

**A SYSTEMATIC REVIEW TO INFORM THE AUSTRALIAN  
SEDENTARY BEHAVIOUR GUIDELINES FOR CHILDREN  
AND YOUNG PEOPLE**

**Prepared for the Australian Government Department of Health  
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## **A Systematic Review to Inform the Australian Sedentary Behaviour Guidelines for Children and Young People**

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**Objective:**

The objective of this review is to: inform Australian Government policy in regards to the relationship between sedentary behaviour/sitting time and health outcome indicators, including the risk and prevention of chronic disease and obesity; and to provide information to guide evidence-based recommendations that can be used to encourage healthy living in children and adolescents aged 5-17 years, and as a basis for monitoring sedentary behaviour on a population level.

**Overview of the Guideline Development Process:**

The quality of practice guidelines depends upon the methodologies and strategies used in the guideline development process [1]. To limit the variability in guideline quality, the Appraisal of Guidelines for Research & Evaluation (AGREE) Instrument was developed. The AGREE instrument was designed to assess guideline quality and direct guideline development and reporting [2]. In 2010, the AGREE instrument was revised and refined resulting in the AGREE II instrument. This tool has been used in the development of the proposed guidelines. The AGREE II instrument is a 23-item tool with six quality domains. The development process for the proposed guidelines using each domain is briefly discussed in the following paragraphs [3-4].

The *Scope and Purpose* domain describes the target population, specific overall objectives and health questions addressed by the guideline. The guidelines apply to healthy children aged 5-17 years old. The objective of these guidelines was to inform Australian Government policy regarding the relationship between sedentary behaviour (including the amount, frequency, and type of sedentary behaviour) and health outcome indicators (including: risk and prevention of chronic disease, unhealthy weight gain, mental health and wellbeing); and to provide information to guide evidence-based recommendations that can be used to encourage healthy, active living in children and young people aged 5-17 years. The specific research questions are stated below.

The *Stakeholder Involvement* domain identifies stakeholders involved in the development process and indicates whether the views and preferences of targeted populations have been sought. The Guideline Development Committee included exercise physiologists, methodologists, behavioural scientists, and social marketing experts. Representatives from major Australian stakeholders, including the National Heart Foundation of Australia, the Australian Government Department of Health and Ageing, Sports Medicine Australia, and the Australian Council for Health, Physical Education and Recreation were involved. In addition, sedentary behaviour experts from the United States, Canada and Australia shared their ideas and previous experiences. The Guidelines provide recommendations for children and youth, parents, educators, public health and health care providers who are the proposed end users of the recommendations.

The *Rigour of Development* domain assesses how the evidence was gathered and synthesised. It outlines the current development and future development initiatives to update the recommendations. The methods used in the development of the guidelines, including the search terms, time periods and

inclusion/exclusion criteria are clearly described in the systematic review. Seven members of the Guideline Development Committee were assigned to review individual studies. The reviewers critically appraised individual studies and reflected on the body of evidence, considering the scientific validity of the studies. One reviewer appraised each study. The Guideline Development Committee met in Canberra, Australia, in May 2012 to develop a draft of the guidelines based on the evidence provided by the reviewers. The Committee worked until they achieved consensus on the draft Preamble and Guidelines. The Committee proposed circulation of the guidelines to national and international sedentary behaviour experts for comment including experts involved in the development of previous guidelines. This also included sedentary behaviour experts from non-government organizations (NGOs; e.g. National Physical Activity Program Committee for the NHFA, ACHPER), as well as Australian State and Territory Government representatives. In line with expert opinion [5, 27] and guidelines from other jurisdictions [6] it is recommended that the proposed Australian Sedentary Behaviour Guidelines for Children and Young People be updated every five years.

The *Clarity of Presentation* deals with the language, structure and format of the guidelines. The recommendations and their rationale are clearly described in the systematic review. The guidelines address the targeted population, key recommendations and specific goals.

The *Applicability* domain focuses on advice for implementing recommendations, resource implications, and monitoring strategies. The Guideline Development Committee recommended that these guidelines be integrated into all relevant Government policies and programs. However, the implementation of these guidelines is beyond the scope of the current development process. Specific goals were included in the recommendations for monitoring purposes (e.g., limit electronic media for entertainment to no more than two hours a day).

The *Editorial Independence* domain examines the potential biases in guideline recommendations with competing interests due to funding or guideline panel conflicts of interests. The development of these guidelines was funded by the Australian Department of Health and Ageing. The Department had no influence on the evidence accumulation or synthesis. However, Department of Health and Ageing staff provided feedback on the draft guidelines. Suggested changes were considered by full consensus among the Guideline Development Committee.

An overview of the guideline development process employed appears in Appendix B.

## **Systematic Review Methodology**

### **Evidence included in the systematic review:**

Any study that used a valid and reliable measure of sedentary behaviour, excluding sleeping and active gaming, was eligible for inclusion in the systematic review. Each study was required to provide sufficient information to ascertain

the duration, and/or frequency of the sedentary behaviour and include at least one measure of a specified health indicator.

Note: Sedentary behaviour is different to physical inactivity.

**Comparator required:**

At least one baseline measure of sedentary behaviour was required for observational studies. A control group was required for all experimental studies.

**Outcomes of interest:**

Cardiometabolic risk, adiposity, musculoskeletal health, mental health, negative health outcomes, high-risk behaviours (such as illicit drug use, smoking) academic achievement and cognitive development, conduct behaviour/pro-social behaviour, motor development, cardiorespiratory fitness, respiratory health, sleeping patterns, ocular health, and vitamin D deficiency.

These outcomes were chosen as they represent the broad spectrum of health outcomes known to be associated with sedentary behaviour in school-aged children and adolescents, are consistent with the latest systematic reviews of evidence in this area, or were areas of emerging interest identified by the Guideline Development Committee. Specifically, cardiometabolic risk, adiposity, skeletal health, mental health, and negative health outcomes were included in a recent systematic review of the evidence to inform the Canadian Sedentary Behaviour Guidelines for Children and Youth [5]. Muscular health, academic achievement, and cardiorespiratory fitness were included in the previous review of evidence that was used to inform the existing Australian Physical Activity Guidelines for Children and Youth [6]. The expert panel that comprised the Guideline Development Committee also reached consensus on the following emerging areas of interest that were to be included in the review: high risk behaviours; pro-social/conduct behaviour; motor development; respiratory health; ocular health; sleeping patterns, and; vitamin D deficiency.

A definition of all outcomes of interest can be found in Appendix A.

***A priori* consensus rankings for each indicator by age group**

In order to assist with decision-making, all outcomes of interest were ranked according to their importance. This was undertaken prior to the literature search.

| <b>Health Indicator</b>                        | <b>Children (5-12 yrs)</b> | <b>Adolescents (13-18 yrs)</b> |
|--|----------------------------|--------------------------------|
| Cardiometabolic risk                           | Critical                   | Critical                       |
| Adiposity                                      | Critical                   | Critical                       |
| Musculoskeletal health                         | Critical                   | Critical                       |
| Mental health                                  | Critical                   | Critical                       |
| Negative health outcomes                       | Important                  | Important                      |
| High risk behaviours                           | Important                  | Important                      |
| Academic achievement and cognitive development | Critical                   | Critical                       |
| Conduct behaviour / pro-social                 | Critical                   | Critical                       |

| <b>Health Indicator</b>   | <b>Children<br/>(5-12 yrs)</b> | <b>Adolescents<br/>(13-18 yrs)</b> |
|---------------------------|--------------------------------|------------------------------------|
| behaviour                 |                                |                                    |
| Motor development         | Important                      | Important                          |
| Cardiorespiratory fitness | Important                      | Important                          |
| Respiratory health        | Important                      | Important                          |
| Ocular health             | Important                      | Important                          |
| Sleeping patterns         | Important                      | Important                          |
| Vitamin D deficiency      | Important                      | Important                          |

**Note:** Health indicators were ranked based on whether they were critical for decision-making, important but not critical, or of low importance for decision-making. The focus when searching and summarising the evidence was on indicators that were important or critical. Rankings were based on the GRADE framework [7], and were made by consensus by the Guideline Development Committee.

**Research Questions:**

- a) *What is the relationship between sedentary behaviour and the biopsychosocial indicators of health and healthy development (as above) in children and adolescents aged 5-18 years?*

The primary aim of this research question was to consider whether evidence existed on the relationship between sedentary behaviour and each health outcome at a sufficiently high level as to inform the development of Australian Sedentary Behaviour Guidelines. For those outcomes that were included in previous reviews, and therefore have a substantial base of evidence, this research question aimed to update the evidence on this relationship by providing a summary of the evidence published since the previous reviews. For novel outcomes, such as motor development, the primary aim was to examine whether a relationship exists with sedentary behaviour at a level sufficient to inform Guideline development.

- b) *Is there evidence to suggest maximal and optimal thresholds for amounts of daily sedentary behaviour that children and adolescents should be exposed to?*

The particular emphasis of this research question was to examine whether a dose-response relationship exists between the frequency and duration of sedentary behaviours and health over each outcome of interest. Specifically, is the most recent evidence consistent with a dose-response relationship with the frequency and/or duration of sedentary behaviour, and is this consistent with the evidence of previous reviews (for example, the systematic review that was used to inform the Canadian Sedentary Behaviour Guidelines for Children and Youth [8])?

- c) *What types of sedentary behaviour need to be limited to prevent unhealthy outcomes?*

Sedentary Behaviour Guidelines that relate to children and adolescents worldwide are consistent in prescribing a maximum of 2 hours of “screen time” daily. The evidence has mostly been accumulated around TV watching and other

uses of electronic media. This research question addressed, in particular, the evidence that existed to inform guidelines pertaining to the types of sedentary behaviours that affect the health of children and young people (also included activities that involved prolonged sitting such as private vehicle travel).

*d) Does the relationship between sedentary behaviour and health differ depending on the specific outcome?*

There is some evidence that television viewing may be especially harmful to health. However, there is less evidence on the impact of other sedentary behaviours on various health outcomes. This research question addressed this by analysing the impact of sedentary behaviour by health outcome.

*e) Do the effects of sedentary behaviour on health and healthy development in children and adolescents vary by sex and/or age?*

Existing Australian Physical Activity Guidelines (which include a recommendation on screen time) have been published separately for those 5-12 and 12-18 years of age. This research question addresses the issue of whether the most recent evidence justified separate Sedentary Behaviour Guidelines for these age groups. In addition the Guideline Development Committee resolved that potential differences in the evidence by sex should also be investigated.

**Inclusion/Exclusion criteria for systematic review:**

- a) Cross-sectional designs were excluded.
- b) Population-based studies (longitudinal studies, retrospective studies) were required to have a minimum sample size of 300 participants.
- c) Randomised controlled trials and other trials were required to have a minimum of 30 participants.
- d) Longitudinal studies were included if there was at least one measure of sedentary behaviour between the ages of 5 and 18 years that was explicitly linked to a health outcome of interest.
- e) Studies investigating the effect of ‘active gaming’ (e.g., Nintendo Wii, Kinect) were excluded.
- f) Physical inactivity (i.e. not meeting physical activity guidelines) was not considered an eligible measure of sedentary behaviour and studies using this definition for “sedentariness” were excluded.

These decisions were made by the Guideline Development Committee for the following four reasons: 1) To ensure that a high level of evidence was obtained by excluding cross-sectional evidence, as well as longitudinal and controlled trial studies with small sample sizes; 2) To ensure that the number of articles included in the review was manageable to ensure timely completion of the project; 3) To maintain consistency across studies in the information that was reported, and that would allow a meaningful and viable summation of the evidence, and; 4) To maintain consistency with previous reviews [7] that followed the AGREE methodology [9].

**Dates for systematic review searches:**

| Outcome              | Date last searched   | New start date |
|----------------------|----------------------|----------------|
| Cardiometabolic risk | February 2010 (CSBG) | February 2010  |

| <b>Outcome</b>                                 | <b>Date last searched</b>         | <b>New start date</b>  |
|--|-----------------------------------|--|
| Adiposity                                      | February 2010 (CSBG)              | February 2010  |
| Musculoskeletal health                         | February 2010 (CSBG)              | February 2010  |
| Mental health                                  | February 2010 (CSBG) <sup>1</sup> | Self-esteem: Feb 2010<br>Others <sup>3</sup> : Open                  |
| Negative health outcomes                       | Nil                               | Open   |
| High risk behaviours                           | Nil                               | Open   |
| Academic achievement and cognitive development | February 2010 (CSBG) <sup>2</sup> | Academic achievement:<br>February 2010<br>Others <sup>4</sup> : Open |
| Conduct behaviour / pro-social behaviour       | February 2010                     | February 2010  |
| Motor development                              | Nil                               | Open   |
| Cardiorespiratory fitness                      | February 2010                     | February 2010  |
| Respiratory health                             | Nil                               | Open   |
| Ocular health                                  | Nil                               | Open   |
| Sleeping patterns                              | Nil                               | Open   |
| Vitamin D deficiency                           | Nil                               | Open   |

\* **Note.** CSBG = Canadian Sedentary Behaviour Guidelines; APAG = Australian Physical Activity Guidelines.

<sup>1</sup>Self-esteem only.

<sup>2</sup>Academic achievement only.

<sup>3</sup>Depression, wellbeing, anxiety, mental illness, social isolation, social discrimination.

<sup>4</sup>Cognitive development, attention, concentration.

#### **Databases to be searched:**

MEDLINE, SportsDISCUS, PsycINFO, PUBMED, Scopus, ERIC.

#### **Grey Literature Search:**

Occurs through contact with key informants, knowledge users, and content experts. Includes unpublished work, but does not include masters or doctoral theses (this is due to potential duplication of evidence should these theses be published). Background documents from alternate guidelines/suggested readings were also be obtained.

#### **Search Strategy (all databases followed an identical search strategy):**

The terms used in literature search were negotiated between the Guideline Development Committee and a librarian with expertise in conducting systematic reviews. In particular, the terms encompassed the major outcome measures within each health outcome, in addition to the corresponding Medical Subject Headings. The Medical Subject Headings are the National Library of Medicine's controlled vocabulary for indexing and cataloguing research articles (found at: <http://www.nlm.nih.gov/mesh/>). The search terms were deliberately employed to capture a wide range of potential evidence in order to ensure that no relevant evidence was missed. A table outlining the complete search strategy can be found in Appendix C. An identical search strategy was conducted over six academic databases: MEDLINE, SportsDISCUS; PsycINFO; PUBMED; Scopus, and; ERIC. Each search was conducted by a single researcher. Where possible, results



were limited to: English language; abstract available online; peer reviewed; journal articles, and; human subjects. The results of each search were saved, and entered into an Endnote X3 database (Thompson Reuters, California). Duplicates were removed by the Endnote program, however, manual searching of the final database revealed that many duplicates remained in the databases due to small differences in the formatting of citations between the databases. Where possible, these duplicates were removed manually prior to initial screening; however, many were removed during the initial screening.

**Results of the search:**

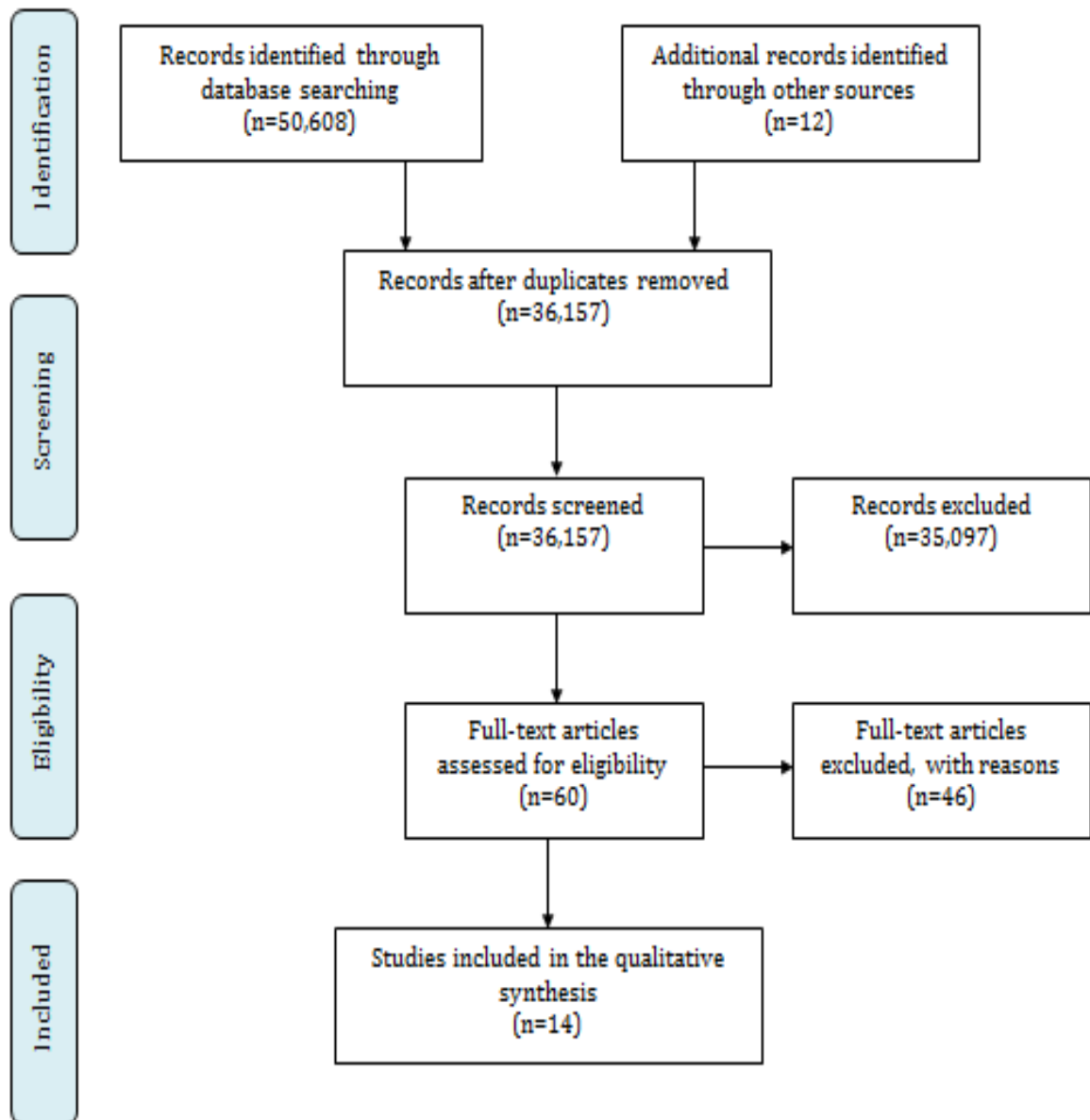
The results of the search are reported below. In total, 36,157 citations were entered into the Endnote database for initial screening. Initial screening was conducted by one researcher. The researcher screened each article by title and abstract for potential relevancy. Initial screening by title and abstract resulted in a total of 60 full text articles being accessed for secondary review. Following review by title and abstract, full text copies of all included articles were screened for relevancy. Where articles were excluded at this stage, a reason for exclusion was documented. A full list of articles included at this stage is available upon request. Secondary screening of full text articles resulted in a total of 14 articles included in the systematic review. Where there was some indecision about the relevancy of any given article, this was discussed between two researchers and a consensus decision was reached between the two. A flow diagram of the systematic review process appears below. A full list of articles included in the review appears in Appendix D.

| Database     | Total Records Found | Duplicates Removed | Records Entered into Endnote | Cumulative Endnote Total |
|--------------|---------------------|--------------------|------------------------------|--------------------------|
| MEDLINE      | 24855               | 457                | 24398                        | 24398                    |
| PsycINFO     | 4695                | 1263               | 3432                         | 27830                    |
| SportsDISCUS | 2039                | 580                | 2791                         | 30621                    |
| Scopus       | 253                 | 10                 | 243                          | 30864                    |
| PubMed       | 15362               | 11489              | 3873                         | 34737                    |
| ERIC         | 2072                | 652                | 1420                         | 36157                    |

**Data Analysis:**

A single reviewer extracted data from each of the 14 included articles. Data were extracted into a Microsoft Excel database (Microsoft Corporation, California). Information that was extracted from each paper included: author; date of publication; country of origin; study design; participants details; frequency, intensity, time, and type of sedentary behaviour; measure of sedentary behaviour used; relevant health outcomes; measures of health outcomes used; length of follow up; control group used (if any); statistical analyses used; statistical measures of the relationship between sedentary behaviour and health outcome; covariates (if any), and; comments on overall quality of the study.

**PRISMA Flow diagram of Literature search:**



### Summary Table of Included Studies Organised by Health Outcome:

| Outcome                        | Studies | Study types        | Summary of Findings: Frequency | Summary of Findings: Interruptions | Summary of Findings: Time | Summary of Findings: Type           | Level of Evidence | Other                 |
|--------------------------------|---------|--------------------|--------------------------------|------------------------------------|---------------------------|-------------------------------------|-------------------|-----------------------|
| Cardiometabolic health         | 1       | CT (1)             | Daily                          | Not reported                       | >5 hrs                    | TV viewing                          | Level 4           | -                     |
| Adiposity                      | 8       | Long (8)           | Daily                          | Not reported                       | >2 hrs                    | Screen time or total sedentary time | Level 3           | -                     |
| Skeletal health                | -       | -                  | -                              | -                                  | -                         | -                                   | Level 4           | -                     |
| Muscular health                | 1       | Long (1)           | Daily                          | Not reported                       | <4 hrs vs >6hrs           | Total sedentary time                | Level 4           | Dose response evident |
| Mental health                  | 3       | CT (1)<br>Long (2) | Daily                          | Not reported                       | Less is better            | Total sedentary time                | Level 4           | Dose response evident |
| Negative outcomes              | 1       | Long (1)           | Daily                          | Not reported                       | Less is better            | -                                   | Level 4           | Dose response evident |
| High risk behaviours           | 1       | Long (1)           | Daily                          | Not reported                       | Less is better            | TV viewing                          | Level 4           | Dose response evident |
| Academic/cognitive development | 1       | Long (1)           | Daily                          | Not reported                       | >3hrs                     | -                                   | Level 4           | -                     |
| Conduct behaviour              | 1       | Long (1)           | Daily                          | Not reported                       | >3hrs                     | TV viewing                          | Level 4           | Dose response evident |
| Motor development              | -       | -                  | -                              | -                                  | -                         | -                                   | Level 4           | -                     |
| Cardiorespiratory fitness      | 1       | Long (1)           | Daily                          | Not reported                       | >2 hrs                    | -                                   | Level 4           | -                     |
| Respiratory health             | -       | -                  | -                              | -                                  | -                         | -                                   | Level 4           | -                     |
| Vitamin D deficiency           | -       | -                  | -                              | -                                  | -                         | -                                   | Level 4           | -                     |
| Sleeping patterns              | -       | -                  | -                              | -                                  | -                         | -                                   | Level 4           | -                     |

**Note:** Some studies included more than one health outcome. Summary of findings is based upon each applicable paper within a single health outcome.

CT = Controlled Trial, Long = Longitudinal Study

### **Assigning the strength of the evidence:**

When determining the strength of the evidence on which the Sedentary Behaviour Guidelines are based, previous systematic reviews must be considered. The reader is referred to the systematic review undertaken by Tremblay et al. [8] for a detailed analysis of the strength of the evidence that underpins the proposed Guidelines. In addition, the strength of the evidence contained in this review was objectively rated. Consistent with the recent review undertaken by Tremblay et al. [8], levels of evidence were assigned using rigorous and evidence-based methodology. The objective appraisal of the evidence is based upon a pre-specified scale that is determined by the study designs and quality. The table below outlines the pre-specified criteria for assigning levels of evidence to each health outcome, and has been adapted from Lau et al. [10]. Levels of evidence in this framework are dependent upon the quality of the studies included within each outcome, with a particular relevance to the studies included in this review. In particular, where there were limitations evident in randomised controlled trials, the level of evidence assigned to a health outcome could drop from Level 1 to Level 2. A level of evidence has been assigned to each health outcome separately for children and young people by one researcher.

| <b>Level of evidence</b> | <b>Criteria</b>   |
|--------------------------|---|
| <b>Level 1</b>           | Randomised controlled trials without important limitations  |
| <b>Level 2</b>           | Randomised controlled trials with important limitations<br>Observational studies with overwhelming evidence |
| <b>Level 3</b>           | Other observational studies   |
| <b>Level 4</b>           | Inadequate or no data in population of interest<br>Anecdotal evidence or clinical experience                |

## **Results of the Systematic Review**

### **Qualitative Synthesis of the Evidence:**

This systematic review provided an update on the evidence examining the effect of sedentary behaviour on selected health outcomes in children (aged 5-12 years) and young people (aged 13-17 years). Overall, results confirm that lower levels of sedentary behaviour are associated with multiple health benefits in these age groups. However, given the recency of a previous systematic review in this area [5], the quantity of evidence available is small. In total, 14 studies were included in this review. Of those studies included, evidence was available for the following health outcomes: cardiometabolic health; adiposity (including the prevention of unhealthy weight gain); muscular health; mental health; negative health outcomes; high risk behaviours; academic/cognitive development; conduct behaviour, and; cardiorespiratory fitness. Of these, only adiposity (8) and mental health (3) contained evidence from more than a single study. The health outcome of adiposity (including the prevention of unhealthy weight gain) accumulated by far the greatest amount of evidence. This evidence is consistent with the existing Australian screen time recommendations, as well as other recommendations worldwide, and indicates that less than 2 hours per day of

sedentary electronic media use is associated with health benefits. Given the lack of evidence for other health outcomes, it is inappropriate to interpret this with the intention of informing Australian Sedentary Behaviour Guidelines. However, a dose-response relationship was evident for other multiple health outcomes, suggesting that less sedentary behaviour is associated with fewer adverse health outcomes. It is recommended that due to the lack of evidence obtained in this updated review, Australian Sedentary Behaviour Guidelines be based upon previous systematic reviews such as that undertaken by Tremblay et al. [5].

#### *Qualitative Description of All Included Studies*

The 14 studies that met inclusion criteria for this review comprised 13 longitudinal studies [11-23] and one experimental study [24]. In total, evidence was drawn from 22,013 participants. Eleven studies [12, 14, 16-24] showed a significant impact of sedentary behaviour on subsequent health outcomes, with only 3 studies showing no impact [11, 13, 15]. Of those that did not report any significant association between sedentary behaviour and health, Aires et al. [11] showed that total screen time (comprised of television and computer time) had no impact on the BMI of 14 year olds at two-year follow-up after adjusting for levels of physical activity. In a similar study, Fisher et al. [15] found that objectively measured total sedentary time (<100 counts per minute) did not have an impact on the BMI of 8-10 year olds at one year follow up after adjusting for total physical activity and MVPA levels. Lastly, Basterfield et al. [13] showed that objectively measured sedentary behaviour was not associated with adiposity in a sample of children (M age = 6.4 years) at two year follow up after adjusting for baseline BMI.

The sole experimental study conducted by Lambiase et al. [24] tested the impact of a simulated sedentary (car journey) or active (walking) commute to school. This study found that those who walked to school had subsequently lower stress reactions to a difficult cognitive task shortly after arriving “at school”. This experimental study was a novel approach to testing the health risks of sedentary behaviour, however, it suffered from the lack of an adequate control group, and this limits the conclusions which can be drawn from the study. All remaining studies which showed positive associations between sedentary behaviour and health outcomes were longitudinal in design. Of these, 4 studies showed significant sex differences in the relationship between sedentary behaviour and health outcomes. Barnett et al. [12] found that total sedentary time (hours watching TV or using the computer per week) was not associated with percentage body fat in girls. However, among boys, those that increased their total sedentary time, or were regarded as steady-high-users had 2.9 and 2.4 percentage units greater body fat when compared with steady-low users. Importantly, this study was the only study which showed a positive adverse association between sedentary behaviour and a health outcome after adjusting for levels of MVPA. In a study of 841 adolescents (M age = 14.7), Schooler et al. [20] showed that hours spent watching TV was negatively associated with body satisfaction among girls at two year follow up, but was not associated with body satisfaction for boys. This was true after adjusting for baseline levels of body satisfaction. In a larger study of 2,464 adolescents (M age = 13.7), Sund et al. [22] demonstrated that high levels of sedentary behaviour (>6 hours per day)

predicted high depressive scores in boys, but not girls. Lastly, Paananen et al. [19] explored the relationship between sitting time and muscular pain, and found that higher sitting time predicted the experience of muscular pain at 2 year follow-up in boys, but not in girls.

Of the remaining studies, the highest level of evidence was presented by Sharif et al. [21] in a study of 6,486 children and adolescents aged 10-14. This study demonstrated that time spent watching TV predicted school performance at 2-year follow-up. This relationship was mediated by anti-social behaviours, high-risk behaviours (such as sex and drug use), and high levels of sensation seeking. It should be noted, however, that the authors of this study were primarily interested in the psychological impact of TV content, rather than the sedentary behaviour component of TV viewing. Similarly, Carson et al. [14] demonstrated that computer use (but not TV viewing) was associated with a 50% increased engagement in multiple risk behaviours including smoking, drunkenness, drug use, and dangerous sexual behaviours.

Two of the remaining studies investigated the influence of sedentary behaviours on BMI. In a study of 3,795 twins and siblings, Graff et al. [16] demonstrated that adolescents who spent less than 14 hours per week in screen time had lesser increases in BMI in early adulthood than adolescents who spent greater than 14 hours per week in screen time. This was true even after adjusting for a genetic component. Hands et al. [17] similarly demonstrated that screen time at age 8 predicted BMI at age 10. However, this did not hold for ages 6 or 10. Mota et al. [18] investigated the influence of TV viewing on cardiorespiratory fitness and found that seven year olds who watched more than 2 hours of TV per day were 2.53 times more likely to be unfit at age 9.

Viner et al. [23] investigated the impact of sedentary behaviours outside of school on persistent fatigue (extreme tiredness twice per week or more). Results showed that, when compared with those who were sedentary for 2 hours or less per day, adolescents who were sedentary for between 2 and 4 hours were 1.1 times more likely to experience persistent fatigue, and those who were sedentary for more than 4 hours per day were 1.6 times more likely to experience persistent fatigue.

## **Discussion**

### **Consideration of special population groups:**

This review covered two developmental stages or age groups: childhood (children) and adolescence (young people). Childhood was defined as between the ages of 5 and 12 years (which corresponds with primary school). Adolescence was defined as between the ages of 13 and 17 (which corresponds with secondary school). It is important to point out that there are clearly variations within these stages and that they serve primarily as a way of categorising the evidence and operationalising the guidelines. These groupings are also consistent with all of the existing international guidelines and the existing Australian recommendations.

It is important to note that whilst the existing guidelines refer separately to children and adolescents (or youth/young people) the specific amount of electronic media use and the types of sedentary behaviours recommended to limit (prolonged sitting, shorts trips by private vehicle) do not differ between the two developmental stages. Differences are only seen in the suggestions in the ways in which the guidelines can be met (such as the types of activities that could be limited) in some of the accompanying public resources (website material, brochures, information/fact sheets).

There is no scientific evidence from the existing systematic reviews and our own updated systematic review to support a different minimum time for the use of electronic media for entertainment for children or young people. There is also no evidence from our updated review or existing reviews that separate guidelines for sedentary behaviour should be developed for boys and girls or for children and young people from different socioeconomic, cultural, and indigenous backgrounds. That is, these guidelines are applicable to the general population.

In undertaking the review, evidence concerning special populations (such as those with diabetes, obesity (not overweight), and various other special medical conditions – e.g., cystic fibrosis, cerebral palsy) was excluded from analyses. Therefore, the evidence reviewed here (and the subsequent Guidelines) cannot be generalised to special populations. This has also been addressed within the Preamble to the Guidelines where it is recommended that those children and young people with special needs or medical conditions should consult their health care provider when using the Guidelines.

### **Existing Guidelines in Australian and Worldwide for Children and Young People:**

When evaluating the development and content of existing Australian and international sedentary behaviour guidelines for children and adolescents, several criteria should be applied. First, guideline development should follow a process consistent with the recommended international best practices [25]. Second, the guidelines should be consistent with the typical patterns of sedentary behaviour in which children and young people aged 5-17 years participate. Third, there should be enough scientific evidence to support the association between the recommended amount of sedentary behaviour (specifically in this case electronic media use for entertainment) and the selected physical, mental and social health outcomes. Finally, sedentary behaviour guidelines should be behaviourally robust. That is, the frequency, duration, interruptions, and type of behaviours recommended should be consistent with enabling factors that have been shown to be associated with minimising sedentary behaviour in children and adolescents.

Canada is the only country to have separate sedentary behaviour guidelines for children and young people. Other countries have either “embedded” a specific sedentary behaviour recommendation (usually to limit screen-based electronic media for entertainment purposes) within their physical activity guidelines (for example the UK and Australia) or developed separate recommendations for

screen-based sedentary behaviour such as television viewing (e.g., the American Academy of Pediatrics in the US). As for the physical activity guidelines, the Canadian Sedentary Behaviour Guidelines have stringently followed recent best-practice recommendations, while others have relied more on existing systematic reviews to inform their final guidelines. Nonetheless, all have attempted to, based on available resources and timelines, apply the aforementioned criteria and apply what was widely acknowledged as best practice at the time the guidelines were developed. The existing international and Australian guidelines that have specific sedentary behaviour recommendations are summarised below:

**Canada: ([www.csep.ca/guidelines](http://www.csep.ca/guidelines)):**

In 2011, the Canadian Sedentary Behavior Guidelines for Children (aged 5-11) and Youth (aged 12-17) were released by the Canadian Society for Exercise Physiology (CSEP). These guidelines followed all of the stages recommended as “best-practice” in the development of sedentary behaviour guidelines and are widely considered as the “gold-standard” for children and young people. The Canadian guidelines are as follows:

For health benefits, children/youth aged 5-11/12-17 should minimise the time they spend being sedentary each day.

This may be achieved by:

- Limiting recreational screen time to no more than 2 hours per day; lower levels are associated with additional health benefit.

Limiting sedentary (motorised) transport, extended sitting and time spend indoors throughout the day.

**United Kingdom**

**([www.dh.gov.uk/en/publicationsandstatistics/publications/PublicationsPolicyAndGuidance/DH\\_127931](http://www.dh.gov.uk/en/publicationsandstatistics/publications/PublicationsPolicyAndGuidance/DH_127931)):**

In 2010, the UK Department of Health released the *UK Physical Activity Guidelines for Children and Young People* (aged 5-18 years) These guidelines drew on recent systematic reviews undertaken in Canada and the U.S. to draft their technical report. The following sedentary behaviour guideline, developed by an international expert panel, was embedded into the Guidelines:

1. All children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods.

**American Academy of Pediatrics (USA).**

In 2001, the American Academy of Pediatrics released a specific policy statement pertaining to television and the use of electronic media for entertainment [26].

This was the first recommendation that set a time limit on the amount of total media time for children and adolescents (no more than 2 hours per day). It is important to note that these recommendations were based on expert opinion and clinical experience rather than a systematic review of the evidence. The recommendations are as follows:

6. Limit children’s total media time (with entertainment media) to no more than 1 to 2 hours of quality programming per day
7. Remove television sets from children’s bedrooms



8. Discourage television viewing for children younger than 2 years, and encourage more interactive activities that will promote proper brain development, such as talking, playing, singing, and reading together.
9. Monitor the shows children and adolescents are viewing. Most programs should be informational, educational, and non-violent.
10. View television programs along with children, and discuss the content.
11. Encourage alternative entertainment for children including reading, athletics, hobbies, and creative play.

#### **Existing Australian Recommendations**

**(<http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines>):**

In 2004, the Commonwealth Department of Health and Ageing released the existing Australian recommendations for 5-12 and 12-18 year olds. A systematic review was not conducted for the sedentary behaviour guideline that was developed. Rather, it was based on the existing recommendation from the American Academy of Pediatrics (2001) and was worded as follows:

For 5-12 year olds

I. Children shouldn't spend more than two hours a day using electronic media for entertainment (eg computer games, TV, internet), particularly during daylight hours.

For 12-18 year olds

II. Adolescents shouldn't spend more than two hours a day using electronic media for entertainment (eg computer games, TV, internet), particularly during daylight hours.

#### *Summary*

The American Academy of Pediatrics Recommendation of 2 hours per day has been studied as a threshold in examining the relationships between television viewing and electronic media use and many health and developmental outcomes in children and adolescents. It has proven to be remarkably robust as a cut-point for detecting adverse health consequences, further self-perpetuating its use. It has been endorsed as a recommendation in subsequent guidelines developed in Australia and Canada. Given this consistency and the rigorous approach followed in the current Canadian Guidelines and our systematic review, it would be prudent to not modify this recommendation unless there were compelling evidence to do so. If variations have been made, the rationale for these has been provided in the section following the proposed guidelines.

## **The Proposed Sedentary Behaviour Guidelines for Children and Young People**

### **Objective:**

The objective of these guidelines is to: inform Australian Government policy in regards to the relationship between sedentary behaviour/sitting time and health outcome indicators, including the risk and prevention of chronic disease and

obesity; and to provide evidence-based recommendations that can be used to encourage healthy living in children and adolescents aged 5-17 years.

**Target Users:**

The target users of the sedentary behaviour guidelines are parents, teachers, caregivers, coaches, policy makers, health care and cross-sector providers, and service and infrastructure providers. This is in addition to children and adolescents aged 5-17 years.

**Draft Guidelines and External Review**

The Guideline Development Committee met to consider the evidence presented above. During this meeting, the evidence was evaluated, and was considered in reference to previous systematic reviews including the reviews that underpin the current Canadian Sedentary Behaviour Guidelines. After consideration of the entire body of literature, in addition to a consideration of current international and Australian guidelines, Sedentary Behaviour Guidelines and a Preamble (scientific statement intended for an informed stakeholder audience) were drafted.

The draft Sedentary Behaviour Guidelines and Preamble were sent for confidential comment to a wide range of key stakeholders via an online survey (N=80). This included national content experts from all states and territories in Australia, content experts involved in the formulation of current international guidelines including the WHO, Canadian, US, and UK Physical Activity Guidelines, individuals who represented key Australian stakeholders including non-government organisations and health professional bodies, and state-based and national government representatives from across Australia. The online survey gave the individuals the chance to respond to the draft Preamble and Guidelines by rating their level of agreement on a five-point Likert Scale, in addition to providing an opportunity to provide open-ended comments. The material used in the online survey appears in Appendix E.

In total, 39 people responded and commented on the draft Preamble and Guidelines. This represented a response rate of 49%. Of those that responded, 41% indicated that they were currently employed in the Government sector, 33% were employed in the education/University sector, 15% in not-for-profit organisations, 8% in the healthcare sector, and 3% were employed in research/science.

The percentage of respondents who “agreed” or “strongly agreed” with the Preambles and Guidelines was high, and is outlined in the table below.

|              |            | N  | %    |
|--------------|------------|----|------|
| Children     | Preamble   | 36 | 92.3 |
| Children     | Guidelines | 35 | 89.8 |
| Young People | Preamble   | 35 | 89.8 |
| Young People | Guidelines | 34 | 87.2 |

All comments were given due consideration by the Guideline Development Committee during a teleconference. Common comments and the response of the Committee are outlined in Appendix F. The majority of comments were concerned with inadequate definitions of terms included in the Preamble. The Guideline Development Committee resolved to address this in the messaging and dissemination of the Guidelines and Preamble, as opposed to addressing this within the Preamble itself. There were some comments that the Guideline Development Committee deemed to warrant small changes in the Preamble and Guidelines. These changes are also listed in Appendix F.

Following this process, the systematic review was sent out for international review by experts in physical activity. Subsequently, the Draft Sedentary Behaviour Preamble and Guidelines were finalised, and appear below:

### **The Draft Sedentary Behaviour Preamble and Guidelines for Children:**

#### [Draft Preamble for the Australian Sedentary Behaviour Guidelines for Children](#)

These Sedentary Behaviour Guidelines apply to all children aged 5 to 12 years\* irrespective of cultural background, gender, socioeconomic status, and ability.

Sedentary behaviour (sitting or reclining during waking hours) should be limited in as many ways as possible at home, in school, in the community and when travelling – particularly by reducing electronic media (screen time) for entertainment.

Compliance with these Guidelines can reduce the risk of adverse outcomes for body composition, cardiorespiratory and musculoskeletal fitness, academic achievement, aspects of mental health and wellbeing, and pro-social behaviours. Less sedentary time is better. Based on current evidence, the benefits of reduced sedentary time exceed potential risks.

For guidance on increasing physical activity please refer to the Australian Physical Activity Guidelines for Children.

\* These Guidelines may be appropriate for children with special needs or medical conditions. Individuals who are unsure should consult their health care provider.

#### [Draft Australian Sedentary Behaviour Guidelines for Children](#)

To reduce health risks, children aged 5-12 years, should minimise the time they spend being sedentary every day. To achieve this:

- Limit electronic media for entertainment (e.g., television, seated electronic games and computer use) to no more than two hours a day; lower levels are associated with reduced health risks.

Break up long periods of sitting as often as possible.

## **The Draft Sedentary Behaviour Preamble and Guidelines for Young People**

### **Draft Preamble for the Australian Sedentary Behaviour Guidelines for Young People**

These Sedentary Behaviour Guidelines apply to all young people aged 13 to 17 years\* irrespective of cultural background, gender, socioeconomic status, and ability.

Sedentary behaviour (sitting or reclining during waking hours) should be limited in as many ways as possible at home, in school, at work, in the community and when travelling – particularly by reducing electronic media (screen time) for entertainment.

Compliance with these Guidelines can reduce the risk of adverse outcomes for body composition, cardiorespiratory and musculoskeletal fitness, academic achievement, aspects of mental health and wellbeing, and pro-social behaviours. Less sedentary time is better. Based on current evidence, the benefits of reduced sedentary time exceed potential risks.

For guidance on increasing physical activity please refer to the Australian Physical Activity Guidelines for Young People.

\*These Guidelines may be appropriate for young people with special needs or medical condition. Individuals who are unsure should consult their health care provider.

### **Draft Australian Sedentary Behaviour Guidelines for Young People**

To reduce health risks, young people aged 13-17 years, should minimise the time they spend being sedentary every day. To achieve this:

- Limit electronic media for entertainment (e.g., television, seated electronic games and computer use) to no more than two hours a day; lower levels are associated with reduced health risks.
- Break up long periods of sitting as often as possible.

#### **Rationale for each recommendation:**

##### **1) To reduce health risks, children aged 5-12 years, should minimise the time they spend being sedentary every day.**

This overall statement is consistent with that presented in the Canadian and UK sedentary behaviour guidelines. This statement is also consistent with the small amount of evidence available to be included in this review, which demonstrates that overall health risks can be reduced through minimising sedentary time. In the absence of overwhelming evidence included in this review, it is appropriate to maintain consistency with the much larger reviews undertaken previously.

##### **2) To achieve this: Limit electronic media for entertainment (e.g., television, seated electronic games and computer use) to no more than two hours a day; lower levels are associated with reduced health risks.**

There is significant international consensus on the recommendation that children and young people spend less than 2 hours per day in electronic media

use (also called recreational screen time, and total media time in alternate guidelines). Thus, this guideline maintains an international consistency. Specifically, it is consistent with the Canadian and US guidelines (the only countries to have placed a time-based guideline on electronic media use for entertainment). Further, this guideline is consistent with the recommendation embedded within the existing Physical Activity Recommendations. Thus, without a high level of evidence presented within this review, it is appropriate to maintain international and national harmonisation by endorsing a guideline of less than 2 hours of recreational screen use per day.

The guideline “lower levels are associated with reduced health risks” also maintains consistency with the Canadian Sedentary Behaviour Guidelines. This guideline reflects the evidence presented by Tremblay et al. [5], in addition to the small amount of evidence presented in this review, which demonstrates a dose-response relationship between sedentary behaviour and health risks.

### **3) To achieve this: Break up long periods of sitting as often as possible.**

Without a sufficient level of evidence obtained within this review to justify a departure from existing guidelines, it is appropriate to maintain consistency with international guidelines. The Guideline Development Committee endorsed the evidence that was used in including this recommendation in the Canadian Sedentary Behaviour Guidelines and believed that it was robust enough, without the addition of a significant body of literature in this review, to include a sub-guideline.

#### **Additional rationale for use of the term “sedentary behaviour”.**

We have used the term “sedentary behaviour” to be consistent with guidelines and recommendations from other international jurisdictions [27]. As these are scientific guidelines, we believe this term more comprehensively incorporates the MET intensity required to perform the behaviours and avoids confusion that may arise if another term such as “sitting” is used as there are some sitting behaviours that are active (e.g, riding a bike, using a rowing machine). We have included specific sedentary behaviours such as electronic media for entertainment and sitting in the specific examples of what sedentary behaviours should be limited. We recommend that the Department of Health and Ageing canvas the public as to the most appropriate term to use in public health messaging around these guidelines.

#### **Brief Recommendations to Support Public Health Messaging & Promotion of the New Australian Sedentary Behaviour Guidelines for Children and Young People:**

Unlike strategies associated with approaches to constructing physical activity public health messages [28-29] the recent Canadian experience of translating the Canadian sedentary behaviour guidelines into public health communications recognised that there may be additional challenges that may arise in the public mind in regards to understanding the difference between the Sedentary Behaviour Guidelines and the Physical Activity Guidelines ([www.csep.ca/guidelines](http://www.csep.ca/guidelines)). As such, the need for formative research with the

target audiences to clarify the definition of sedentary behaviour and their responses to the Sedentary Behaviour guidelines are paramount.

As such, recommendations below are based on the principles of social marketing communications [30], the Canadian Sedentary Behaviour Guidelines Clinical Practice Development Report (Canadian Society for Exercise Physiology, 2011). Reference is also still given to successful approaches to constructing physical activity public health messages [28-29] – whilst acknowledging the potential need for distinct messages and approaches. In line with these, an Australian health messaging strategy to accompany the development of the new Sedentary Behaviour Guidelines for children and adolescents should:

- Be based on an understanding of a definition of sedentary behaviour that is meaningful to the target audiences
- Be based on an understanding of the preferences for and barriers to reducing sedentary behaviours that are meaningful to the target audiences. Potential barriers that have been identified include lifestyle, habit and enjoyment, whilst potential facilitators include improved health and ease of reducing sedentary behaviour (compared to increasing physical activity) for some segments of the target audience
- Offer specific content about the type and amount of sedentary behaviours that are recommended for each age group
- Be designed for specific population audiences and targeted at those specific groups (e.g. children, adolescents, parents, schools, government and non-government organisations). Further tailoring could also be considered on the basis of factors such as demographics (e.g. gender), motivation (e.g. readiness to change) and health literacy (including consideration of groups in Australia such as indigenous and culturally and linguistically diverse populations)

Whilst, there is not sufficient evidence to make recommendations regarding ‘gain-framed’ vs ‘loss-framed’ messages for reducing sedentary behaviours, messages should still attempt to:

- Encourage specific target audiences towards meeting the new guidelines; including the promotion of valued outcomes that are attractive to the audience
- Maximise novelty and appeal to encourage messages being ‘tuned into’ and remembered
- Promote ways to assist the target audiences to overcome barriers to reducing sedentary behaviours including ‘how-to’ information, or use of vignettes or case studies modelling success, to foster self-efficacy
- Be tested with the target audience to ensure salience and acceptability
- Utilise targeted and appropriate media and distribution channels relevant to ‘reaching’ the different target audiences (e.g. print, internet, mobile, TV, Radio)
- Consider the use of appropriate ‘messengers’ to whom the audience can relate, and in situations where the target audiences can ‘engage’ with the messages
- Be evaluated in regards to whether the messages reach their target audiences, change knowledge and awareness of the new guidelines,

impact on self-efficacy to adopt recommended behaviours, and impact on intentions to change sedentary behaviours

- Be implemented on the basis of the understanding that the development and distribution of ‘messages’, will require incorporation into a comprehensive “social marketing approach” if adoption and adherence to the recommended behavioural guidelines is to be achieved.

These recommendations are consistent with contemporary understandings that whilst public health messages can create awareness of the benefits of adopting a behaviour (such as decreasing a sedentary behaviour), they are insufficient to bring about behaviour change in the absence of other elements of the marketing mix (i.e., ‘on-the-ground’ activities and resources to facilitate behaviour change).

### **Future research needs, including next steps in policy development:**

Several areas have been identified as future research priorities. These include:

1. A need for greater use of objective measures of sedentary behaviour (e.g., accelerometer) in longitudinal studies.
2. More high quality evidence that examines the dose-response between sedentary behaviour and health outcomes. For example, variations of time and type should be included in research studies.
3. The health outcome of sleep should be incorporated into future research on the health impact of sedentary behaviour.
4. Studies incorporating measures of sedentary behaviour should be expanded from screen time measures to include measures of sitting time and other sedentary behaviours.
5. Greater evidence is needed on the impact of sedentary behaviour on mental health.

There are several important research areas that will impact upon Sedentary Behaviour Guideline policy and development. Firstly, research is needed into how the Guidelines will be communicated. For example, what is the effectiveness of positively versus negatively framed guidelines, or paper versus television versus social media as a dissemination tool? This should incorporate research into social marketing in the area of sedentary behaviour.

It is recommended that these Guidelines be integrated into all relevant Government policies and programs. Updating of the Australian Sedentary Behaviour Guidelines for Children and Young People should occur every 5 years. Thus, a review of the evidence and the Guidelines is recommended to occur in 2017.

### **Monitoring/surveillance compliance**

It is recommended that these proposed guidelines are regularly monitored on a national level. The current Australian Health Survey will be able to partly monitor compliance with the first of the proposed guidelines (limit electronic media for entertainment (e.g., television, seated electronic games and computer use) to no more than two hours a day) in both children and young people. We say partly because the wording of the relevant question in the current Australian Health Survey is “*On how many of the past 7 days did [you/(child’s name)] watch*

*TV/ videos/DVDs or play video or computer games for entertainment for less than two hours?" As such, if a child or young person spent exactly two hours using electronic media for entertainment they would meet both the existing recommendations and the proposed guidelines but would not meet either of them according to the above question. That is, the question does not allow accurate monitoring of either the existing recommendations or proposed guidelines for those who spend exactly two hours using electronic media for entertainment. We suggest that in future monitoring surveys, a slight amendment of the question as follows (amendments underlined):*

*On how many of the past 7 days did [you/(child's name)] watch TV/ videos/DVDs or play video or use electronic media for entertainment for two hours or less?"*

We also suggest that the "a day" component of this guideline be interpreted as 7 days in the past week for monitoring compliance with this guideline.

The second proposed guideline (Children and Young People's should break up long periods of sitting as often as possible) is not able to be monitored for compliance using the questions in the current Australian Health Survey. It is recommended that specific questions and objective monitoring of sitting time using accelerometry (e.g., Actigraph or activPAL) be incorporated into future waves of this Survey.



## APPENDIX A: Glossary of Key Terms

**Relevant definitions** (adapted from Tremblay et al. [31] and [Canadian Physical Activity Guidelines](#)):

**Academic achievement and cognitive development:** This includes measures such as language development and attention, typically measured using cognitive assessments. These outcomes may also be measured through parent, caregiver or teacher proxy. Academic achievement is typically measured through school grades.

**Adiposity (including the prevention of unhealthy weight gain):** Outcomes of adiposity and unhealthy weight gain include multiple measures of overweight, obesity and fat mass. This includes measures of Body Mass Index, measures of waist circumference, and clinical measures of obesity including skin-folds, and dual energy x-ray absorptiometry.

**Cardiometabolic health:** Cardiometabolic health indicators are measured in a variety of different ways. Indicators may cluster or be presented individually. Indicators include: plasma lipids and lipoprotein concentrations (e.g. HDL-cholesterol, triglycerides), hypertension, fasting glucose, insulin resistance and inflammatory markers (e.g. C-reactive protein).

**Cardiorespiratory fitness:** Fitness includes a variety of measures that include measures of lung capacity (VO<sub>2</sub> max), cardiac function (e.g. resting heart rate), and measures of physical fitness (e.g. shuttle run test or one-mile run).

**Conduct behaviour/pro-social behaviour:** This includes a wide range of social behaviours that fall into either prosocial and antisocial behaviours. Measures are highly varied within this outcome.

**Frequency:** The number of times a sedentary behaviour is performed. Frequency is generally expressed in sessions, episodes, or bouts per day or week.

**High-risk behaviours:** High risk behaviours include measures of substance use and substance abuse, including alcohol and drug use, and smoking. This outcome may also include high risk sexual behaviours and other risk-taking behaviours.

**Interruptions:** Refers to the break or cessation of sedentary behaviour.

**Mental health:** Mental health encompasses the absence of mental illness and the presence of wellbeing. This may be measured as reductions in levels of mental illnesses (which may be clinical or subclinical) such as depression or anxiety. Measures will also include positive measures such as quality of life, wellbeing or happiness, and self-esteem.

**Metabolic equivalents (METs):** Unit of energy expenditure where 1 MET is equal to resting energy expenditure (3.5 ml O<sub>2</sub>/kg/min).

**Motor development:** This outcomes includes the development of motor skill proficiency, coordination, and balance. There are a wide range of measures used to assess motor skill development.

**Muscular health:** Muscular health includes outcomes pertaining to muscle strength/power (e.g. one repetition max), muscle endurance (e.g. sit up or push up tests), and flexibility (e.g. sit and reach test).

**Negative health outcomes:** These are the negative outcomes directly associated with participation in physical activity and include injuries (including fractures and overuse injuries) and burnout.

Ocular health: Outcomes related to the health of the eye and its related processes/functions. Measures include visual status and visual acuity.

Physical activity: Bodily movement that is produced by the contraction of skeletal muscle and that substantially increases energy expenditure. Moderate- to vigorous-intensity physical activity (MVPA) is activity equivalent to  $\geq 3$  METS (e.g., brisk walking pace).

Physically active: meeting established guidelines for physical activity (see Australian guidelines at <http://www.health.gov.au/internet/main/publishing.nsf/content/health-pubhlth-strateg-phys-act-guidelines> )

Physically inactive: not meeting established guidelines for physical activity.

Respiratory health: Includes physiological improvements to the respiratory system, as well as improvements in respiratory symptoms such as wheezing.

Skeletal health: Measures of bone and skeletal health include bone mineral density (BMD), and bone mineral content (BMC) which are measured using dual energy x-ray absorptiometry.

Sleep patterns: This is a measure of the quality of sleep obtained by children and young people. The primary measures within this outcome are the duration and quality of sleep, trouble getting to sleep, and in some instances insomnia.

Time (duration): The length of time in which sedentary behaviour is performed. Duration is generally expressed in minutes.

Type (mode): The type of sedentary behaviour that the individual is engaging in.

Vitamin D deficiency: Indicated by insufficient levels of Vitamin D.

## APPENDIX B – An Overview of the AGREE Process

Adapted from Tremblay and Haskell [25].

| Stage | Task  |
|-------|---|
| 1     | Assemble a leadership team to oversee the development process.  |
| 2     | Put in place assessment procedures to assess the development process.   |
| 3     | Establish an expert advisory committee to drive the development process.                                      |
| 4     | Domestic and international scan to ensure international and inter-jurisdictional harmonisation.               |
| 5     | Review of the existing literature.  |
| 6     | Interpretation of the findings of the literature review.  |
| 7     | Identification of research gaps from the literature review.   |
| 8     | Consultation of stakeholder organisations to establish consensus of the scientific recommendations.           |
| 9     | Knowledge translation strategy, including language, presentation, communication and dissemination strategies. |
| 10    | Comprehensive evaluation of the guideline development process and the impact of guidelines.                   |
| 11    | Plan for updates and revision of the guidelines.  |

### APPENDIX C – The Search Strategy Used

| Database: |   | Date of Search: |         |
|-----------|---|-----------------|---------|
| #         | Search Terms  | Date Limit      | Results |
| 1         | Sedentar* OR chair OR sitting OR car OR automobile OR screen OR computer OR low energy expenditure OR video OR television OR physical inactivity OR bed rest OR screen based media OR small screen OR gaming OR social media OR electronic games  | 2010 - present  |         |
| 2         | Metabolic syndrome OR insulin resistance OR cardiovascular disease OR cardiometabolic OR heart disease OR vascular disease OR cholesterol OR hypercholesterol* OR hyperlipid* OR blood pressure OR hypertension OR deadly quartet OR plurimetabolic syndrome OR lipoprotein OR triglyceride OR diabetes OR c-reactive protein | 2010 - present  |         |
| 3         | Adiposity OR obes* OR overweight OR body fat OR body composition OR waist circumference OR skin?fold OR body mass index OR body weight  | 2010 - present  |         |
| 4         | Skeletal health OR bone density OR bone strength OR bone mass OR bone health OR bone mineral density  | 2010 - present  |         |
| 5         | Musc* health OR musc* fitness OR musc* strength OR explosive strength OR maximal strength OR musc* endurance OR flexibility   | 2010 - present  |         |
| 6         | Self esteem   | 2010 - present  |         |
| 7         | Self concept OR stress OR anxiety OR depression OR Mental health OR wellbeing OR emotional health OR psychological health OR psychosocial health OR mental illness OR mental disorder OR psychiatric disorder OR satisfaction with life OR social isolation OR social discrimination OR quality of life                       | 2010 - present  |         |
| 8         | Overtraining OR overuse OR Injur*   | 2010 - present  |         |
| 9         | Alcohol OR drug OR drinking OR substance  | 2010 - present  |         |
| 10        | Academic achievement OR educational achievement OR school admission criteria OR grade point average OR average grade OR school performance OR school dropout OR academic performance  | 2010 - present  |         |
| 11        | Cognition OR cognitive function OR cognitive development OR attention OR concentration  | 2010 - present  |         |

|    |   |                |  |
|----|---|----------------|--|
|    | OR executive function OR memory   |                |  |
| 12 | Behavi* conduct OR prosocial behavi* OR antisocial behavi* OR aggression OR social behavi*  | 2010 - present |  |
| 13 | Fundamental movement skills OR fundamental motor skills OR motor development OR motor skills OR coordination OR psychomotor OR motor performance  | 2010 - present |  |
| 14 | Physical fitness OR physical conditioning OR cardiovascular fitness OR cardiorespiratory fitness OR aerobic fitness OR heart rate OR lung capacity OR physical endurance OR lung volume OR respiratory health OR respiratory fitness OR vo2 max | 2010 - present |  |
| 15 | Asthma OR wheezing OR bronchitis OR respiratory   | 2010 - present |  |
| 16 | Ocular health OR ocular vision OR low vision OR visual acuity OR eyesight OR visual status  | 2010 - present |  |
| 17 | Sleep* OR sleep disturbance OR sleep patterns OR dyssomnias OR sleep disorders OR sleep deprivation   | 2010 - present |  |
| 18 | Vitamin D deficiency  | 2010 - present |  |
| 19 | 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18  | None           |  |
| 20 | 1 AND 19  | None           |  |
| 21 | Child OR adolescent OR school aged OR youth OR juvenile OR teenage OR young person OR teen OR preteen   | 2010 - present |  |
| 22 | 20 AND 21   |                |  |

## APPENDIX D – Articles included in the Systematic Review

1. Aires, L., et al., *A 3-year longitudinal analysis of changes in fitness, physical activity, fatness and screen time*. *Acta Paediatrica*, 2010. **99**(1): p. 140-144.
2. Barnett, T.A., et al., *Teens and screens: the influence of screen time on adiposity in adolescents*. *American Journal of Epidemiology*, 2010. **172**(3): p. 255-62.
3. Basterfield, L., et al., *Longitudinal study of physical activity and sedentary behavior in children*. *Pediatrics*, 2011. **127**(1): p. e24-30.
4. Carson, V., W. Pickett, and I. Janssen, *Screen time and risk behaviors in 10- to 16-year-old Canadian youth*. *Preventive Medicine*, 2011. **52**(2): p. 99-103.
5. Fisher, A., et al., *MVPA is associated with lower weight gain in 8-10 year old children: a prospective study with 1 year follow-up*. *PLoS ONE [Electronic Resource]*, 2011. **6**(4): p. e18576.
6. Graff, M., et al., *The combined influence of genetic factors and sedentary activity on body mass changes from adolescence to young adulthood: the National Longitudinal Adolescent Health Study*. *Diabetes/Metabolism Research Reviews*, 2011. **27**(1): p. 63-9.
7. Hands, B.P., et al., *The associations between physical activity, screen time and weight from 6 to 14 yrs: the Raine Study*. *Journal of Science & Medicine in Sport*, 2011. **14**(5): p. 397-403.
8. Lambiase, M.J., H.M. Barry, and J.N. Roemmich, *Effect of a simulated active commute to school on cardiovascular stress reactivity*. *Medicine & Science in Sports & Exercise*, 2010. **42**(8): p. 1609-16.
9. Mota, J., et al., *Television viewing and changes in body mass index and cardiorespiratory fitness over a two-year period in schoolchildren*. *Pediatric Exercise Science*, 2010. **22**(2): p. 245-53.
10. Paananen, M.V., et al., *Risk factors for persistence of multiple musculoskeletal pains in adolescence: a 2-year follow-up study*. *European Journal of Pain*, 2010. **14**(10): p. 1026-32.
11. Schooler, D. and S. Trinh, *Longitudinal associations between television viewing patterns and adolescent body satisfaction*. *Body Image*, 2011. **8**(1): p. 34-42.
12. Sharif, I., T.A. Wills, and J.D. Sargent, *Effect of visual media use on school performance: a prospective study*. *Journal of Adolescent Health*, 2010. **46**(1): p. 52-61.
13. Sund, A.M., B. Larsson, and L. Wichstrom, *Role of physical and sedentary activities in the development of depressive symptoms in early adolescence*. *Social Psychiatry & Psychiatric Epidemiology*, 2011. **46**(5): p. 431-41.
14. Viner, R.M., et al., *Longitudinal risk factors for persistent fatigue in adolescents*. *Archives of Pediatrics & Adolescent Medicine*, 2008. **162**(5): p. 469-75.

## **APPENDIX E – Survey Material used for Online Review.**

[Presentation of the Draft Preamble to the Sedentary Behaviour Guidelines for Children]

Please indicate whether you agree or disagree with Draft Preamble.

- 1 – Completely Disagree
- 2 – Disagree
- 3 – Neutral
- 4 – Agree
- 5 – Completely Agree

Are there any words in the Preamble that require a definition?

[Presentation of the Draft Sedentary Behaviour Guidelines for Children]

Please indicate whether you agree or disagree with Draft Sedentary Behaviour Guidelines.

- 1 – Completely Disagree
- 2 – Disagree
- 3 – Neutral
- 4 – Agree
- 5 – Completely Agree

If you have any comments, you can write them here.

[Presentation of the Draft Preamble to the Sedentary Behaviour Guidelines for Young People]

Please indicate whether you agree or disagree with Draft Preamble.

- 1 – Completely Disagree
- 2 – Disagree
- 3 – Neutral
- 4 – Agree
- 5 – Completely Agree

Are there any words in the Preamble that require a definition?

[Presentation of the Draft Sedentary Behaviour Guidelines for Young People]

Please indicate whether you agree or disagree with Draft Physical Activity Guidelines.

- 1 – Completely Disagree
- 2 – Disagree
- 3 – Neutral
- 4 – Agree
- 5 – Completely Agree

If you have any comments, you can write them here.

Sedentary Behaviour Guidelines are an important component of public health.

1 – Completely Disagree

2 – Disagree

3 – Neutral

4 – Agree

5 – Completely Agree

Should the Physical Activity and Sedentary Behaviour Guidelines be combined for dissemination? That is, appear in the same or separate documents?

Same document

Separate document

Do you have any other comments?

What is your gender?

Male

Female

What is your age range?

Under 18

18-24

25-34

35-54

55-64

65 +

In which sector are you currently employed?

Consulting

Education/University

Government

Healthcare/Medical

Non-profit

Research/Science

Other

In which country do you currently reside?

If you currently reside in Australia, in which state/territory is your primary residence?



## APPENDIX F – Summary of Online Comments and Guideline Development Committee Responses.

| <b>COMMENT</b>  | <b>COMMITTEE RESPONSE</b>   |
|---|---|
| It is presumed that the term “reclining” refers to “lying down”. If so, this needs a qualifier to state that this does not refer to sleeping, which is necessary for good health. | “during waking hours” was added within parentheses to indicate that sedentary behaviour does not include sleeping or naps.  |
| The Preamble and the Guidelines make no reference to a time allocation or dose-response relationship between sedentary behaviour and health risks.                                | “Less sedentary time is better” was added to the preamble. Further, the Sedentary Behaviour Guidelines incorporates the statement: “lower levels are associated with reduced health risks”, which reflects a dose-response relationship.                                |
| There should be a message about breaking up long periods of sitting in the Preamble. Further, what is a long period of sitting? And, how can you break it up?                     | The Committee acknowledged the need for clarity around these questions. However, it was preferable for these questions to be answered during public health messaging, rather than in the scientific statement (Preamble) or Guidelines themselves.                      |
| Stating that sitting should be “no more than 2 hours per day” implies or endorses that 2 hours per day is acceptable.   | It was important that these Guidelines were consistent with those from other jurisdictions, and thus, the 2-hour Guideline is acceptable. Further, for monitoring purposes, an unambiguous number is warranted (as opposed to “limit sitting to 1 to 2 hours per day”). |
| It may be beneficial to make reference to overall wellbeing in addition to mental health (which can often be interpreted as mental illness only).                                 | Immediately following the health outcome “mental health”, the “(e.g. self esteem)” was replaced with “and wellbeing”. This was undertaken to be consistent with the Physical Activity Guidelines.   |

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