formally, sedentary behaviour is any waking behaviour characterised by a low expenditure of energy while in a sitting or reclining posture.¹ It is one of the four states of activity into which the day can be divided:

- sleeping
- sedentary time
- light activity, which involves moving but not sweating (such as walking, gardening, riding a bike slowly and sports such as bowls or swimming)
- health-enhancing moderate to vigorous intensity physical activity (such as running, brisk walking, climbing stairs and sports such as netball and football)

Informally, sedentary behaviour generally refers to sitting.

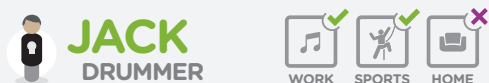
Contemporary life in many countries comprises a vast number of daily activities requiring sitting – working at a desk, sitting in school, reading a newspaper, watching TV, eating a meal, interacting through social media, driving a car, sitting on the train and more.

But being sedentary is not simply the opposite of being active. Some people sit for 12 hours a day, and then are physically active for an hour at night. They are classified as sedentary but they also meet the national guidelines for ‘sufficient physical activity’. The issue of sedentary behaviour is an independent issue in its own right, with its own health risks.

Sedentary, active or both?



Connie works as a waitress, on her feet and moving all day. When she gets home, she cooks dinner then hits the couch for a night of TV. While she has low daily sitting time, she does not engage in much health-enhancing physical activity.



Jack is a drummer in a rock band. He sits most of evening, but uses up a lot of energy banging the drums. His other passion is mountain-climbing, and he trains most days. He is both ‘highly physically active’ and also ‘not sedentary’.



Suu Kim is a finance analyst. She rarely leaves her desk, but stops for an hour at the gym each night. She spends a lot of time sitting, but is also physically active.

Australia’s Physical Activity and Sedentary Guidelines recommend that children and adults should minimise the amount of time spent in prolonged sitting and being sedentary everyday.²

HOW MUCH TIME DO WE SPEND BEING SEDENTARY?

Australians typically spend between 50-70% of their waking hours being sedentary.³

Adults

Most adults spend about 8-12 hours per day being sedentary out of an average of 16 waking hours.⁴⁻⁷ Although, we typically report 5-6 hours, total sitting time is usually under-estimated.⁸⁻¹⁰ Most of the rest of the time is spent in light activity, which is mostly spent standing. “Moderate to vigorous physical activity”, which is of sufficient intensity to improve health and fitness, makes up very little of a typical adult’s time (Figure 1).

AUSTRALIANS ARE SEDENTARY



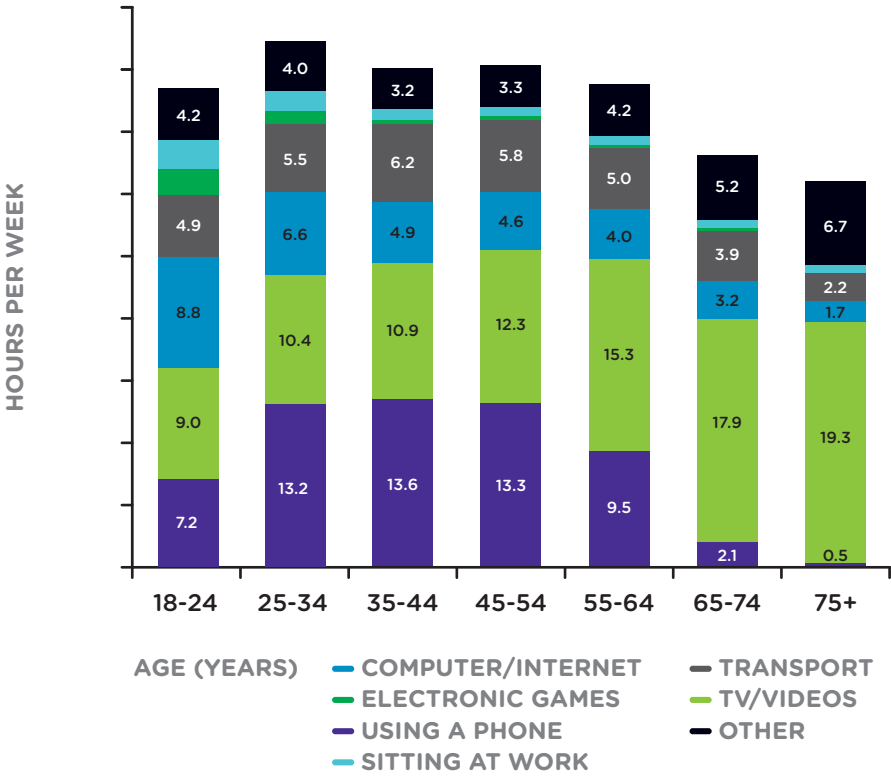
FIGURE 1: TYPICAL BREAKDOWN OF AN AUSTRALIAN ADULT’S WAKING HOURS



Source: Healy et al 2008, AusDiab study

Sitting at work or in educational settings and watching TV are the main ways Australians spend time being sedentary. Being on the internet and playing electronic games (e-games) also contribute, especially for people aged 18-24. Watching TV dominates the sedentary behaviours of those over 65¹¹ (Figure 2). Adults spend an average of 5.2 hours per week sitting for transport, slightly higher among those aged 35-44 and slightly lower among those over the age of 65.

FIGURE 2: AVERAGE TIME SPENT IN DIFFERENT FORMS OF SEDENTARY BEHAVIOUR



Source: Data from the Australian Health Survey: Physical Activity, 2011–12.
 Note: Other includes sitting or lying down to do other social or leisure activities

Children

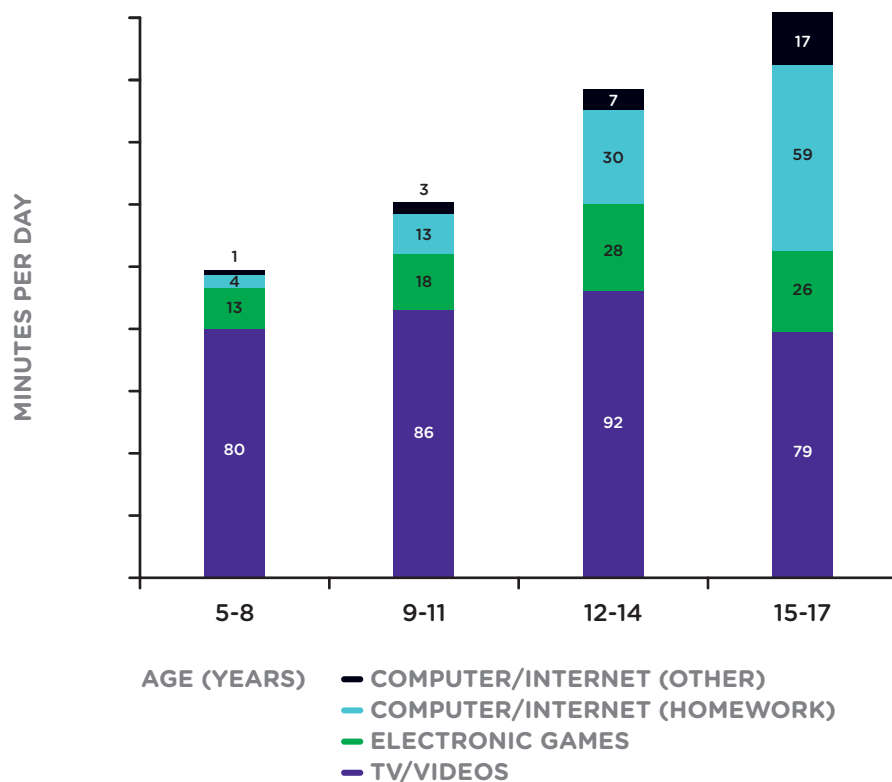
Compared with adults, children spend less time sitting. Among children 6-11 years of age, the average sitting time is 7-8 hours. However, time spent sitting increases with age and a 17-18 year old may spend as much time sitting as an adult.^{4,7,12-14}

Research has focussed on what is called screen time, which includes watching TV, playing e-games and using tablets and smartphones (Figure 3). Children in Australia spend an average of 2-4 hours per day in front of screens,^{15,16} with younger children spending less time in front of screens than teenagers, which is similar to data from many other countries.¹⁷ Screen time is higher on weekends than on weekdays.

Time spent watching TV varies little by age and gender. Boys spend more time than girls on e-games. Time spent on the internet increases with age. Travelling to and from school contributes to sedentary time for an increasing number of children. It is estimated that over three quarters of Australian schoolchildren aged 5-14 are driven to and from school.¹⁸

Australian children who are socioeconomically disadvantaged report more screen time than those who have higher incomes, and **urban children are more sedentary than rural children**.¹⁶

FIGURE 3: TIME SPENT ON SEDENTARY SCREEN-BASED ACTIVITY (CHILDREN AND ADOLESCENTS)



Source: Data from the Australian Health Survey: Physical Activity, 2011-12. Note: Computer/internet (other) excludes electronic games

Trends

There are single surveys that have started to describe sedentary behaviours at the national level, but no Australian data are yet available that monitor trends in sedentary behaviour. However previous research in Australia, Norway and the USA indicates that people are spending substantially more time sitting when this is tracked over the past four decades.

Adults

Overall, the amount of energy Australians adults expend each day is slowly declining.^{19,20} Sedentary leisure time among Australian adults increased slightly between 1992 and 2006, probably due to increases in time spent sitting for transport and in front of screens.^{21,22}

These trends reflect widespread changes in society. Fifty years ago most people used a lot of energy at work, doing household chores and getting from one place to another.^{20,23} Car travel, computers, automation and labour-saving devices have changed our daily patterns of activity, meaning people spend less energy each day just living.

Also, fewer people work in agriculture and manufacturing, and more in service-related and financial industries, meaning people spend less energy at work. A change in society, along with personal preference, has meant that many people drive instead of walking or cycling.

Children

Children are becoming more sedentary. In NSW, boys spent slightly more time being sedentary in 2010 than in 2004. There was no change for girls.¹⁶

There has been a steep decline over the past 30 years in the proportion of Australian children who walk or ride their bikes to school,²⁴ with many more children being driven to school.¹⁶

Time spent watching TV is declining slightly among young people, but is being replaced by a rise in internet, social media and e-games use over the past 20 years.²⁵

WHAT ARE THE HEALTH EFFECTS OF BEING TOO SEDENTARY?

There is emerging evidence that being too sedentary has negative health effects. These occur because sitting for long periods results in reduced use of the large muscles in the back, trunk and legs. These large muscles consume much of the body's intake of sugars and fats. So not using these muscles when sitting down, means there are higher than normal levels of blood glucose and fats,^{26,27} increasing risk of a range of health conditions.

Adults

People who spend too much time being sedentary have a higher mortality rate than people who are less sedentary, and are more likely to develop type 2 diabetes and cardiovascular disease.²⁸⁻³²

Prolonged periods being sedentary increases the risk of dying early³³ and developing diabetes.³⁴⁻³⁸

People who sit for prolonged periods are more likely to be overweight than others.^{29,31,39-44} However, it is not clear whether being sedentary causes a person to become overweight, or whether overweight people are sedentary for longer periods than non-overweight people, or whether both are true.⁴⁵⁻⁴⁹

These increased risks of sedentary behaviour, death, diabetes, cardiovascular disease and possibly becoming overweight, seem to be independent of whether a person is physically active or not.⁵⁰ They also seem to be independent of other risk factors for chronic disease such as smoking, alcohol use and level of education.⁵¹

Sitting for prolonged periods each day, no matter what else people do, impairs health.

Evidence suggests that being sedentary for more than 11 hours a day impairs health and it is possible that being sedentary for more than 8 hours a day impairs health. As this is an emerging area of research, it is not yet clear whether it is best to reduce the total amount of sitting time⁵² or to interrupt sitting time by 2-3 minutes per hour⁵³ or both. However, it is clear that we need to reduce our sitting time.

Children

Children who are sedentary for prolonged periods are less fit than others.^{17,54-56} In addition, too much screen time is associated with being overweight and obese.⁵⁴⁻⁵⁸ Some studies have found that cholesterol and blood pressure are also higher among sedentary children than among those who are less sedentary.¹⁷

It is known that spending more than 2 hours per day in front of screens impairs children's health, and the Australian physical activity and sedentary guidelines reflect this.² Some of this health effect comes through being sedentary, and some through the poor diet that is often associated with watching TV. It is likely that being sedentary as a child sets up patterns of this behaviour that will lead to poorer health in adult life.

There is emerging evidence that too much screen time affects other aspects of child development and is associated with low self-esteem, poor social behaviours, poor results at school and slower development of the brain.^{17,55,56}

WHAT INFLUENCES HOW SEDENTARY WE ARE?

Adults

Many factors influence how much we sit. They can be grouped broadly into:

- individual factors
- occupational factors
- physical environment
- societal trends
- other

Individual factors include:

- age – younger adults (around 18) and older adults (>65) report the highest amounts of daily sedentary behaviour
- gender – males before age 30 years are more sedentary than females, but this pattern may be reversed after the age of 60
- poor health – having a chronic illness is associated with increased levels of sedentary behaviour
- education – adults with higher levels of education are the most sedentary due to sitting at work

Occupational factors include the type of work and the organisation of the workplace. For example, people in occupations that require desk-based or computer work generally sit more than those in service industries, with manual labourers and farm workers sitting even less.

The physical environment includes issues such as low residential density, poorly connected streets and limited land use diversity,⁵⁹⁻⁶¹ limited public transport⁶¹ and lower population density,⁶² which probably contribute to increased TV viewing and car use.⁶³

Societal trends include the move towards urbanisation, car use, mechanisation and the increasing use of technology for everyday tasks that involve sitting.

Fundamental changes to the pattern of family life due to work commitments, the need for care outside of the home and the lowering of the age range for early childhood education has resulted in a reduced tolerance of children having a 'freer range' of independent mobility.⁶⁴ Parental concern about safety and stranger danger may have also contributed to reduced walking or cycling to school.^{65,66}

Children

For children, much of the research has focused on time spent viewing TV and other screen time. It is clear that children are strongly influenced by their parents' behaviour around TV. Parents who watch a lot of TV and who have it on during meals are likely to have children who watch a lot of TV. Children with TVs or computers in their bedroom are likely to use them more than the recommended limit of 2 hours per day.² Also, households with rules around restricting TV viewing have children who watch less TV.

But there is a lot more to understand about what influences children, such as the environment in which they live, and the importance of the behaviour of their parents and friends.

CAN WE REDUCE SEDENTARY TIME?

It is clear from the research that sedentary time should be reduced,^{17,21,67} and that it would have health benefits. It is also clear that it can be reduced, although it is not yet clear about the best ways to do this. While research is in the early stages, there are some promising results.

Adults

Most research in adults has been carried out in workplaces, partly because they are readily modifiable.⁶¹ One approach has been to use adjustable sit-stand workstations, in which workers can raise or lower their desks depending on whether they want to stand or sit.^{68,69} A second approach is to use computer-based reminders to encourage workers to get up and walk around every hour or two.^{70,71} Other approaches use offices designed to encourage standing and light activity.⁷²

There has been some research on reducing sedentary behaviour in adults in home environments using individualised behaviour-change programs,⁷³ although it may be more difficult to reduce sedentary behaviours in this setting.

There has been some initial success in reducing sedentary time, particularly in workplace environments. However definitive recommendations are not possible at this time since few interventions have been tried in non-work environments, or have assessed the duration of effect.

Children

Most research regarding children's sedentary behaviour has been done in homes.¹⁷ In general, rules around TV viewing and computer use reduce screen time,¹⁶ and support from electronic timers has been useful in reducing screen time.^{74,75}

Results from research in schools⁷⁶⁻⁷⁸ and pre-school settings⁷⁹ have been mixed, with no single approach showing consistent positive results.

Overall, while many studies have shown that it is possible to reduce the time children spend being sedentary, research does not provide consistent guidance on how best to do this.

WHAT WE NEED TO UNDERSTAND BETTER

There is much we need to understand better. It is clear that being sedentary harms health, but there are many outstanding questions which include:

- How much sedentary time each day is acceptable before it becomes harmful?
- Does this threshold differ for different groups of people and at different ages?
- Does being physically active counteract the effects of being sedentary?
- Does being sedentary contribute to conditions like osteoporosis, mental health issues and some types of cancer?
- How could sitting time be reduced at work without compromising productivity?
- How can we increase population levels of active travel to work and school, and encourage adults and children to walk more or cycle, rather than using a car?

There are no data for Aboriginal and Torres Strait Islander adults or children on sedentary behaviours, nor for culturally and linguistically diverse populations and these data should be collected in future population surveys.

In terms of trends, we need to understand better how people spend their time each day, and regularly follow the changes in that use of time.

CONCLUSION

Although the concept of sedentary behaviour is still relatively new, measurement of sedentary behaviour is possible and it is clear that Australians, both adults and children, spend considerable time being sedentary. Changes in society are driving us towards being more sedentary. **Reversing these trends would be beneficial for individual and population health.**

Although the exact point when sedentary behaviour starts to become harmful is not known, there is little doubt that encouraging people to be less sedentary would reduce the risk of sedentary behaviour related chronic disease risks.

Policies developed to reduce sedentary behaviours should take into account the range of factors that encourage them, including individual, societal, occupational and the physical environmental factors. Examples include changing the physical environment to encourage more people to walk, ride bikes and use public transport.

Clear and appropriate evidence-based guidelines exist around screen time for children. As research and more evidence is accumulated it will be possible to provide specific guidance around sedentary time for both adults and children. The key challenge is implementing large scale interventions and policies that address the risks posed by sedentary behaviours.



REFERENCES

1. Sedentary Behaviour Research, N. Letter to the editor: standardized use of the terms “sedentary” and “sedentary behaviours. *Appl Physiol Nutr Metab* 2012 37(3): 540-542.
2. Australian Department of Health (2014). Australia’s Physical Activity and Sedentary Guidelines for Australians. Department of Health. Canberra Available from: <http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines#apaadult>. Accessed 24.03.14.
3. Healy GN, Wijndaele K, et al. Objectively measured sedentary time, physical activity, and metabolic risk: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Diabetes Care* 2008 31(2): 369-371.
4. Matthews CE, Chen KY, et al. Amount of time spent in sedentary behaviors in the United States, 2003-2004. *Am J Epidemiol* 2008 167(7): 875-881.
5. Hagstromer M, Ainsworth BE, et al. Comparison of a subjective and an objective measure of physical activity in a population sample. *J Phys Act Health* 2010 7(4): 541-550.
6. Healy GN, Matthews CE, et al. Sedentary time and cardio-metabolic biomarkers in US adults: NHANES 2003-06. *Eur Heart J* 2011 32(5): 590-597.
7. Spittaels H, Van Cauwenberghe E, et al. Objectively measured sedentary time and physical activity time across the lifespan: a cross-sectional study in four age groups. *Int J Behav Nutr Phys Act* 2012 9: 149.
8. Miller R, Brown W. Steps and sitting in a working population. *Int J Behav Med* 2004 11(4): 219-224.
9. Bauman A, Ainsworth BA, et al. The descriptive epidemiology of sitting. A 20-country comparison using the International Physical Activity Questionnaire (IPAQ). *Am J Prev Med* 2011 41(2): 228-235.
10. Bennie JA, Chau JY et al. The prevalence and correlates of sitting in European adults - a comparison of 32 Eurobarometer-participating countries. *Int J Behav Nutr Phys Act* 2013 10(1): 107.
11. Australian Bureau of Statistics. Australian Health Survey (2011-13). Australian Health Survey: Physical Activity. Canberra, ACT, <http://www.abs.gov.au/ausstats/abs@.nsf/mf/4364.0.55.004>.
12. Steele RM, van Sluijs EM, et al. An investigation of patterns of children’s sedentary and vigorous physical activity throughout the week. *Int J Behav Nutr Phys Act* 2010 7: 88.
13. Nilsson A, Andersen LB, et al. Correlates of objectively assessed physical activity and sedentary time in children: a cross-sectional study (The European Youth Heart Study) 2009 *BMC Public Health* 9: 322.
14. Mitchell JA, Pate RR et al. A prospective study of sedentary behavior in a large cohort of youth. *Med Sci Sports Exerc* 2012 44(6): 1081-1087.
15. Hardy LL, Dobbins TA, et al. Descriptive epidemiology of small screen recreation among Australian adolescents. *J Paediatr Child Health* 2006 42(11): 709-714.
16. Hardy L, King L et al, 2010 NSW Schools Physical Activity and Nutrition Survey (SPANS)-Full Report. N. M. o. Health. Sydney. Available from: http://www0.health.nsw.gov.au/pubs/2011/pdf/spans_full.pdf
17. Salmon J, Tremblay MS et al. Health risks, correlates, and interventions to reduce sedentary behavior in young people. *Am J Prev Med* 2011 41(2): 197-206.
18. van der Ploeg HP, Merom D, et al. Trends in Australian children traveling to school 1971-2003: burning petrol or carbohydrates? *Prev Med* 2008 46(1): 60-62.

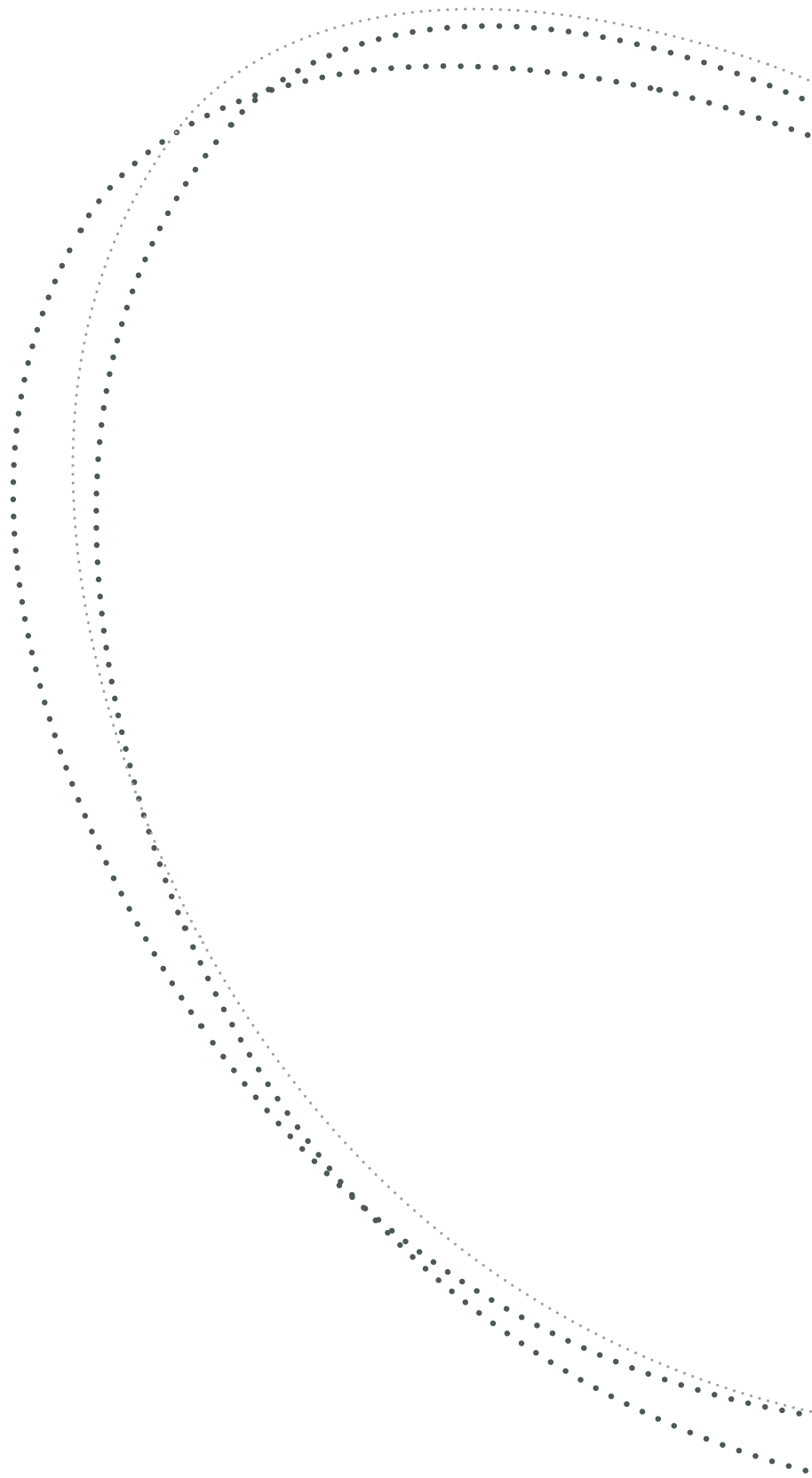
19. Bauman A, Allman-Farinelli M, et al. Leisure-time physical activity alone may not be a sufficient public health approach to prevent obesity--a focus on China. *Obes Rev* 2008 9 Suppl 1: 119-126.
20. Church TS, Thomas DM et al. Trends over 5 decades in U.S. occupation-related physical activity and their associations with obesity. *PLoS One* 2011 6(5): e19657.
21. Chau JY, der Ploeg HP et al. Are workplace interventions to reduce sitting effective? A systematic review. *Prev Med*. 2010 Nov;51(5):352-6. doi: 10.1016/j.ypmed.2010.08.012. Epub 2010 Aug 27.
22. Chau JY, Merom D et al. Temporal trends in non-occupational sedentary behaviours from Australian Time Use Surveys 1992, 1997 and 2006. *Int J Behav Nutr Phys Act* 2012 9: 76.
23. Graff-Iversen S, Skurtveit S, Sørensen M, Nybo A. What are the associations between occupational physical activity and overweight?]. *Tidsskr Nor Lægeforen* 2001; 121: 2579–2583.
24. Salmon J, Timperio A et al. Trends in children's physical activity and weight status in high and low socio-economic status areas of Melbourne, Victoria, 1985-2001. *Aust N Z J Public Health* 2005 29(4): 337-342.
25. ABS - 2012 Survey of Children's Participation in Cultural and Leisure Activities. Available from: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4901.0.55.0012000%20to%202009?OpenDocument>
26. Hamilton M, Hamilton DG et al. Role of low energy expenditure and sitting in obesity, metabolic syndrome, type 2 diabetes, and cardiovascular disease. *Diabetes* 2007 56(11): 2655-2667.
27. Bergouignan A, Rudwill F, et al. Physical inactivity as the culprit of metabolic inflexibility: evidence from bed-rest studies. *J Appl Physiol* 2011 111(4): 1201-1210.
28. DCCR Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and Complications Trial Research Group. *N Engl J Med* 1993 329(14): 977-986.
29. Proper KI, Singh AS et al. Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies. *Am J Prev Med* 2011 40(2): 174-182.
30. Thorp AA, Owen N et al. Sedentary behaviors and subsequent health outcomes in adults a systematic review of longitudinal studies, 1996-2011. *Am J Prev Med* 2011 41(2): 207-215.
31. Wilmot EG, Edwardson CL, et al. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: Systematic review and meta-analysis. *Diabetologia* 2012 55(11): 2895-2905.
32. Bauman A, Chau JY, et al. Too Much Sitting and Cardio-Metabolic Risk: An Update of Epidemiological Evidence. *Current Cardiovascular Risk Reports* 2013 7(4): 293-298.
33. Dunstan DW, Barr EL, et al. Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation* 2010 121(3): 384-391.
34. Hu FB, Leitzmann MF et al. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. *Arch Intern Med* 2001 161(12): 1542-1548.
35. Hu FB, Li TY, et al. Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA* 2003 289(14): 1785-1791.
36. Krishnan S, Rosenberg L et al. Physical activity and television watching in relation to risk of type 2 diabetes: the Black Women's Health Study. *Am J Epidemiol* 2009 169(4): 428-434.
37. Matthews CE, George SM et al. Amount of time spent in sedentary behaviors and cause-specific mortality in US adults. *Am J Clin Nutr* 2012 95(2): 437-445.
38. Grøntved A, Hu FB. Television viewing and risk of type 2 diabetes, cardiovascular disease, and all-cause mortality. *JAMA: the journal of the American Medical Association* 2011 305(23), 2448.

39. Gomez-Cabello A, Pedrero-Chamizo R et al. Sitting time increases the overweight and obesity risk independently of walking time in elderly people from Spain. *Maturitas* 2012 73(4): 337-343.
40. Shuval K, Leonard T et al. Sedentary Behaviors and Obesity in a Low-Income, Ethnic-Minority Population. *Journal of Physical Activity & Health* 2013 10(1): 132-136.
41. Sugiyama T, Healy GN et al. Joint associations of multiple leisure-time sedentary behaviours and physical activity with obesity in Australian adults. *Int J Behav Nutr Phys Act* 2008 5: 35.
42. Banks E, Lim L et al. Relationship of obesity to physical activity, domestic activities, and sedentary behaviours: cross-sectional findings from a national cohort of over 70,000 Thai adults. *BMC Public Health* 2011 11: 762.
43. Mummery WK, Schofield GM et al. Occupational sitting time and overweight and obesity in Australian workers. *Am J Prev Med* 2005 29(2): 91-97.
44. Chau JY, van der Ploeg HP et al. A tool for measuring workers' sitting time by domain: the Workforce Sitting Questionnaire. *British Journal of Sports Medicine* 2011 45(15): 1216-1222.
45. Brown WJ, Williams L et al. Identifying the energy gap: magnitude and determinants of 5-year weight gain in midage women. *Obes Res* 2005 13(8): 1431-1441.
46. Ekelund U, Brage S et al. Time spent being sedentary and weight gain in healthy adults: reverse or bidirectional causality? *Am J Clin Nutr* 2008 88(3): 612-617.
47. Pulsford RM, Stamatakis E et al. Sitting Behavior and Obesity Evidence from the Whitehall II Study. *American Journal of Preventive Medicine* 2013 44(2): 132-138.
48. De Cocker KA, van Uffelen JG et al. Associations between sitting time and weight in young adult Australian women. *Prev Med* 2010 51(5): 361-367.
49. van Uffelen JG, Watson MJ et al. Sitting time is associated with weight, but not with weight gain in mid-aged Australian women. *Obesity (Silver Spring)* 2010 18(9): 1788-1794.
50. Katzmarzyk PT, Church TS et al. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci Sports Exerc* 2009 41(5): 998-1005.
51. Chau JY, Grunseit AC, et al. Daily Sitting Time and All-Cause Mortality: A Meta-Analysis. *PLoS One* 2013, 8(11), e80000.
52. Stephens BR, Granados K et al. Effects of 1 day of inactivity on insulin action in healthy men and women: interaction with energy intake. *Metabolism* 2011 60(7): 941-949.
53. Dunstan DW, Kingwell BA et al. Breaking up prolonged sitting reduces postprandial glucose and insulin responses. *Diabetes Care* 2012 35(5): 976-983.
54. Aires L, Andersen LB et al. A 3-year longitudinal analysis of changes in fitness, physical activity, fatness and screen time. *Acta Paediatr* 2010 99(1): 140-144.
55. Tremblay S, Colley R et al. Physiological and health implications of a sedentary lifestyle. *Appl. Physiol. Nutr. Metab* 2010 35: 725-740.
56. Tremblay MS, LeBlanc AG et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act* 2011 8: 98.
57. Hardy LL, Grunseit A et al. Co-occurrence of obesogenic risk factors among adolescents. *J Adolesc Health* 2012 51(3): 265-271.
58. Hardy LL, King L et al. Weight status and weight-related behaviors of children commencing school. *Prev Med* 2012 55(5): 433-437.
59. Sugiyama T, Salmon J et al. Neighborhood walkability and TV viewing time among Australian adults. *Am J Prev Med* 2007 33(6): 444-449.

60. Sugiyama T, Ding D et al. Commuting by car: weight gain among physically active adults. *Am J Prev Med* 2013 44(2): 169-173
61. Bento AM, Cropper ML et al. The Effects of Urban Spatial Structure on Travel Demand in the United States. *Review of Economics and Statistics* 2005 87(3): 466-478.
62. Cao X. Disentangling the influence of neighborhood type and self-selection on driving behavior: an application of sample selection model. *Transportation* 2009 36(2): 207-222.
63. Owen NT, Sugiyama T et al. Adults' sedentary behavior determinants and interventions. *Am J Prev Med* 2011 41(2): 189-196.
64. Zubrick SR, Wood L, Villanueva K, Wood G, Giles-Corti B, and Christian H (2010), Nothing but fear itself: parental fear as a determinant of child physical activity and independent mobility, Victorian Health Promotion Foundation (VicHealth), Melbourne.
65. Timperio A, Ball K et al. Personal, Family, Social, and Environmental Correlates of Active Commuting to School. *Am J Prev MeD* 2006 30(1), 45-51.
66. Timperio A, Crawford D et al. Perceptions about the local neighbourhood and walking and cycling among children. *Preventive Medicine* 2004 38(1), 39-47.
67. Liao Y, Liao J, et al. Which type of sedentary behaviour intervention is more effective at reducing body mass index in children? A meta-analytic review. *Obesity Reviews* 2013. Article first published online: 25 SEP 2013 DOI: 10.1111/obr.12112
68. Alkhajah TA, Reeves MM et al. Sit-stand workstations: a pilot intervention to reduce office sitting time." *Am J Prev Med* 2012 3(3): 298-303.
69. Pronk NP, Katz AS et al. Reducing occupational sitting time and improving worker health: the Take-a-Stand Project, 2011. *Prev Chronic Dis* 2012 9: E154.
70. Evans RE, Fawole HO et al. Point-of-choice prompts to reduce sitting time at work: a randomized trial. *Am J Prev Med* 2012 43(3): 293-297.
71. Cooley D, Pedersen S. A pilot study of increasing nonpurposeful movement breaks at work as a means of reducing prolonged sitting. *J Environ Public Health* 2013: Volume 2013, Article ID 128376, <http://dx.doi.org/10.1155/2013/128376>
72. Gorman E, Ashe MC et al. Does an 'activity-permissive' workplace change office workers' sitting and activity time? *PLoS One* 2013 8(10): e76723.
73. Gardiner PA, Eakin EG et al. Feasibility of reducing older adults' sedentary time." *Am J Prev Med* 2011 41(2): 174-177.
74. Epstein LH, Paluch RA et al. The effect of reinforcement or stimulus control to reduce sedentary behavior in the treatment of pediatric obesity. *Health Psychol* 2004 23(4): 371-380.
75. Roemmich JN, Epstein LH et al. Association of access to parks and recreational facilities with the physical activity of young children. *Prev Med* 2006 43(6): 437-441.
76. Salmon J, Ball K et al. Outcomes of a group-randomized trial to prevent excess weight gain, reduce screen behaviours and promote physical activity in 10-year-old children: switch-play. *Int J Obes (Lond)* 2008 32(4): 601-612.
77. Salmon J, Jorna M et al. A translational research intervention to reduce screen behaviours and promote physical activity among children: Switch-2-Activity." *Health Promot Int* 2011 26(3): 311-321.
78. Spruijt-Metz D, Nguyen-Michel ST et al. Reducing sedentary behavior in minority girls via a theory-based, tailored classroom media intervention. *Int J Pediatr Obes* 2008 3(4): 240-248.
79. Campbell KJ, Lioret S et al. A parent-focused intervention to reduce infant obesity risk behaviors: a randomized trial. *Pediatrics* 2013 131(4): 652-660.

NOTES

NOTES



The background features several overlapping, curved dotted lines in a light grey color, creating a sense of movement and flow. A solid green oval is positioned in the lower-middle section of the page, containing the text.

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