Assessment of physical activity and sedentary behaviour in Australian children and adolescents: an audit and recommendations for survey questions

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Abbreviations

ABS	Australian Bureau of Statistics
ACHPER	Australian Council for Health, Physical Education and Recreation
ACT	Australian Capital Territory
AHKA	Active Healthy Kids Australia
ARC	Australian Research Council
BEACHES	Behaviors of Eating and Activity for Children's Health: Evaluation System
CATI	Computer assisted telephone interview
CCA	Corrected Covered Area
CHMS	Canadian Health Measures Survey
GPS	Global Positioning System
GSHS	Global School-based Student Health Survey
HBSC	Health Behaviour in School-Aged Children Survey
HPE	Health and Physical Education (curriculum subject)
MTS	Momentary time sampling
MVPA	Moderate-to-vigorous physical activity
NAPLAN	National Assessment Plan – Literacy and Numeracy
NHMRC	National Health and Medical Research Council
NSW	New South Wales
NT	Northern Territory
OSHC	Outside of school hours care
QLD	Queensland
SA	South Australia
SD	Standard deviation
SOPLAY	System for Observing Play and Leisure Activity in Youth
SPANS	NSW Physical Activity and Nutrition Study
SQL	Structured Query Language
TAS	Tasmania
US	The United States
VIC	Victoria
WA	Western Australia
WHO	World Health Organization

Glossary

Domain	The category of physical activity or sedentary behaviour.
Study	The research project reporting analysed data.
Dataset	The data derived from a sample of participants. If a different sample of participants was used within the same data collection wave, then it was separated into a different dataset.
Question	The survey questions used to measure participation in physical activity and sedentary behaviours.
Index questions	The total number of unique questions found.
Question instances	The distinct questions per study.
Measurement instances	The total number of times which participation has been measured.
Expert	A person with great knowledge of physical activity and sedentary behaviour research.
Survey	A set of questions used to collect data.
Participant	The children and adolescents who participated in each study.

Summary

Most Australian children and adolescents are not sufficiently active, with only 20% meeting the recommended 60 minutes of moderate-to-vigorous physical activity (MVPA) every day. In addition, many exceed the recommended 2 hours of recreational screen time. This picture is mirrored globally, with no meaningful improvements in the past decade and few children and adolescents accumulating the well-documented health benefits.

Australia lacks a comprehensive and consistent approach to physical activity measurement for children and adolescents. Sporadic national surveys and smaller state-based surveys, with varying measurement techniques, are instead used to piece together a picture of current activity levels and to identify areas of improvement. Without a standardised measurement approach or accessible data repository, it proves difficult to measure and compare activity levels and participation across time and jurisdictions, highlighting the need for better data.[1, 2] Therefore, the aim of this thesis is to:

1. Identify all existing data measuring physical activity and sedentary behaviour of Australian children and adolescents.
2. Identify existing survey questions, and through expert opinion develop a set of recommended questions.

This was achieved through three connected studies, each with an individual objective:

Study 1: To identify and describe existing data on Australian children's and adolescents' participation in physical activity and sedentary behaviours.

Study 2: To collate, classify and describe existing questions measuring Australian children's and adolescents' participation in physical activity and sedentary behaviours.

Study 3: To explore experts' perspectives on existing questions and create a set of recommended questions that could be used to measure children's and adolescents' participation in physical activity and sedentary behaviours.

Using a systematic search strategy, Study 1 synthesised data on Australian children's and adolescents' participation in physical activity and sedentary behaviours. A total of 190 datasets were identified over the past 68 years, with most data collected from 2000 onwards, and more than three-quarters using self-report and proxy-report measurement techniques. Research gaps were identified; specifically, few studies were identified capturing participation levels of young children (0–4-year-olds) and there are few national datasets.

Study 2 collated, classified and analysed existing questions measuring Australian children's and adolescents' participation in physical activity and sedentary behaviours. A total of 362 unique questions measuring participation levels were identified, with more than half used only once and few repeatedly used, resulting in largely incommensurable data. Questions were also classified and described according to the specific domains they measured, with an imbalance identified on the existing questions per each domain.

A Delphi survey was conducted in Study 3 to develop a recommended set of questions to measure children's and adolescents' participation in physical activity and sedentary behaviours. Two central questions were identified to best measure compliance with national guidelines: one measuring overall physical activity and one measuring screen time. A series of alternative questions were ranked for measurement of other domains. If the central questions were adopted, more comparable data would result across different geographic and demographic groups, and assist the design and evaluation of interventions and policies.

Declaration

I declare that:

this thesis presents work carried out by myself and does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; to the best of my knowledge it does not contain any materials previously published or written by another person except where due reference is made in the text; and all substantive contributions by others to the work presented, including jointly authored publications, is clearly acknowledged.



Verity Booth 18/04/22

Acknowledgement

I am excited to be finally writing this section of my thesis, and what a journey it has been. “Journey” is an interesting word, not overly eloquent but suggestive of exploration, experience, and existence. This journey has been shaped by many people, but firstly the two crazy kids which entered my life during the years which I worked on this research. They are both so free-spirited and accepting, keeping me grounded throughout. My patient and supportive husband Ryan, and my parents, sisters and friends for being the raft which I often relied on to stay afloat. Also, with an extra mention to Dad, for always willingly and eagerly assisting with the sometimes-overwhelming computer-related tasks, and Mum for your enthusiasm, devoted support with the kids and invaluable home help.

To be honest, I never would have expected to do a PhD with Prof Tim Olds, especially after your intimidating questions on my honours thesis about how physical activity is measured. Not sure how I ended up doing a thesis under your guidance on the same topic, but I have learnt so much from you. Despite my absent page numbers and substandard grammar, you have somewhat turned me into a PhD scholar. Thanks for your quick email replies and the time you have dedicated on assisting me to finally get there.

To my other supervisors, Dr Natasha Schranz, thanks for your ongoing support and always keeping the light at the end of the tunnel. Thanks also to Prof Dave Lubans and Prof Grant Tomkinson, for your valued contributions and insights.

This wouldn’t have also been possible without the financial support of an Australian Government Research Training Program Scholarship, Active Healthy Kids Australia, Health Development Adelaide and BUPA.

It is 11 o’clock at night, a little voice wakes from the next room. “Mummy!”, my 4-year-old calls me in to his room to ask an important *can’t wait until the morning* question. “Have you finished your book yet?”, he asks.

Yes, Callan, I have finally finished my book! And I dedicate it to you, and your little sister Macey. I remain optimistic and hopeful, that this research may translate and make some small difference to the big, larger than life world of a

child, and provide you and all the other kids with more opportunities to live an active life. I look forward to the special certificate you have promised to make for me, “with a ribbon on it”.

Thesis structure

This thesis includes five chapters. *Chapter 1* provides an introduction to this research area, as illustrated in Figure 0.1, and delves further into some of the complex issues this research seeks to address. This chapter outlines Australia's physical activity and sedentary behaviour guidelines and discusses their creation. Next, the activity-related behaviours addressed throughout this research are identified and defined, followed by a summary of evidence of the impact that physical activity and sedentary behaviours have on health and wellbeing. Different measurement techniques, past and present, are then identified, followed by a discussion of the complexities of measurement, particularly at a population level. This knowledge was then applied to current measurement and estimation of prevalence rates, recognising how measurement inconsistencies impact these estimations, especially regarding population surveillance. To complete this first chapter is a discussion of existing research on physical activity and sedentary behaviours to identify trends in the activities participated in and recognise relevant historical context. This last section shows how changes in physical activity and sedentary behaviours over time have implications for measurement and the estimation of trends.

Chapter 2 presents the research conducted in Study 1, in which I conducted an audit of existing data on Australian children's and adolescents' physical activity participation and sedentary behaviours. Specifically, it includes background reasoning for the research, aims and methods, results and main findings.

Chapter 3 presents the research conducted in Study 2, in which I collated and described existing questions measuring Australian children's and adolescents' participation in physical activity and sedentary behaviours. Following a similar structure to Chapter 2, it includes background reasoning for the research, aims and methods, results, and main findings.

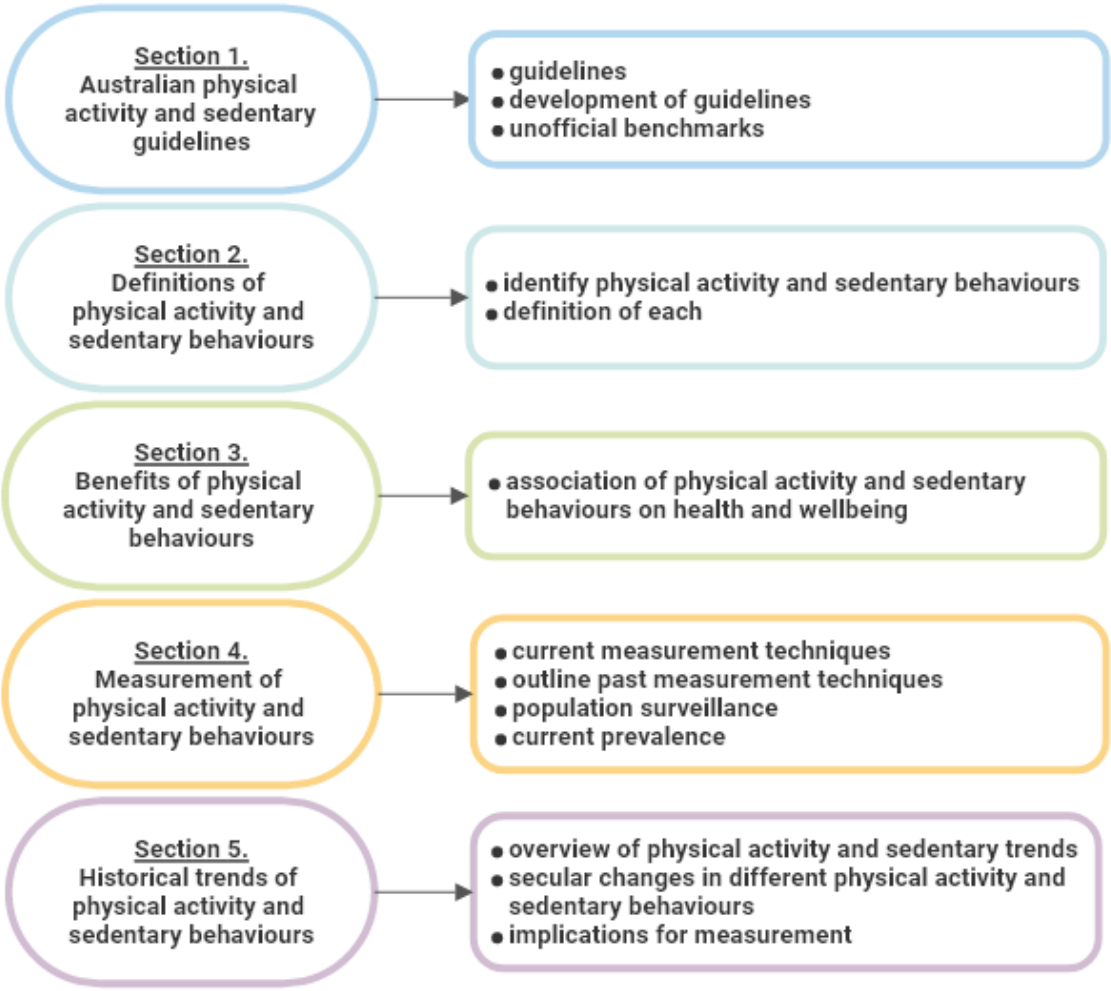


Figure 0.1 Overview of information presented in Chapter 1.

Chapter 4 presents the research conducted in Study 3, in which I conducted a Delphi survey to explore and determine experts' perspectives on existing questions. In this research, I also created a set of recommended questions that could be used moving forward to measure children and adolescents' participation in physical activity and sedentary behaviours.

Chapter 5 compiles all the findings within the main discussion section. Within this chapter, I discuss the implications of this research and suggestions for further research.

CHAPTER 1.

Introduction

We must remind ourselves that there is one asset which stands above all others, in terms of national resources, even above coal and iron, our dairying, wood, timber and wheat and that is the Australian people. Our resources are the optimistic prediction of the future, but the realisation of that prediction is in the hands of our children.

Gordon Young

Port Macquarie News and Hastings River Advocate 1944[3]

1. Introduction

Physical activity is a fundamental necessity for children and adolescents. Most children enjoy being active and express this in a variety of ways.[4] Across many centuries, children have enjoyed active games and sports, in the street, fields or bush.[5, 6] Parents of today's children recollect walking and riding their bikes everywhere, and generally playing in the street and neighbourhood.[7] In contemporary society, an array of opportunities to be active exists, including the re-emergence of nature play and modern trends towards adventure sports.

Leading an active life is essential for children of all ages, with well-documented health and wellbeing benefits. Decades of research have found that physical activity participation has numerous physical, social, cognitive, and psychological benefits.[8-10] Despite this, only 1 in 5 children participate in the recommended 60 minutes of MVPA daily.[11] Currently, there is a global health crisis when it comes to participation in physical activity, and as habitual patterns of physical activity develop early in life, many children have an increased risk of various health conditions as adults.[12, 13] Furthermore, exceeding the screen time recommendations can have independent health and wellbeing implications, with over half of children and adolescents worldwide exposed to these health detriments.[14]

Despite the numerous attempts at improving physical activity levels, it appears that Australian children's and adolescents' participation levels are not making meaningful improvements. Various reasons have been suggested as to why this may be so, many stipulating the need for better data. Having accurate data is needed to determine compliance to movement guidelines, inform interventions, policies, and future research, and make temporal and global comparisons. As illustrated in Figure 1.1, inconsistencies exist in the data currently collected, arising due to the complex nature of children's and adolescents' physical activity and sedentary behaviours, lack of consistent and comprehensive measurement and the uncertainty around what data currently exists. Many of these variables will be explored further throughout this thesis.

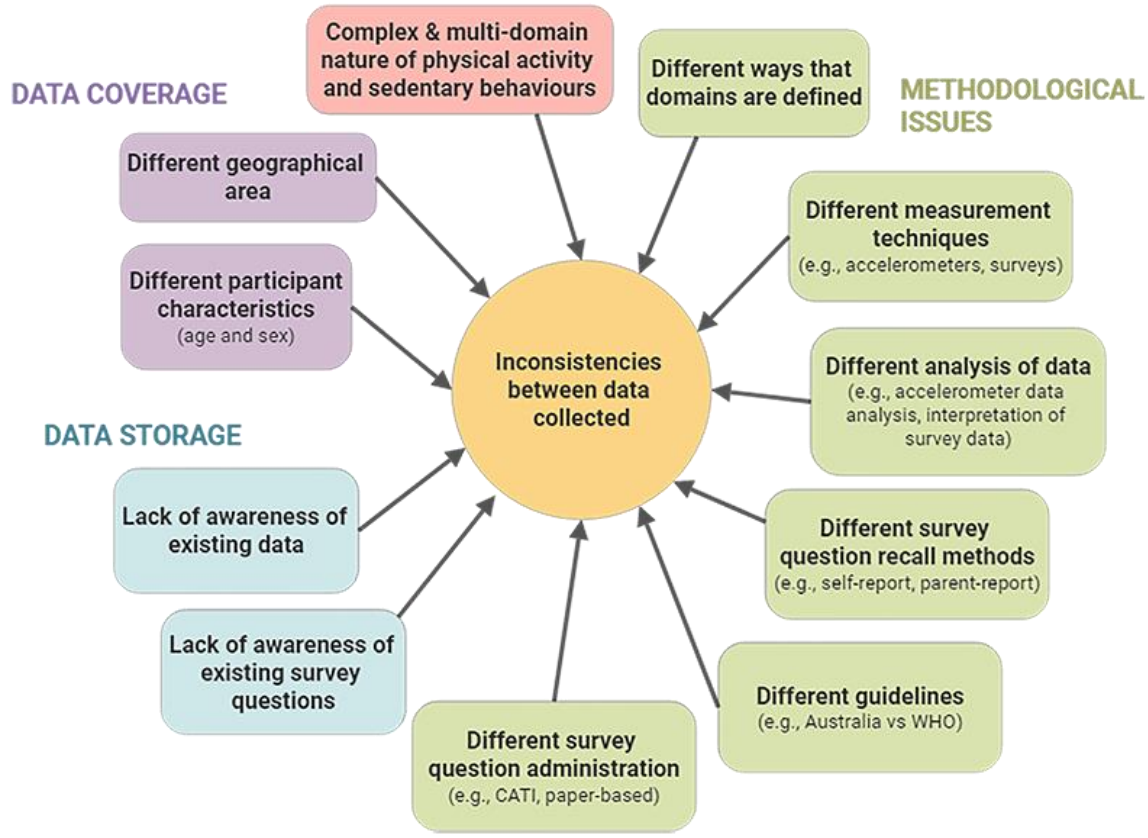


Figure 1.1 Outline of potential sources of inconsistencies in data collected on children's and adolescents' participation in physical activity and sedentary behaviours.

WHO = World Health Organisation, CATI = Computer Assisted Telephone Interview

1.1 Physical activity guidelines for children and adolescents

Over the past few decades, extensive research has indicated the importance of participation in physical activity and identified concerns regarding recreational screen use for children and adolescents, resulting in the development of targeted national guidelines. In 1994, the United States (US) was the first country to release national physical activity guidelines for children, following advice provided by the International Consensus Conference on Physical Activity Guidelines.[15, 16] Shortly after, in 2001, the National Heart Foundation of Australia released a similar set of recommendations for Australian children and adolescents. However, it was not until 2004, following a comprehensive 4-year

development process, that the Department of Health and Ageing released the first Australian guidelines for children and adolescents.[17] These guidelines were:

1. Children and youth should participate in at least 60 minutes (and up to several hours) of moderate-to-vigorous-intensity physical activity every day.

2. Children and youth should not spend more than 2 hours per day using electronic media for entertainment (e.g., computer games, internet, TV), particularly during daylight hours.

Official guidelines for younger children (0-5 y) were not released until 2010,[18] owing to a lack of evidence around the health implications of movement for children of this age. Despite this, Australia was the first country to release government-endorsed recommendations for this age group. These guidelines consisted of:

> Toddlers (1–3 years) and pre-schoolers (3–5 years) should be physically active (light-to-vigorous intensity) every day for at least 3 hours, spread throughout the day.

The latest Australian guidelines have incorporated movement behaviours (physical activity, sedentary behaviours and sleep) across a whole day in response to evidence that these behaviours impact each other. Systematic reviews conducted by teams of experts reviewed available evidence to determine what recommendations would be associated with improved health and development.[9, 19, 20] Australia adopted the current 24-hour guidelines, outlined in Table 1.1, for 0- to 5-year-olds in 2018 and 5- to 17-year-olds in 2019. It should be noted that despite the title, these are not true *24-hour guidelines* in the sense of recommending an optimal mix of time use, but instead, they bring together separate recommendations for physical activity, sedentary behaviour, and sleep under a single umbrella.

Table 1.1 Australian 24-Hour Movement Guidelines for infants (0-1 years), toddlers (1-2 years), pre-schoolers (3-5 years), children (5-12 years) and young people (13-17 years).

Age	Guideline
Infants (0-1 years)	Physical activity: Being physically active several times in a variety of ways, particularly through interactive floor-based play; more is better. For those not yet mobile, this includes at least 30 minutes of tummy time spread throughout the day while awake.
	Sedentary behaviour: Not being restrained for more than 1 hour at a time (e.g., in a stroller, car seat or highchair). Screen time is not recommended. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.
Toddlers (1-2 years)	Physical activity: At least 180 minutes spent in a variety of physical activities including energetic play, spread throughout the day; more is better.
	Sedentary behaviour: Not being restrained for more than 1 hour at a time (e.g., in a stroller, car seat or highchair) or sitting for extended periods. For those younger than 2 years, sedentary screen time is not recommended. For those aged 2 years, sedentary screen time should be no more than 1 hour; less is better. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.
Pre-schoolers (3-5 years)	Physical activity: At least 180 minutes spent in a variety of physical activities, of which at least 60 minutes is energetic play, spread throughout the day; more is better.
	Sedentary behaviour: Not being restrained for more than 1 hour at a time (e.g., in a stroller or car seat) or sitting for extended periods. Sedentary screen time should be no more than 1 hour; less is better. When sedentary, engaging in pursuits such as reading and storytelling with a caregiver is encouraged.
Children and young people (5-17 years)	Accumulate 60 minutes or more of moderate to vigorous physical activity per day involving mainly aerobic activities.
	Several hours of a variety of light physical activities.
	Limit sedentary recreational screen time to no more than 2 hours per day.
	Incorporate activities that are vigorous, as well as those that strengthen muscle and bone at least 3 days per week.

Globally, many countries have now adopted guidelines, however differences exist as to the activity recommended. A systematic review conducted by Parrish and collegues[21] found considerable variability between the recommendations, including difference in the frequency of muscle and bone strengthening exercise and time restrictions placed on sedentary activities. This has further implications in how these behaviours are measured, resulting in the need for different measurement globally.

Guidelines mainly provide recommendations around the *amount* and *intensity* of activity but lack advice about the various *types* of activity. Children's and adolescents' physical activity and sedentary behaviours are made up of different types of activities which can be categorised into various domains. It is difficult to monitor participation rates for each of these domains using the overall movement guidelines, therefore unofficial benchmarks are often used instead (Table 1.2). These benchmarks are used by Active Healthy Kids Australia (AHKA), a national collaboration of children's physical activity researchers, and are also used by the other member countries comprising the Active Healthy Kids Global Alliance.[22]

Table 1.2 Unofficial benchmarks used by the Active Healthy Kids Global Alliance.

Domain	Unofficial benchmark
Organised sport participation	Percentage of children and youth who participate in organised sport and/or physical activity programs.
Active play	Percentage of children and youth who engage in unstructured/unorganised/active play for several hours a day.
Active transportation	Percentage of children and youth who use active transportation to get to and from places (school, park, mall, friend's place).
Physical Education	Percentage of children and youth who participate in Physical Education at school.
Exercise	Percentage of children and youth who participate in moderate to vigorous exercise.
Screen-time	Percentage of children and youth who meet the age-appropriate screen-time guidelines.
Non-screen sedentary time	Percentage of children and youth who meet the age-appropriate non-screen-related sedentary behaviour guidelines.

In summary, physical activity and sedentary behaviour guidelines were developed to provide guidance on the amount, frequency, intensity, duration, and type of activity needed to enhance health and development, and to avoid health deficits. The guidelines explicitly address physical activity and sedentary behaviour generically, however, to determine participation levels in specific types of domains, unofficial benchmarks can be used. Definitions of each of these domains will be provided in the next section.

1.2 Physical activity and sedentary behaviours

Children and adolescents can participate in a wide range of physical activities and sedentary behaviours. Observations across a 24-hour time span may include a range of physical activity types such as walking to school, playing in the playground, sport in Physical Education, and playing in the backyard after school.

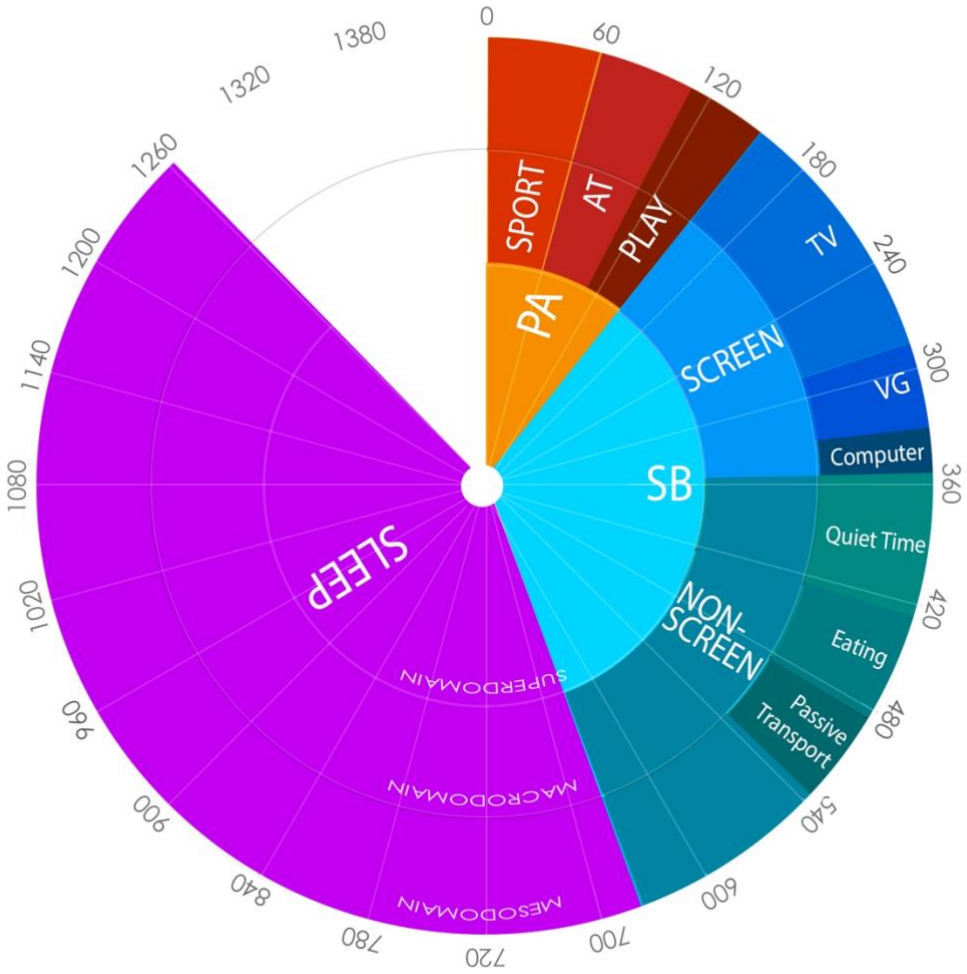


Figure 1.2 Proportion of time consumed by physical activity and sedentary behaviours within a 24-hr period. Values are in minutes (1440 minutes per day).

Data are based on time-use recalls of 35,655 days from 12,814 9-17 year old children over the period 2002-2019.[23] PA= physical activity, SB= sedentary behaviour, AT= active transport, VG= video gaming, superdomain = type of behaviour, macrodomain = physical activity or sedentary behaviour domains, mesodomain = specific activity

Possible sedentary behaviours may include sitting in a car on the way home from school, sitting and talking to family at home, lying down while using social

media, and reading a book in bed. These and many other activities have been recalled by children and adolescents across a 24-hour time span, as illustrated in Figure 1.2. After collating these into similar activities, some activity domains deserve particular attention. On average their day consists of 133 minutes of physical activity consisting of three main domains of activity; sport (47%), play (25%), and active transport (29%). Additionally, 529 minutes was consumed by sedentary behaviours consisting of two main domains: screen time (41%), and non-screen sedentary time (59%).

Sallis and colleagues[24] developed an ecological model to provide further context to the different types of physical activity. Despite being designed for adults, it suggests that physical activity behaviours can occur across four main domains: recreation, transport, occupation, and household. The model includes interactions between the domains and the environment and policies, illustrating susceptibility to change over time. Even though Sallis's model does not solely speak to children and the activities they may participate in, the notion that physical activity behaviours are impacted by many factors outside of the individual (e.g., neighbourhood walkability, availability of community sports programs) is relevant to children, adolescents, and adults alike. Social trends, government policies and the environment can impact an activity domain, modernising and altering how it is defined over time. The fluid nature of physical activity domains over time will be explored further in an upcoming section. An understanding of the complexities that exist while attempting to define physical activity and sedentary behaviours are important to call attention to.

Despite the existing difficulties in defining the types of physical activity and sedentary behaviours, the need to measure outweighs these complexities. To assess compliance to guidelines and determine trends over time, some boundaries need to be placed on activity-related behaviours. Applying consistent definitions will improve how each domain is measured, providing clarity for both the researcher, policy maker or practitioner and the respondents recalling the behaviour. Due to the inconsistencies in how physical activities and sedentary behaviours are defined, it is important to clearly state domains of physical activity which are used throughout this thesis.

In response to this issue, part of this research project involved developing a classification system which can be used to define physical activity and sedentary behaviours. How this classification tool was created and designed are outlined in Chapter 3, however it has been introduced in this section to clearly state the domains of physical activity which are operational throughout this thesis.

A list of all possible domains of physical activity and sedentary behaviours was conceptualised and then structured into the classification system, namely the Classification System for Physical Activity and Sedentarism (CS-PAS). The definitions for each type of physical activity were located within research published by experts or government organisations related to that field. The domains included:

- active play
- active transport
- sport
- physical education (PE)
- exercise
- other physical activity
- screen-time
- non-screen sedentary time

These domains are based on the purpose for participation in physical activities or sedentariness, then within each domain, children and adolescents could partake in a variety of activities. For example, adolescents may participate in muscle strengthening activities within the domain of exercise, such as CrossFit. In addition, children may participate in the same type of activity (muscle strengthening) within a different domain, such as sport, by participating in swimming. Definitions of the domains of physical activity and sedentary behaviours are outlined in the following sections.

1.2.1 Physical activity

Physical activity is defined as *any bodily movement produced by skeletal muscle that substantially increases energy expenditure*.[25] Due to the nature of youth

physical activity, it can be difficult to measure accurately and consistently. Depending on age, physical activity tends to be intermittent and unplanned in nature, with the majority of bouts lasting 3–22 seconds.[26] Participation can also occur at different intensities: light (1.6–2.9 metabolic equivalents METs); moderate (3.0/4.0–5.9 METs); and vigorous (≥6 METs).[27] As previously stated, the Australian guidelines provide recommendations on the intensity of physical activity but also recommends participation in muscle and bone strengthening activities. This type of activity is defined as physical activity that increases *skeletal muscle, strength, power, endurance, and mass*.[28] Examples of muscle strengthening activities include resistance training, yoga, Pilates, martial arts, and rock climbing. Physical activity of different intensities and types, such as muscle strengthening, can be measured within each specified domain.

1.2.1.1 *Active play*

Active play is often very broadly defined. Truelove and colleagues define active play as *a form of gross motor or total body movement in which young children exert energy in a freely chosen, fun and unstructured manner*.[29] Examples include running, swinging, and jumping[29] in different settings including at home, in the backyard, in the street or in public open spaces including a park, playground or bush/river.[30] Other opportunities for active play occur at school, especially during recess and lunch break times.

1.2.1.2 *Active transport*

Active transport is defined as *human powered transport modes*.[31] Mostly completed at a low-to-moderate intensity, active transport includes walking, cycling, scooting, skateboarding, and any other active movement to and from school, as well as other destinations.

1.2.1.3 *Sport*

There has been debate about how sport should be defined.[32] Vella and Schweickle[33] collated various published definitions of sport and developed some key concepts concerning what constitutes sport, including; *physical activity which should involve either physical exertion or physical skill, a structured or organised setting, and some level of competition against others or a defined goal*.

1.2.1.4 *Physical education*

The Australian Council for Health, Physical Education and Recreation (ACHPER) defines PE as *the curriculum area that engages students in worthwhile learning experiences to develop skills, knowledge, self-efficacy and dispositions that will enable young people to live healthy and active lifestyle*.[34] Alongside this definition it is also stated that *contexts of physical activity and sport are central to Health and PE (HPE), but HPE is distinguished from 'physical activity' and 'sport' by virtue of its core focus on learning*.[34] This alludes to the fact that the time allocated for students to take part in this learning area includes not only the acquisition of movement skills, but also the acquisition of important knowledge around health and wellbeing.

1.2.1.5 *Exercise*

Exercise is defined as a *subset of physical activity that is planned, structured, repetitive, and done to improve or maintain physical fitness*.[35] A common understanding is that exercise mainly occurs at gyms or fitness centres, however it can also occur in many other settings including activities such as running/jogging, walking, gym, Pilates, yoga, cycling, and sports.

1.2.2 Sedentary behaviour

Sedentary behaviour is defined as any waking behaviour characterised by an energy expenditure ≤1.5 metabolic equivalents (METs), while in a sitting, reclining, or lying posture.[36] Sedentary behaviours are commonly related to activities that occur using a screen but can involve non-screen-related activities.

1.2.2.1 *Screen-time behaviour*

Screen time refers to *the time spent on screen-based behaviours*.[36] There are two main types of screen time, passive and active. Passive screen time includes activities such as TV watching and smartphone use while sitting or lying down, whereas active screen time includes *time spent using a screen-based device while not being stationary*.[36] Directly measured active screen time, such as active gaming, is not included in this domain, only sedentary screen time. Televisions, computers, laptops, tablets, and other mobile handheld devices can be used for

two primary purposes: education and recreation/entertainment. Most educational facilities now use computers, laptops, and tablets for those aged five and up, integrating them into their learning as the Australian Curriculum suggests.[37]

1.2.2.2 *Non-screen sedentary activities*

Non-screen-based sedentary time refers to the time spent in sedentary behaviours that do not involve the use of screens.[36] These behaviours consist of low-intensity sitting or reclining activities without using a screen, for example, reading a book, listening to music, drawing/painting, music practice, passive transport, and school-related work. For young children, it also includes awake time when restrained, such as in a pram, highchair, or car seat.[38]

1.3 Benefits and detriments of participation in physical activity and sedentary behaviours

The relationship between children's and adolescents' physical activity, sedentary behaviours and health has been well researched. Several systematic reviews have been conducted, showing positive associations for cardiometabolic health and fitness, adiposity, musculoskeletal health and mental health.[19] Other systematic reviews have considered relationships with cognitive function, psychological wellbeing and brain structure, finding positive associations with mental health and white matter integrity.[39, 40]

Despite the documented positive effects, researchers are calling on improved evidence to further understand these relationships. Currently, there is a lack of well-designed interventions and experimental studies, providing limitations around the strength of evidence available. Furthermore, few high quality studies have investigated the relationship between physical activity, sedentary behaviours and health and wellbeing in younger children. More research is required on the impact of sedentary behaviours in infants and toddlers.[8, 20, 41] This has further implications on the prescription of official guidelines, since a better understanding of the associations can lead to improved recommendations with more specific activity dimensions outlined. There were two key systematic

reviews to inform official movement guidelines, most of the included studies are cross-sectional, some are longitudinal, with few randomised-control trials, interventions and case-control studies. Systematic reviews conducted to inform the WHO guidelines for younger children (aged 0-5)[42] and Australian guidelines for school-aged children and adolescents (aged 5-18)[9] will form the evidence base used to outline the implications of physical activity and sedentary behaviours on health and wellbeing.

An examination of the implications of physical activity participation for younger children (aged 0-5) revealed improved motor development, cognitive development, psychosocial and cardiometabolic health, bone and skeletal health, and improved fitness levels.[42] Across 96 included studies, screen time was seen to be negatively associated with adiposity, motor development, cognitive development and psychosocial health. The limited available evidence suggests that encouraging both tummy time and unrestrained infant movement was positively associated with improvements in motor development and adiposity.[42]

Regarding school-aged children and adolescents, similar positive associations were found for engaging in physical activity and unfavourable associations for participating in screen time.[9] In a review of 247 studies, evidence was found for positive associations between participation in physical activity and fitness, motor and cognitive development, fitness, cardiometabolic health, adiposity, skeletal health and potentially *on-task performance* in classroom. Lower levels of sedentary screen time are related to lower adiposity, improvements in cognitive and motor development and psychosocial health.

Despite evidence for the benefits of less screen time, the official guidelines stipulate those limitations on duration only apply to recreational screen time. This can appear inconsistent. Most educational facilities integrate smartboards, computers, laptops and tablets into learning programs for children from age five upwards.[37] Secondary students can use a laptop for a large portion of their learning. The appropriate balance between the educational benefits of screen time and the negative impact on health and wellbeing is a matter of ongoing debate.[37]

Opportunities to be physically active also enhance physical literacy in an individual, with associated improvements in motor competence, confidence, motivation, knowledge and understanding of the value of physical activity.[43] Despite varied measurement approaches currently used to assess these different contributes, evidence suggests that enhancing each supports participation in physical activity across the lifespan.[44]

Participation in other physical activity and sedentary behaviours can elicit additional benefits. A review of reviews investigating the potential impact of sports participation included 23 review studies[45] and found there are accumulated dose-response benefits related to bone health, mental health, perceived health and well-being, self-concept, self-esteem, self-regulation, self-efficacy, competence, social skills, enjoyment, satisfaction, connectedness, belonging, interdependence and group cohesion. Likewise, a position statement on active outdoor play created by Tremblay and colleagues[46] surmised that *when children are outside they move more, sit less and play longer – behaviours associated with improved cholesterol levels, blood pressure, body composition, bone density, cardiorespiratory and musculoskeletal fitness and aspects of mental, social and environmental health.*

In summary, there is strong evidence to support the notion that physical activity benefits children's and adolescents' health and wellbeing, and extended screen time is not good for health. It is important to ensure all children and adolescents have access to opportunities and are supported to participate in the recommended amount of activity. More well-designed interventions and experimental studies are needed to better understand the associations between younger children and screen time, and how this can influence established guidelines.

1.4 Measurement of physical activity and sedentary behaviours

Many parameters must be assessed to understand physical activity participation and its impact on health and wellbeing. Specifically, the inclusion of: type, frequency, duration, and intensity will help provide an overall estimation of

activity levels or sedentarism. Although complex, it will provide much needed information on health status and a base from which improvements can occur.

Numerous measurement techniques have been used, providing different information about the activity being measured with differing levels of validity and reliability. Each measurement technique taps into different physiological responses to body movement and energy expenditure to capture active or sedentary behaviour. This section provides an overview of current and past measurement techniques. Revisiting some of the previously used measurement techniques over the past few decades provides more context to the current issues. In addition, this section includes a discussion on population surveillance and the consequential issues arising from inconsistent measurement.

1.4.1 Current measurement techniques

Many different methods can be used to measure children's and adolescents' activity levels, and there is no one gold standard method that can capture all physical activity parameters. Despite doubly labelled water being the most reliable and valid measure of energy expenditure, it is not able to capture the duration, intensity or type of participation.[47] As illustrated in Figure 1.3, other measurement techniques involve measuring body movement either subjectively (self- or proxy-report) or objectively (device-based), or capturing energy expenditure using different biological approaches. The most widely used techniques include self- or proxy-report and device-based measurement; hence, these will be the focus for this section.

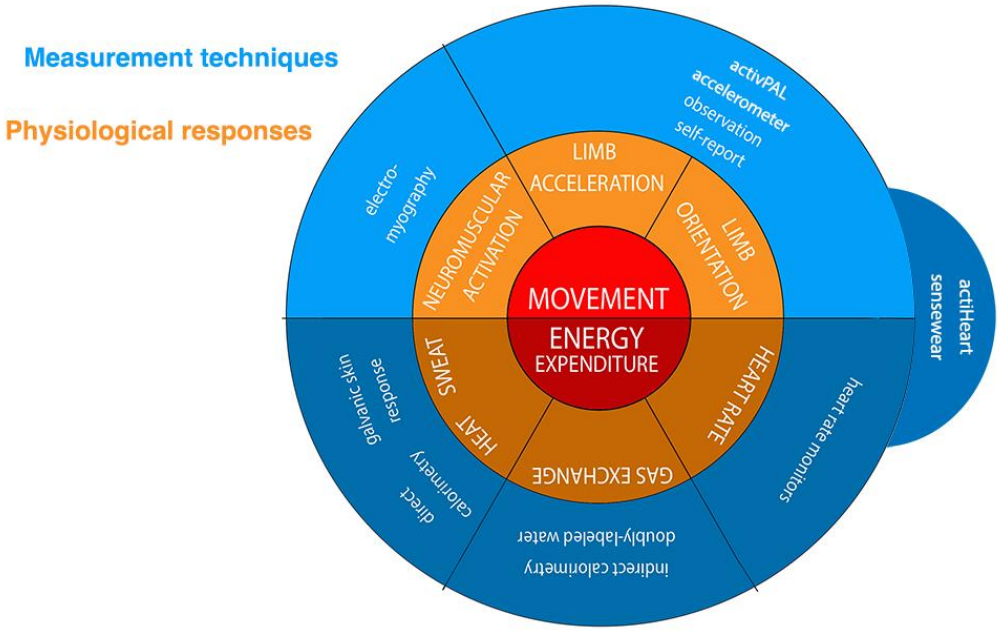


Figure 1.3 Diagram illustrating the different measurement techniques and the physiological responses they used to measure physical activity.

Subjective measures are used to measure activity participation mainly through recall across a specified timeframe. There are four main categories of subjective measurement[48] consisting of:

- self-report surveys
- parent- or proxy-report
- interviews
- dairies or activity logs

Self-report and parent- or proxy-report are common and convenient approaches for measuring physical activity and sedentary behaviours. These involve recalling participation in various activities over short time frames such as 1 day, through to longer time frames such as 1 year.[49] Surveys can vary in the type of activities measured, centring around participation within one or many of the activity-related domains. This measurement approach can be administered differently, using interviews (e.g., face-to-face or Computer Assisted Telephone Interview [CATI]) or self-complete questionnaires (e.g., paper-based or online).

Consistent with most forms of measurement, error can occur when collecting data. Regarding self-report and parent/proxy-report, measurement can be skewed through social desirability, poor recall and misinterpretation of the questions.[50] Research suggests that children under the age of ten are unable to understand concepts such as time-frame and what constitutes physical activity, therefore they are unable to accurately recall their activities.[49] For this age group, parent-report or proxy-report of activity is recommended. For example, one study found 60% of students aged ten or less had difficulty differentiating between the recall of various sedentary and physical activities.[49] Another potential source of error can result when surveys are coded to estimate time of physical activity or energy expenditure (i.e.; estimating the intensity of a sport to determine minutes of MVPA).[51] Despite this, the advantages of using this measurement is the ability to capture participation in different domains, along with the potential to estimate trends through use of repeated measures.[50]

Objective measurement includes the use of devices such as pedometers and accelerometers which directly measure an individual's body movement. These devices are worn on a participant's body and use step counts (pedometer) or motion sensors (accelerometer)[47] to detect limb acceleration and orientation. Pedometers can measure steps taken or distance covered, although limitations exist in their ability to measure some forms of activity (e.g., cycling) and therefore their ability to measure compliance to guidelines. However, in comparison to other device-derived measurement, there is a lower cost associated with their use in larger studies. Accelerometers have the ability to record frequency, volume, intensity and duration of a participant's movement, along with capturing the pattern of participation.[26] Research has found good validity when comparing energy expenditure measured using doubly labelled water.[49] Despite this, there was a lack of standardised data processing methods and analytical approaches that may not be commensurable, for example, sampling frequency, epoch length, non-wear time definitions, and algorithms used.[49, 52] Other limitations include compliance issues, higher cost and practicalities of use, especially in large studies.

1.4.2 Overview of past measurement techniques

Over time, measurement techniques have evolved, improving accuracy and ability to measure a population's activity levels. Despite the positive improvements in measurement capabilities, using a wide variety of instruments also limits establishing long-term trends. Although not an exhaustive overview, Figure 1.4 provides an indication of when various measurement techniques were first used to measure children's and adolescents' physical activity and sedentary behaviours within Australia and other countries.[53] [54, 55] [56] As seen below, many different measurement techniques exist, also evident in Figure 1.3, ranging from early studies using questionnaires and surveys to the inclusion of more technology in the form of accelerometers. Few techniques from the 1950s to 2000s are commonly used in contemporary research, placing limitations on past data, which can be used to make comparisons with recent data. An overview of previously used measurement techniques is below.

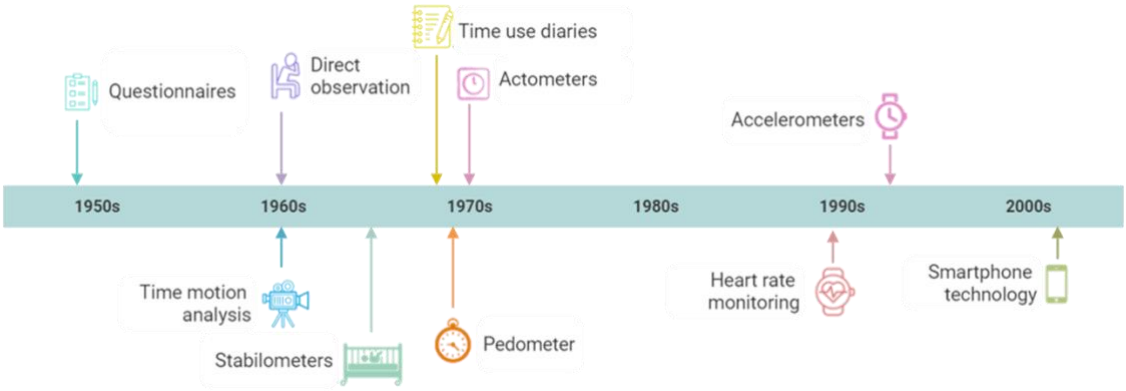


Figure 1.4 Timeline indicating the first use of different measurement technologies used to measure physical activity levels of children and adolescents.

Time-motion analysis: used to capture activity of small samples. Two studies were mentioned, in 1964 and 1968, in which a time period was filmed, such as school recess time, combined with activity diaries to establish the activity level of the children.[53]

Direct observation: researchers observe participants' activity levels within a specific setting to determine the dimensions of their activity and are often

captured alongside other aspects of the environment.[57] In a study conducted in 1966 the observations were communicated to a central recording station using walkie-talkies.[53] The Behaviors of Eating and Activity for Children's Health: Evaluation System (BEACHES) used momentary time sampling (MTS) to collect both physical activity and environmental data, first used in the early 1990s. Another validated system using MTS to capture physical activity and sedentary behaviours is the System for Observing Play and Leisure Activity in Youth (SOPLAY), which is still used to capture active play in designated areas. Observer reliability of 80% or higher is considered sufficient for these instruments.[57]

Time-use diaries: used by some studies to establish physical activity behaviour.[53]

Pedometers: reportedly used in the 1920s although used more in the 1970s to measure children's activity. During this time period, correlations with other methods including direct observation and questionnaires were also inconsistent, and concurrent validity between different device brands was low.[53]

Actometer: a device to measure uniaxial acceleration and deceleration, was reportedly used in small studies of infants and children worn on the ankle, wrist or back (1968). One study using the device reported good test-retest reliability and another reported poor reliability.[53] This progressed into the development of the triaxial accelerometer.

Accelerometer: an earlier iteration of a triaxial accelerometer used today and was only just starting to be used in a smaller studies in the early 1980s.[53] [54] A notable increase in studies using accelerometers occurred since the 2000s.[55]

Heart-rate monitoring: provides an indication of the pattern and intensity of activity. There is much error in this estimate of activity levels, due to many other variables that could influence heart rate (fitness, emotional stress, environment, muscle groups being used).[55]

Stabilometers: a type of motion sensor placed in a mattress to measure activity level of infants was used in the 1960s and 70s.[54]

Smartphones: measures activity levels by the inbuilt smartphone's accelerometer, Global Positioning System (GPS) or by an external sensor connected to the

smartphone. These can be placed in the waist-hip area, chest, limbs, handheld or in a bag. Overall, studies have reported varying measurement accuracy between 52-100%.[56]

To summarise, many different techniques have been used to capture children's and adolescents' activities and sedentariness over the last seven decades. The varying approaches and captured parameters limit the comparability of the collected data.

1.4.3 Population surveillance and associated issues

Population surveillance is needed to assess, track, and monitor physical activity and sedentary behaviours over time. The purpose of population surveillance is to assess the proportion of a population who meet a defined benchmark, specifically the Australian movement guidelines, outlined in an above section (Section 1.1).[48] Due to the complex nature of physical activity participation, it can be difficult to measure accurately and consistently. Ideally, measurement needs to be comprehensive and inclusive of various activity-related behaviours. Furthermore, consistency in measurement across time and location is another important aspect to allow for comparisons of data collected.[48]

Numerous methods can be used to measure participation in physical activity and sedentary behaviours, however self- or parent-report and accelerometers are the two most used approaches.[58] Self-report is more commonly used for population surveillance, particularly considering it is more cost-effective and easier to administer to large samples.[47] In comparison to surveys, accelerometers are more accurate and have better test-retest reliability, with ICCs of 0.77-0.90 compared to questionnaires ICCs 0.59-0.84.[59] However, due to inconsistent data collection and processing occurring while using an accelerometer in population surveillance, some experts believe it would be preferable not to use them until a standardised approach has been established.[59]

Inconsistencies in prevalence estimates can also result from differing interpretations of how compliance to guidelines is assessed. One research study identified that prevalence estimates differed between 20% to 68% depending on the measurement approach.[60] The percentage meeting MVPA guidelines can be

defined as meeting the guidelines on all days (4 days for this study), on most days (3 out of 4 days), the average across all days, or on any random day. Even though Australia's guidelines specify *60 minutes of MVPA per day*, it has not been clearly established whether the health benefits are ideally acquired from activity every day, or the same amount accumulated over a few days. To add further complexity, WHO guidelines have recently been reviewed and altered to specify *an average of 60 min of MVPA per day across the week*, requiring different measurement needs in comparison to Australia's guidelines.[61]

The use of different methodological approaches adds more complexity, creating difficulties when making comparisons between datasets and when trying to investigate how activity levels have changed over time.[22] Different measurement techniques measure various dimensions of physical activity and sedentary behaviours, emphasising the importance of using consistent measurement techniques to capture population compliance. This has further impact, consequently affecting the interventions and policies that are created and evaluated using this data. Temporal trends in physical activity levels can be used to inform or evaluate public health measures.[62] Other reasons for measuring activity levels of a population include measuring public health impact or to informing/assessing current interventions and policies.[62]

On a global scale, children's and adolescents' participation in physical activity and sedentary behaviours has been labelled by WHO as a concern.[63] A necessary first step to effectively address this issue is a consistent and systematic international surveillance system, providing invaluable data on participation rates across all countries which could easily be compared and used for public health promotion. Standardised self-reporting measures are currently used in many countries around the world, including over 40 countries in Europe.[64, 65] Two standardised international surveys are regularly administered across multiple countries; the Health Behaviour in School-Aged Children (HBSC) Survey, and the Global School-based Student Health Survey (GSHS). The HBSC was first used in 1982 and now completed every 4 years by 11-, 13-, and 15-year-olds across 50 countries.[62] The GSHS is a self-report questionnaire for secondary

students (13- to 17-year-olds). It has been conducted in 98 countries, each administering it with different frequencies.[62]

Many other countries also implement their own national surveillance system, including Canada and the US. The Youth Risk Behaviour Surveillance System, first collected data across the US in 1990,[66] initially measuring light to moderate physical activity, vigorous physical activity, physical activity for weight control, strength and flexibility, sports participation, and school physical education. The survey has been conducted biennially on students in grades 9 to 12, totalling 4.9 million students. This is one of many other national surveillance surveys conducted in the US including the National Health and Nutrition Examination Survey, the National Household Transportation Survey, and the American Time Use Survey.[67]

Canada also collects regular data on children's and adolescents' participation in physical activity and sedentary behaviours. A recent review documenting their surveillance of sedentary behaviours found that it had previously been measured in 19 national surveys, including four regular surveys.[68] The Canadian Health Measures Survey (CHMS) collects self-report and accelerometry data on children aged 3-11 years and the Canadian Community Health Survey collects self-report data on adolescents 12 years and older.[68] Despite the amount of data that has been previously collected, there are some reported limitations in the comparability of the data due to changes in the questions asked.[68]

In Australia, there is a lack of comprehensive and consistent measurement of activity levels in children and adolescents. Instead, adherence to guidelines is determined from a mix of different national and state-based studies, which pose difficulties in their overall accuracy and ability to track activity levels. To measure activity levels, these various studies often employ different questions which can measure different dimensions of physical activity and use different time frames for recall. A study investigating nationally used questionnaires measuring activity levels of Australian adults found large variability between the reported physical activity between the questionnaires.[69] These limitations also exist with children and adolescents, highlighting the difficulties that exist when comparing different survey data. To improve our measurement, a standardised national system

should be utilised which consistently and comprehensively measures activity levels over time.[64]

In summary, population surveillance of physical activity and sedentary behaviours involves the collection, measurement, and interpretation of how active a representative sample from the population is.[62] The difference in type of measurement techniques and the validity and reliability of each make it challenging to combine and synthesise data. Whereas, consistent measurement allows for the investigation of trends in physical activity levels to inform or evaluate public health interventions.[62] Currently, sporadic national surveys and smaller state-based surveys, with varying measurement techniques, are used to create a picture of current activity levels, and to help identify areas where improvement is needed. These complexities will be explored further in the next section, by describing the current prevalence rates of physical activity and sedentary behaviours.

1.4.4 Current prevalence of physical activity and sedentary behaviours

The proportion of Australian children and adolescents who comply with national guidelines and benchmarks is currently unclear. A lack of comprehensive national surveillance leads to difficulties when trying to estimate the prevalence of children and adolescents meeting the Australian 24-hour movement guidelines (Table 1.1 above) and unofficial benchmarks (Table 1.2 above). Alternatively, a variety of national and state/territory-based data, often captured using inconsistent measurement techniques, is compared to establish overall prevalence rates.

Active Healthy Kids Australia (AHKA) biennially follow a systematic process of collating and synthesising data to establish how active Australian children and adolescents are. This involves a comprehensive process of selecting representative data and providing a synthesis of the best available evidence to create the Physical Activity Report Card for Children and Young People.[70] This is a complex process, due to differing measurement techniques used, particularly different survey questions. National and state-based representative prevalence

rates as selected by AHKA for the 2022 Report Card have been used in Figure 1.5 and 1.6, to illustrate the variance between data collected from different studies. The first combination of charts (Figure 1.5) includes current estimates of both children's and adolescents' participation in physical activity, specifically compliance to the national metric of *at least 60 minutes of MVPA per day*. The prevalence estimates reported from included studies range from 2% of 15- to 17-year-olds[71] to 67% of 5-to 7-year-olds.[72] The charts show the variation between the prevalence estimates and the resultant effect when adjusting for age of the participants, sex of the participants and the recall method (self-, proxy- or parent-report). The y axis shows the percentage deviation from the mean of each participation rate and the x axis shows the individual studies which measured the participation data, with the shaded section representing 1 standard deviation (SD). The first chart illustrates the large variance between the prevalence rates reported for each study. Reduction in the variance occurs as the estimates are adjusted by age (reduced variance by 57%), age and sex (further 11% reduction), then age, sex and recall method (further 24% reduction), resulting in an overall reduction in variance by 92%.

Figure 1.6 illustrates the variation of prevalence estimates of screen use. Likewise, a large variation exists between the prevalence of children and adolescents who exceed two or more hours of recreational screen time in a day reported from different studies from 36% of 5- to 8-year-olds[73] to 86% of 15- to 17- year-olds on a weekend day,[74] with the variation decreasing when accounting for different variables. The main variables that effect the variation are age (reduction in 29%) and age and scope, which refers to the screen types (e.g., computer, TV, all screen time, etc.) included in the question (further reduction of 13%). Other variables including sex, geographical region, recall method, day type and recall time frame had little effect on the variation in prevalence estimates.

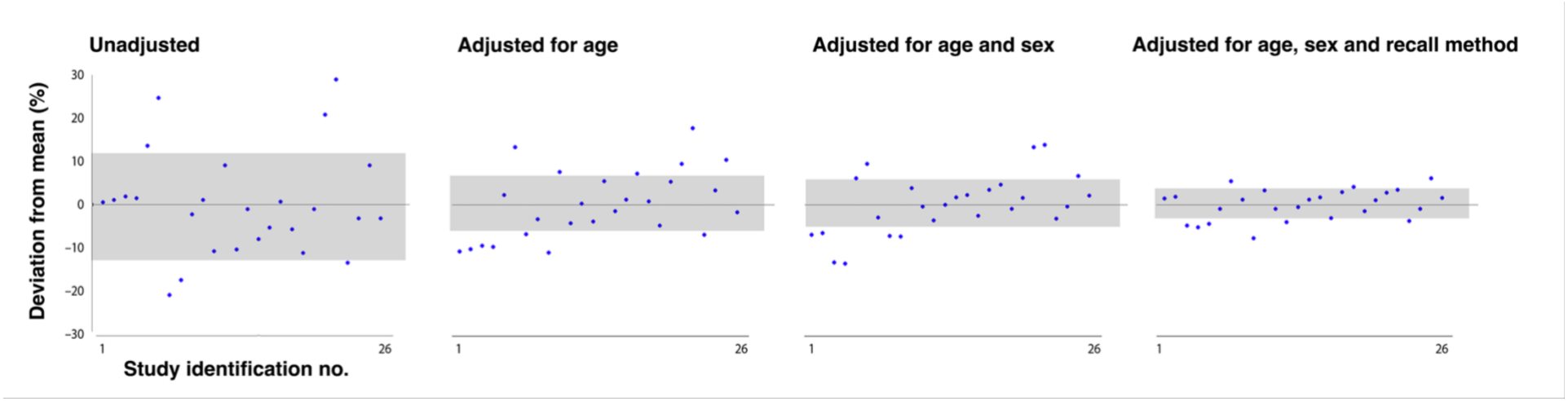


Figure 1.5 Variance of estimates of Australian children's and adolescents' physical activity participation, illustrating the deviation from the mean when adjusted for age, age and sex, and age, sex and recall method. Prevalence data from the 2022 Report Card on Physical Activity for Children and Young People was used showing compliance to the Australian physical activity guidelines which was collected within different studies.

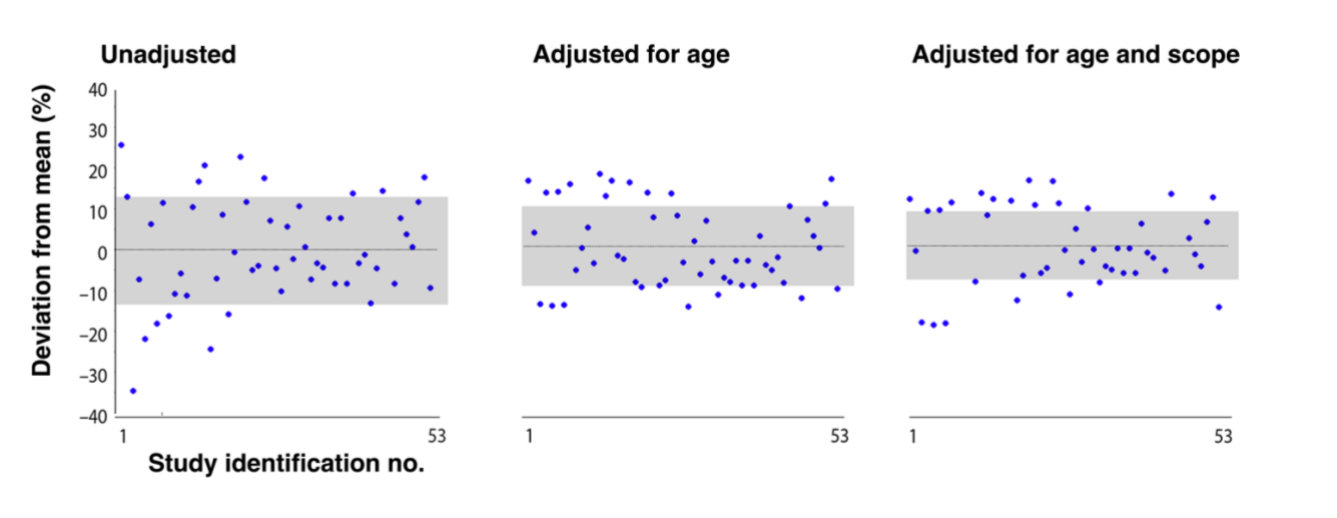


Figure 1.6 Variance of estimates of Australian children's and adolescents' screen time prevalence, illustrating the deviation from the mean when adjusted for age, and age and scope. Prevalence data from the 2022 Report Card on Physical Activity for Children and Young People was used showing compliance to the Australian screen time guidelines which was collected within different studies.

In summary, there are inconsistencies in reported prevalence rates which are used to inform interventions, policies and future research. One main reason is the difference in participant ages when comparing studies. Other inconsistencies when comparing physical activity prevalence estimates is due to the sex of participants and how their physical activities were reported. The inconsistencies in screen time prevalence estimates arise to a lesser extent from differences in the definition of screen time within survey questions, for example, measuring only TV viewing or measuring all screen device use. The reason for other inconsistencies in screen time prevalence estimates are more unknown but could possibly be attributed to the less structured nature of screen time (e.g., events on TV which involve more screen time at the time of measurement). Despite this, low prevalence rates demonstrate that children and adolescents are generally not achieving enough movement for health and wellbeing benefits.

1.5 Historical trends in physical activity and sedentary behaviours

Tracking activity levels over time is essential to inform and evaluate intervention design and measure the effects of public health policy. There is limited research on temporal trends in children's and adolescents' physical activity, including insufficient baseline data, methodological inconsistencies between studies, and a lack of research capturing participation in the various physical activity behaviours.

Popular opinion considers that children's and adolescents' physical activity has declined over the last few decades.[75] Additionally, parents have rated the rise in screen time as a predominant concern.[14] Undeniably the use of screen devices has increased since being introduced in the 1950s, however, it is less clear how physical activity has changed over this time. Few studies have looked at trends in specific physical activity behaviours. The results of these studies range from declines evident in the percentage who actively commute to school,[76, 77] to mixed results for trends in participation in other behaviours.[78] A narrative review conducted by Dollman and colleagues likewise found declines in organised sport

and PE had occurred, particularly in Australia.[75] Reasons cited were the emergence of environments inconducive to active behaviours.

In the absence of quality trend data, two AHKA Report Cards were compared to establish how participation rates may have changed over time. Figure 1.7 shows the overall participation level for each physical activity and sedentary behaviour from the 2014 report card[70] and the recent 2018 report card.[11] For this figure, the grades allocated by AHKA to each of the domains have been presented as the equivalent participation prevalence for each domain. The Y-axis shows the proportion who meet the guidelines or unofficial benchmarks, and the domains are presented on the X-axis. Comparatively little change has occurred over the past 8 years, with no evidence of improvement in participation levels. No prevalence rates have been presented for active play due to the lack of data available. Various reasons have been reported as to why few improvements have been made. Many researchers have expressed the need for better data globally as one important component to address concerning levels of physical activity and sedentarism.[1, 2]

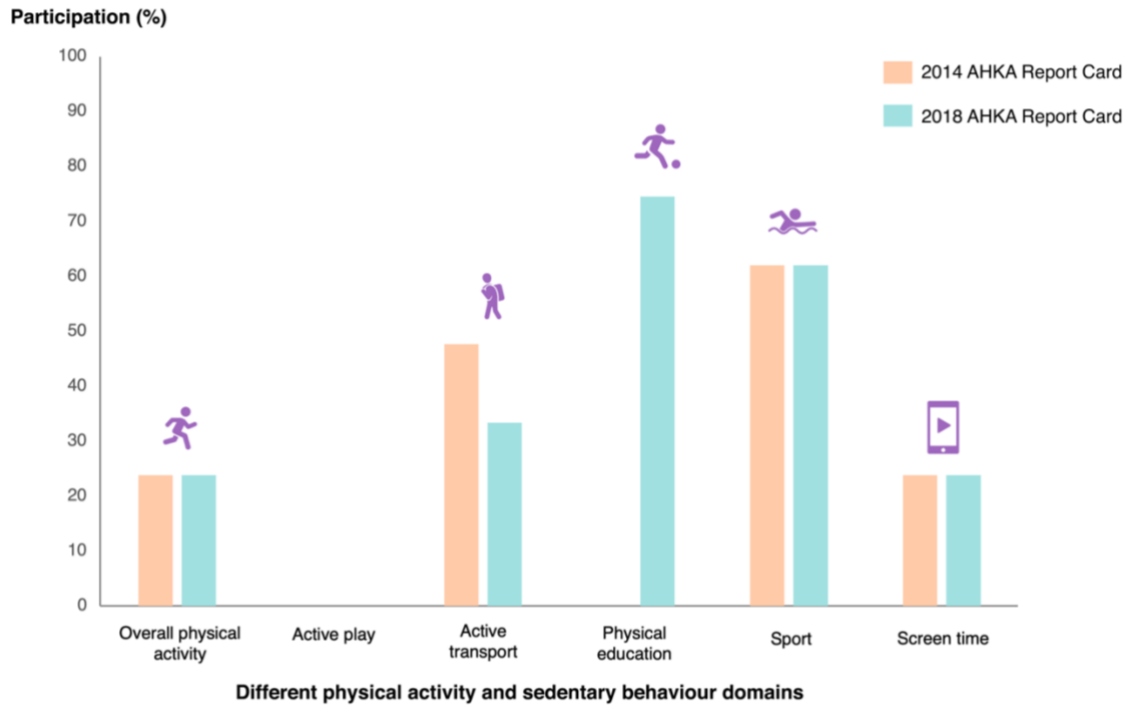


Figure 1.7 Comparison of overall participation rates for different domains of physical activity and sedentary behaviours from the 2014 Report Card on Physical Activity for Children and Young People and the 2022 unpublished Report Card.

Participation % (y-axis) refers to the proportion of Australian children and adolescents who meet the national guidelines or unofficial benchmarks for each domain.

1.5.1 Secular changes in physical activity and sedentary behaviours over time

The absence of clear trend data creates gaps in our understanding of young peoples' past activity participation. The opportunities that youth have to be active are dependent on various individual, interpersonal, policy-related and global determinants.[79] These may have been present for past generations of children and adolescents, influencing their participation. Identifying patterns of behaviour over time provides context and insight into how measurement needs have evolved.

In the absence of trend data, looking at children's and adolescents' activity from an alternative perspective may provide some insight and more transparency. To explore previous research describing each different behaviour and describe changes in participation over time, a narrative review was conducted. This focused on the interpersonal, environment, policy-related and global determinants at a population level. After reading through several review publications, studies, official documents, and books, key events and contexts were identified to reconstruct previous participation in each behaviour within Australian history. Some key determinants that may have influenced physical activity levels are outlined in these next sections.

Figure 1.8 shows a timeline of selected events that have influenced the type and amount of physical activity and sedentary behaviours children have experienced over the past two and a half centuries. This selection of events is included as they have been discussed more in the historical literature and deemed to be important in shaping activity levels of this time. Each of these events, and how it may have been a determinant for a physical activity or sedentary behaviour, is further discussed in the following section.

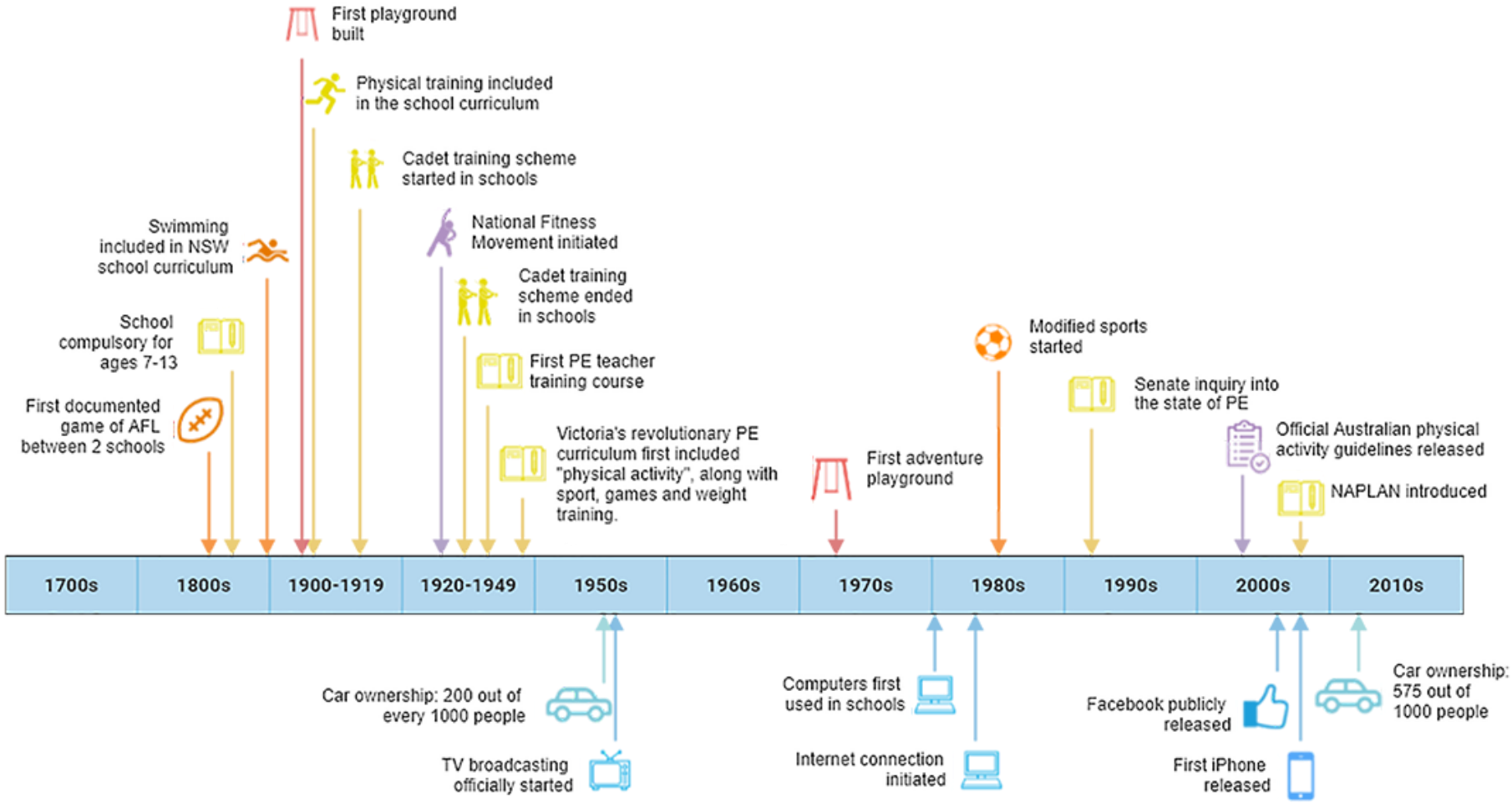


Figure 1.8 Timeline of selected historical events which have influenced Australian children's and adolescents' physical activity and screen time participation over the past few centuries.

1.5.1.1 *Active play*

Despite active play being an ingrained part of children's lives, this behaviour is complex and hard to define. It is also a behaviour that has shifted over the last two centuries, due to social and environmental changes. Active play used to occur in many different locations, including on public streets and in parks.[6] In the early 1900s, there were reports of unruly play in public spaces, leading to the first public playgrounds being created. This provided a dedicated space for children and adolescents to go and play, essentially redirecting their play into a more structured setting.[80] Purpose-built playgrounds first appeared in Australia around 1907. However, they were more structured and sometimes gender-segregated. This shift in the location of active play was pivotal and is still a common setting for participation in this behaviour. It provides a clear, easily defined location in relation to measurement needs.

Reportedly, children and adolescents frequently played in public spaces such as streets, parks, and natural bushland with peers,[7] however, some research indicates a gradual decline since the 1960s.[81] Since this time the urban environment has become increasingly more built up, with more children living in city apartments,[82, 83] busier roads,[84] more hard surfaces in suburbs,[85, 86] fewer green spaces,[81] and greater parental safety concerns;[46] resulting in less play on the streets and more occurring within the home. The increasing population may have also impacted play spaces available in the school setting. The number of students per school has dramatically increased since the 1950s, with 1,788,255 students attending a total of 9,738 schools across Australia, compared to in 2020 4,006,974 students attended 9,542 schools,[87 88] a 128% increase in the number of children per school. This has a few implications for the measurement requirements. There are fewer settings in which play occurs, hence, less to include when asking about participation levels. Also, it means that play is more subject to adult observation. Their play has shifted from more roaming unsupervised play to more adult supervised. This possibly makes it easier for parent-report of play within surveys,

compared to earlier decades when their play occurred in areas with less supervision.

Adventure playgrounds were initially constructed in Australia in the 1970s, increasing opportunities for risky play by increasing the height and including more moving structures in playgrounds. Potential litigation, and the creation of Australian playground safety standards in the 1980s, resulted in changes in playground design, attempting to improve safety and reduce the risk of injuries.[84] Schoolyards increased the regulation around children's play by adding more rules concerning where and how children should play. Restrictions were placed around where children could run, climb, and what they could play with when on the school grounds.[89, 90] However, playgrounds and public play spaces are transitioning towards including natural elements and encouraging play in natural environments.[91] A systematic review found that nature play may positively impact children's physical activity levels.[91] This transition back to play in nature is a necessary inclusion when measuring active play. Compared to the safer structured playgrounds, structured natural play spaces may involve different activities for children, including water play, rocks, logs and tepees instead of or in addition to slides, swings and climbing frames.

1.5.1.2 *Active transport*

Over the last century, the most significant impact on active transport has been the changing environment, particularly in response to the increase in car numbers. Specifically, an annual growth of 4% in the number of cars in Australia (1955-2013),[92] increasing to current figures indicating half of adults own a car.[92] Interestingly, car passenger kilometres per capita increased steadily from 9,000 kilometres per capita per year in 1976 to a peak in 2004 of 13,000, then steadily decreasing to 12,000 in 2018.[93]

Some research has measured trends in active transport and independent mobility over the last few decades, finding a decline has occurred.[78, 94] In 1991, Schoeppe and colleagues[94] discovered that two-thirds of children aged ten or less were able

to independently move around their neighbourhoods, compared to less than one-third in 2012. In addition, a decline in the percentage of active trips of less than one kilometre while commuting to school or education occurred between 1984-1994.[95] Some reported barriers to this decline; noting that the built and social environments are often not conducive to walking, cycling and outdoor play.[94, 96] However, the most significant barrier appears to be parental attitudes towards active transport. Many parents perceive the environment as unsafe for their children to walk or ride to school.[95]

Measurement needs to also consider different modes of transport, transport patterns, age of child or adolescent and social norms.

1.5.1.3 *Sport*

Sport can include *either physical exertion or physical skill, a structured or organised setting, and some level of competition against others or a defined goal.*[33] Historically in Australia, sport has been an important part of Aboriginal and Torres Strait Islander culture, with children participating in canoeing, football, wrestling, spear throwing, sham fighting and climbing contests.[5] Colonisation resulted in sports being imported from England, Ireland and Scotland to Australia, in particular cricket, hurling, wrestling and football. Traditional sports such as these were played in schools, although the size of their contribution has varied over time.[97] Initially, the school sector's focus on military-style physical training resulted in few sport opportunities, leading to development of after school sport opportunities, which are still frequently available to many school students.[98] In 1858, the first organised games of Australian Rules football reportedly took place, between some male students playing for different schools.[99] A few decades later, a club competition was initiated for Australian Rules football, first appearing in South Australia.[100] Another contemporarily popular sport, swimming, first appeared in the New South Wales (NSW) school curriculum in 1897.[101]

In the 1930s and 40s, the potential impact of sport on children's fitness appeared to be more recognised, resulting in more sport being included in the school sector. The National Health and Medical Research Council (NHMRC) supported this idea and encouraged the provision of community recreational facilities such as swimming pools and ovals to encourage children to improve their physical fitness.[101-103] The National Fitness Movement resulted in more sporting organisations and clubs being established, creating more opportunities for youth to be active, especially targeting 14- to 18-year-olds.[104] This resulted in opportunities to participate in the school sport sector during school and after-school hours, in addition to more club sport opportunities. Although, during much of the 1970s, gender disparity seemingly impacted participation rates. It was not as socially acceptable for women to participate in sport,[105] in comparison to more recent decades. Reasons cited were a lack of interest, with only 6% of adolescent females reporting an interest in being successful in sport. In 1977, Cole conducted interviews with adolescent females, citing reasons for dropping out of sport to be motivated by the worry of getting big muscles if they continued to participate.[105]

Nationwide, the practice to modify sports for younger children began with the AUSSIE sports program in 1986,[106] to provide more opportunities for this age group to engage in sport-like activities, and to develop motor skills in a supportive and sport-like environment.[107] To enhance the sport opportunities for young children, modified sports were introduced in both the school sport and club sport sectors to make sport more widely available to children. Equipment and rules are altered to assist them in developing skills and ultimately improve participation.[108] Examples of these modified sports include AusKick[109] and Little Athletics,[110] which are still operating today. These modified activities focus less on competition and more on participation and fun. Modified sports also differ in terms of participation dimensions, in the absence of training sessions and competition, which respondents may be asked about when measuring participation in traditional sporting behaviours.

Likewise, recent sports participation trends reflect a move away from traditional sports towards participation in individual, less structured activities.[111] Action sports such as BMX and skateboarding, initially not considered sports, have recently experienced an increase in participation and interest. Skateboarding originated in the 1950s, with its popularity now apparent with inclusion into the 2020 Olympics. There are now more than 1000 skate parks in Australia. Like other individual action sports, participation does not need to occur in a set location.[111] Given the rapid evolution of sports, more consideration into how sports are defined to respondents is essential for accurate measurement, to ensure all participation is captured.

1.5.1.4 *Physical education*

Compulsory schooling began in Australia in late 19th century.[112] Since the start of schooling, the initial focus of PE was to improve the physical fitness of students. At this time, structured activities were conducted to physically train students to be the next generation of soldiers.[113] In 1911, the Defence Department funded the compulsory Cadet Training Scheme conducted daily, including military-style drill training and rifle use.[114-116] This was exclusively for boys; however, girls undertook a modified version of physical discipline. Gymnastics was also included in the early physical training content, adopting a similar disciplined military-like format. Daily participation in these structured activities occurred for almost two decades until the military-style PE was discarded in 1929.[97]

In the 1930s, PE continued to be centred around physical training, however recreational activities, such as games, swimming, rhythmic exercises and folk dancing emerged.[117, 118] In 1939, in response to experts' concerns on the state of children's (and adults') fitness, the National Fitness Movement was created to focus on improving the *physique* and physical fitness of youth along with *modernising* teaching within PE.[119] This led to the National Fitness Act 1941 being created and the provision of more fitness and sports facilities, including fitness camps for students and funding for improving PE teacher training.[120]

In 1946 Victoria (VIC) released their reshaped and updated PE curriculum,[3] which was revolutionary and finally focused on youth physical activity. In the curriculum, the authors quoted:

> *We therefore insist that every child has the right to play, and that this right must be restored to all children who have lost it. The only logical approach to this ideal is to adopt the method of providing physical education by teaching participation in games … The aims of this system of physical education are that each individual shall be enabled to develop to his [sic] maximum potential and that each one shall acquire a sufficient degree of proficiency in at least one form of physical activity to maintain an interest in healthy activities throughout his adult life.*[3]

This was a significant turning point in the documented importance of physical activity for children, as it was the first time that *physical activity* was used rather than *physical exercise* or *physical training*. This subject was also progressively being turned into an academic subject. The main ideas outlined in this curriculum, including the importance of encouraging children's lifelong physical activity, remain a fundamental component of the curriculum 70 years later.

During the 1970s, 80s, and early 90s, many researchers deemed PE to be *in crisis*, noting an increased focus on theory and less time for opportunities to be active and to practice essential motor skills, particularly for secondary students.[121] This resulted in a Senate Inquiry into PE.[122] The findings disclosed that a decrease in the time allocated to PE had occurred, and fewer PE specialists were employed, likely resulting in the apparent decline in students' motor skills and fitness.[122]

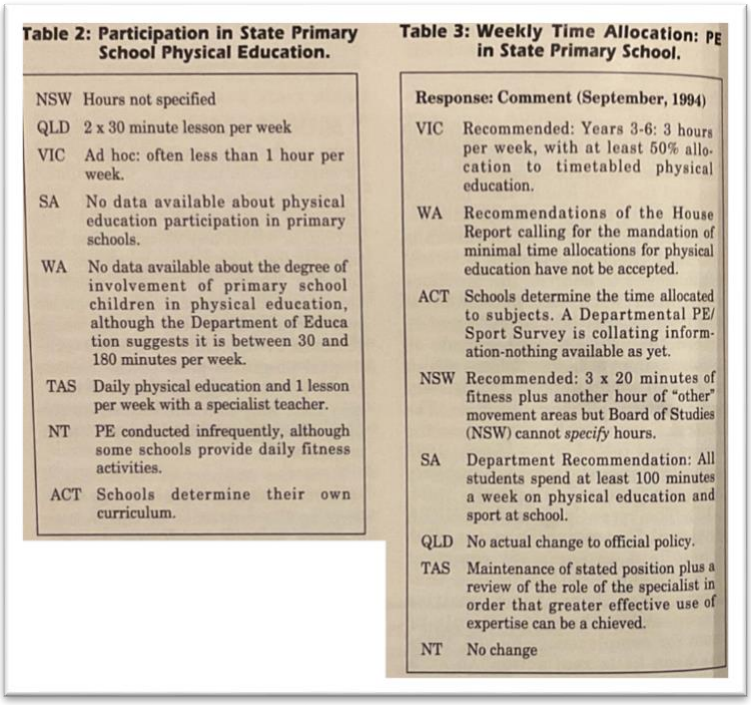


Table 2: Participation in State Primary School Physical Education.

NSW	Hours not specified
QLD	2 x 30 minute lesson per week
VIC	Ad hoc: often less than 1 hour per week.
SA	No data available about physical education participation in primary schools.
WA	No data available about the degree of involvement of primary school children in physical education, although the Department of Education suggests it is between 30 and 180 minutes per week.
TAS	Daily physical education and 1 lesson per week with a specialist teacher.
NT	PE conducted infrequently, although some schools provide daily fitness activities.
ACT	Schools determine their own curriculum.

Table 3: Weekly Time Allocation: PE in State Primary School.

Response: Comment (September, 1994)	
VIC	Recommended: Years 3-6: 3 hours per week, with at least 50% allocation to timetabled physical education.
WA	Recommendations of the House Report calling for the mandation of minimal time allocations for physical education have not be accepted.
ACT	Schools determine the time allocated to subjects. A Departmental PE/Sport Survey is collating information-nothing available as yet.
NSW	Recommended: 3 x 20 minutes of fitness plus another hour of "other" movement areas but Board of Studies (NSW) cannot *specify* hours.
SA	Department Recommendation: All students spend at least 100 minutes a week on physical education and sport at school.
QLD	No actual change to official policy.
TAS	Maintenance of stated position plus a review of the role of the specialist in order that greater effective use of expertise can be a chieved.
NT	No change

Figure 1.9 The amount of time allocated to PE within the different states/territories of Australia, before the 1992 Senate Inquiry (left) and after (right).

The Senate Inquiry found that the amount of PE conducted across states and territories was inconsistent. As seen in Figure 1.9, time dedicated to PE was low, with little improvement occurring by 1994.[123] A recent review illustrates that the time allocated to PE and physical activity in schools is still inconsistent across Australia. For example, NSW also includes mandatory planned physical activity in addition to HPE time. This can include school sports, school break time activities, and class time energiser breaks,[124] and is not consistent across all states and territories. Schools can differ regarding how they define PE and physical activity, along with the amount of time offered for each and its structure. Some schools provide opportunities all year, while others might offer PE more intensively for only half the year.[125] Pill[126] also highlights that approaches to PE and lesson content can change depending on the PE teacher.

Table 1.3 Indication of the amount of Health and Physical Education and/or physical activity that is conducted in schools around Australia (2018). (Modified from (Stylianou and Walker 2018).[127]

State / territory	Requirement / recommendation	Mandatory
National	At least 2 h/wk of physical activity	Mandatory
QLD	Approximately 2 hrs/wk of HPE	Not mandatory
NSW	At least 150 min/wk of planned MVPA Between 80-120 min/wk of HPE, depending on year level	Mandatory to Year 10
VIC	Between 20 min/day and 180 min/wk, of physical activity depending on year level	Mandatory to Year 10
SA	At least 2 hrs/wk of HPE	Not mandatory
WA	At least 2 hrs/wk of physical activity	NA
TAS	At least 2 hrs/wk of physical activity	Mandatory to Year 10
ACT	Between 25 min/day and 150 mins/wk of MVPA, depending on year level	Mandatory to Year 10
NT	At least 2 hrs/wk of physical activity At least 2 hrs/wk of HPE	Mandatory to Year 10

QLD = Queensland, NSW = New South Wales, VIC = Victoria, SA = South Australia, WA = Western Australia, TAS = Tasmania, ACT = Australian Capital Territory, NT = Northern Territory, HPE = Health and Physical Education, MVPA = Moderate-to-vigorous physical activity, NA = information not available, Not mandatory = physical activity opportunities that have not been mandated.

Due to an inconsistent approach to defining and structuring PE and physical activity across Australian schools, measurement of student participation is needed to establish the duration, intensity and type of physical activity accumulated. Even though the primary goal of PE is not solely to provide physical activity opportunities, it is still an important domain where physical activity can occur.

1.5.1.5 *Screen time behaviour*

Technology has improved at a rapid rate, having a profound effect on our modern culture as one of the most influential factors in the last century. New labour-saving devices are continually being developed and a reported 300,000 health-related smartphone applications are currently available.[128] Screen devices started to influence people decades ago, however an important historical event was the first Australian TV broadcast in 1956.[7] One study reported TV viewing from the 1960s, finding the median time spent on weekdays was 1.6 hours and weekends

between 1.8 hrs (boys) and 2 hrs (girls), compared to an average of 2 hrs (weekday) and 4 hrs on a weekend in 2019 (across all screen devices).[129, 130]

In the 1970s and 80s, the first internet connection in Australia occurred, along with the introduction of computers into schools.[131] Over the past 40 years, computer technology has continued to improve and now the use of such devices is included within the school curriculum.[37] Most primary and secondary educational facilities now use computers, with students spending long hours using them for school-related tasks.

Another screen device which has rapidly increased in use are mobile phones. The Australian Bureau of Statistics (ABS) measured access to mobile phones across Australia finding the percentage of households that had access to one increased from the late 1990s (44%) to 2002 (72%).[132] As seen in Figure 1.10, by 2009 76% of adolescents aged 12-14 years owned a mobile phone, and by 2017 87% of 13- to 18-year-olds owned a mobile phone.[14, 133, 134] During this time, social media sites such as Facebook were developed.[135] Smartphones and tablets came with greater interaction and versality, and an increase of screen media multitasking, using more than two screen devices at once.[136] In addition, playing video games on various devices is a screen activity children and adolescents participate in regularly.[137]

Across the last few decades, significant changes have occurred contributing to an increased amount of screen time participation for children adolescents. Screen-time recommendations were included in the Australian guidelines in 2004, highlighting the need to measure compliance. As seen over time, the types of screens now available for use have increased, starting with just TV through to the current array of devices and uses that need to be captured by surveys.

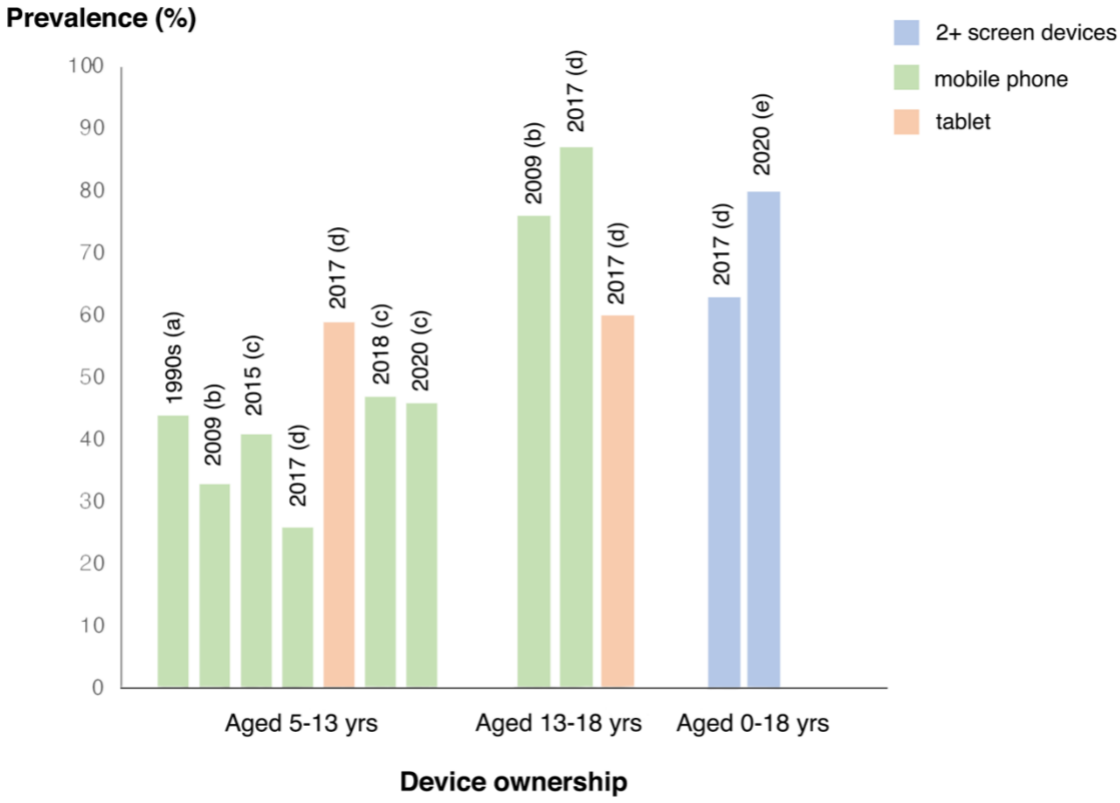


Figure 1.10 Prevalence of Australian children and adolescents who own a screen device (or access to a device).

Sources of data; a[132], b[138], c[139], d[14], e[140].

1.5.2 Non-screen sedentary activities

There have been some changes in this behaviour over time, mainly due to changes in technology. Recreational book reading is an activity that was historically more prevalent. One Australian research study measured children's participation in reading in the 1960s, finding that 60-62% of children aged 9-11 read for 30 minutes or more daily.[129] Recent Australian data (2016) shows a decline in recreational reading has likely occurred: only 36% of adolescents aged 13-16 years read at least twice per week.[141]

Changes in non-screen sedentary time have also occurred concerning transport. As previously mentioned, a decrease in active transport has occurred, resulting in

an increase in passive transport and the time spent sitting in cars to travel to and from school. In addition, the first child restraint systems were designed in the 1960s but became mandatory in Australia in the 1980s.[142] The change in legislation and a new awareness of safety also saw the creation of infant carriers, which with extended use can lead to prolonged restriction in movement, along with deformational plagiocephaly (flat head syndrome).[143] Furthermore, a large variety of strollers and other restrictive infant devices are now available, which parents have reported using not only for transport but also to confine infants and children to allow the parent access to opportunities that they may otherwise find difficult to do.[144] In general, non-screen sedentary time has a broad scope, and with parents leading busy lifestyles, this sedentary behaviour needs to be more considered.

In summary, these select behaviours (active play, active transport, PE, sport, screen time, and non-sedentary screen time) have experienced change over time. The activities that children and adolescents participate in within each behaviour have been modified compared to the constructs of the activities undertaken decades ago. The changes outlined above include:

- how they are defined
- the settings where the behaviour occurs
- the structure of the activities
- trends in social importance
- parent supervision
- policy changes
- improvements in technology
- environmental changes

These changes influence how each behaviour has been measured, along with the current measurement needs. Despite the importance of altering measurement to ensure each behaviour is accurately captured, this has implications for consistency in measurement used over time to track trends.

1.6 Summary

Despite the well-documented benefits of physical activity, few Australian children and adolescents comply with current recommendations. To reach the required 60 minutes of MVPA daily, participation can occur in different domains, of various durations, frequencies, and intensities. The complex nature of physical activity and sedentary behaviours has implications for how they are measured, resulting in inconsistencies in the data collected (Figure 1.0). In addition, when measuring participation in each domain over time to track trends, the continual social, environmental and cultural changes have implications for consistency in measurement.

With a lack of consistent national surveillance in Australia, various national and state data sources are used to establish activity levels. Data collected using different measurement techniques and definitions results in limitations in the amount of data available to track changes in activity over time. A lack of standardised measurement also creates uncertainty in current and past participation rates. Likewise, this has implications when the data are needed to inform interventions, policies, future research, and make temporal and global comparisons.

1.7 Aims of this research

Following the background information presented in the introduction chapter, this thesis includes three connected studies, each with an individual aim:

Study 1 aim: To provide a synthesis of existing data on Australian children's and adolescents' participation in physical activity and sedentary behaviours.

Study 2: To collate, classify and analyse existing questions measuring Australian children's and adolescent's participation in physical activity and sedentary behaviours.

Study 3: To create a set of recommended questions to measure children's and adolescent's participation in physical activity and sedentary behaviours.

CHAPTER 2.

Study 1: The audit

Despite unequivocal evidence of health benefits of physical activity and of the extraordinary population attributable risk associated with insufficient physical activity, global surveillance of physical activity has been superficial, irregular, incomplete, and fraught with limitations. …Too much is at stake not to carefully measure physical activity and monitor progress going forward.

Mark Tremblay

The Lancet Child & Adolescent Health 2020[145]

2. Study 1: The audit

2.1 Introduction

The purpose of this chapter is to fulfil the first aim of this thesis relating to an audit of datasets consisting of Australian children's and adolescents' participation in physical activity and sedentary behaviours. Various national and state-based data with varying measurement techniques have been used to establish prevalence rates and compliance with guidelines. In addition, there is no publicly available data repository where data custodians can allow their metadata and findings to be stored and accessed. An audit of available data may help identify and address research gaps, chart temporal trends, detect geographical differences, highlight potential inequalities, compare estimates derived using different methodologies, and decide which measures to use to assure data continuity. I will begin by further exploring the rationale for this research and then outlining the methodological approach used to complete the audit. The following sections relate the audit results, and the main findings are interpreted in light of research, including the implications, strengths and limitations.

2.2 Background

We live in a world that is replete with information, but an increasing problem is knowing what information is available. There have been many studies of Australian children's and adolescents' physical activity and sedentary behaviour, collected using various methods, from traditional pencil-and-paper surveys to wearable activity trackers. Not all these data are published or accessible. Many of them reside in the grey literature or in forgotten data repositories curated by individual researchers, which disappear when they retire. Often, the data underlying research publications have been lost. In fact, Chalmers and Glasziou[146] estimate that 85% of research is wasted due to poor research design and methods, incorrectly reported results, or not being published.

It is likely that deployable data on participation levels are lacunary and represent only a fraction of the data that have been collected. Recently, a systematic review identified and collated all the international physical activity research conducted since 1950.[147] A total of 23,860 publications from 176 countries were located. Publication rates show that physical activity research has significantly increased since 1990.[147] Australia was identified as the 9th most productive country regarding the number of publications adjusted for our population. As a result of this research, the authors concluded that it was necessary to regularly monitor physical activity research worldwide to address research gaps to improve the public health impact.[147] Thus, an audit of available data may help identify and address research gaps, chart temporal trends, detect geographical differences, highlight potential inequalities, compare estimates derived using different methodologies, and decide which measures to use to assure data continuity. Ultimately, an audit might be the foundation for building a dynamic central data repository.

Therefore, this study aimed to conduct an audit of existing data on Australian children's and adolescents' physical activity participation and sedentary behaviours. More specifically, this study sought to describe the scope, methods and coverage of the available datasets.

2.3 Methods

The first aim of this thesis was to conduct a comprehensive audit of existing datasets on the physical activity and sedentary behaviour of Australian children and adolescents. The intention was to locate and describe these datasets and to create a searchable database through which descriptive metadata could be accessed. This study involved the following steps:

1. Systematic search
2. Identification of datasets
3. Defining and applying metadata
4. Creating a searchable database.

To provide clarity, the terms used in this research are defined as:

- a *study* refers to the research project reporting analysed data.
- *participants* refers to the children and adolescents who participated in a study.
- a *dataset* refers to the data derived from a sample of participants. If a different sample of participants was used within the same data collection wave, then it was separated into a different dataset.

2.3.1 Systematic search

This search was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[148]

2.3.1.1 *Eligibility criteria*

Studies were included if they consisted of data on Australian children's and adolescents' participation in physical activity and sedentary behaviour. To be eligible for inclusion, datasets were required to:

- have a minimum participant number of 50 per age x sex group (e.g., 10-year-old boys). If no information was provided on age x sex strata, then datasets with a minimum sample size of 100 were included.
- provide information on children and adolescents aged 0–18 years living in Australia.
- include measures relating to at least one of the following domains: overall physical activity, organised sport, physical education, active transport, active play, or sedentary behaviour.
- include device-based, self-report, and proxy-report measures.

Databases were excluded if they:

- provided data only on adults (≥19 years).
- reported only on participants living outside of Australia.
- did not include measurement of physical activity or sedentary behaviour.

- included data only on subpopulations likely to have atypical physical activity patterns (e.g., members of sports clubs, obese children, physically impaired children/adolescents).
- did not meet the sample size requirements.

There were no restrictions on study design or date.

2.3.1.2 *Information sources*

This process involved interrogating online databases using a systematic search strategy. Following consultation with an academic librarian, the following databases were searched: Medline, Embase, Epub ahead of print, SPORTDiscus, ERIC, CINAHL, Informit, and Scopus. The University of South Australia library has online access to databases dating back to 1983, and the library catalogue consists of some paper-based documents available before this date; therefore, other searches were conducted to locate older datasets, including similar searches of Trove, Google Scholar (first 200 records), Clearinghouse for Sport, the National Library of Australia, South Australian State Library, and the University of Adelaide library.

Grey literature searching was also conducted using Google, Google Scholar, Trove, ProQuest, and various government and university websites such as Australian Bureau of Statistics, University of Melbourne archives, University of Sydney archives, Department of Health data (health.gov.au), Australian Institute of Health and Welfare, and each state/territory government health department website. Some online databases were checked including LifeCourse and Australian National Data Service. Pearling and hand searching techniques were also used. Potentially relevant journals were also checked on microfilm at the State Library of South Australia.

Key authors selected due to their extensive experience or by recommendation from others were also contacted (e.g., via email) to enquire about any datasets they may know about. All data custodians and/or first authors were emailed, sent

a list of all the identified datasets, and asked to check and suggest other datasets, including unpublished datasets.

2.3.1.3 *Search strategy*

The systematic search was conducted on 8th September 2017 and 13th February 2018. Search terms (Table 2.1) identified physical activity and sedentary behaviours (overall physical activity, sport participation, active transport, active play, sedentary behaviours, physical education, school-based physical activity), the population and the location. Truncation was used when required and some variations of these terms were included and documented.

Table 2.1 Search terms used for the systematic search.

Location			**Population**			**Constructs**		
	Australia*			Child*			Physical activity*	
OR	Victoria*		OR	Adolescent*		OR	Sport* participation	
OR	New South Wales		OR	Teen*		OR	Sport* performance	
OR	Queensland		OR	Youth		OR	Physical education	
OR	Northern Territory		OR	Infant*			PE	
OR	Tasmania	**AND**	OR	Toddler*	**AND**	OR	Activ* transport*	
OR	Adelaide		OR	Preschooler		OR	Activ* commut*	
OR	Melbourne		OR	Student*		OR	Walk* to school	
OR	Canberra		OR	Kids		OR	Cycl* to school	
OR	Sydney		OR	Bab*		OR	Bik* to school	
OR	Brisbane		OR	Boys		OR	Exercise	
OR	Darwin		OR	Girls		OR	AND	Active
OR	Perth							Play
OR	Hobart					OR	Sedentary	
						OR	Screen time	

*These words were used with truncation symbols ($1 or *)

2.3.1.4 *Selection process*

All records were downloaded and imported into a reference manager database, Endnote (version X9.3.3). The selection process involved two components. Firstly, I screened all the records at title and abstract against the inclusion criteria. A random selection of abstracts (10%) was screened independently by two supervisors, with 91% agreement (kappa=0.78). For the second component of the search process, I screened all the full texts against the inclusion criteria. Any discrepancies were resolved by discussion with supervisors.

2.3.1.5 *Data collection process*

For this thesis it was not necessary to acquire the complete dataset, but rather a minimum amount of metadata (data about the datasets). Sometimes it was unclear which dataset was aligned with a particular study. For example, two studies may draw on the same dataset, but use different subsamples, or a single study may combine different datasets. The dataset that informed each published manuscript was usually identified from different sections in each publication, the Introduction, Methods, or Acknowledgements. If it was not clear which dataset was used, then the dataset was named after the lead author (e.g., NoName_Dollman). Once a dataset was identified, then other publications also using that dataset were grouped together. Information on each dataset (e.g., name, location, lead researcher) was identified and used to locate the dataset metadata through the publications, on Google, the University library, Trove, or other researchers. If the dataset was unidentifiable, then the corresponding author was contacted for more information.

2.3.2 Defining and compiling metadata

For this thesis, metadata were used to describe the included datasets. Metadata were used to describe how available datasets are relevant, and for administrative control and information management.[149] The following were considered when designing a metadata structure for a searchable online database:

- requirements of the data user
- overall description of the dataset
- common language and terminologies used
- dataset accessibility
- interoperability between human and online platforms to ensure it can be searched by both

A random selection of publications were reviewed to generate a list of included data, with this list reviewed and expanded by the research supervisors. The metadata categories and details for each are outlined in Table 2.2.

Table 2.2 The metadata extracted from each of the datasets.

SEIFA = Socio-Economic Indexes for Areas

Name of dataset	Sample size	Age of participants	Sex of participants	Year/s of data collection	Geographic representation	State/territory of data collection	Research design
• Name • NoName_(first author's last name), if no name is provided	• Total number of participants • Total number per gender • Total number per state/territory • Total number per age	• Age 0-18	• Both • Boys • Girls	• Year	• National • State/territory • Other (more than one state/territory, but not national)	• All • Australian Capital Territory • New South Wales • Northern Territory • Queensland • South Australia • Tasmania • Victoria • Western Australia	• Cross-sectional • Longitudinal • Serial cross-sectional

Sampling frame	Measurement used	Type of measurement	Specific measurement details	Socio-economic status metric used	Data availability/ data contact details	Research team	Funding source
• Cluster • Convenience • Stratified • Random	• Accelerometer • Pedometer • Parent-report • Proxy-report • Self-report • Field observations	• Questionnaire • Time-use diaries • Specific device model (Actigraph GT3X+)	• Questionnaire name • Accelerometer cut points • Device wear time	• SEIFA index • Postcode	• Data custodian name • Dataset accessibility • Access requirements	• Name of lead researcher's • Organisation / institution which conducted the research	• List of funding organisation / institution

2.3.3 Data extraction

Metadata were extracted for each identified dataset. If access was available, then dataset information was extracted directly from the dataset, otherwise it was extracted from the corresponding publication. Google and Trove were used to search for missing information, otherwise data custodians or lead authors were contacted.

2.3.4 Creating a searchable database

An appropriate database was required to enter the metadata. Microsoft Access was chosen due to its ease of availability, low cost, and capacity to store data in complex ways. Microsoft Access (version 2108)[150] is a data management software tool that can store, organise, and map relationships in data and perform basic analysis of large data. It has the capacity to house thousands of records of data in multiple tables interconnected through a relational structure. Appendix 1 shows the final database structure and Appendix 2 presents screenshots of the database.

2.3.4.1 *Designing the database*

This type of relational database requires thorough planning prior to data entry. The following steps were used to design the database structure:

1. Identify the purpose of the database.
2. Organise the metadata into the different information types.
3. Allocate the information into different tables.
4. Decide how best to tabulate the information (rows and columns).
5. Choose which column(s) would be primary and foreign keys within each table.
6. Determine what the relationships were between the tables.

2.3.4.2 *Purpose of the database*

To create a data repository consisting of the metadata which describes the existing datasets which have collected data on Australian children's and adolescents' physical activity and sedentary behaviours. It should be searchable and empower people to relate datasets and combine data from different sources in a consistent and comparable

way. A relational database model was used due to the large amount of metadata. The benefits of this approach are:

- data can more easily be retrieved using queries and reports
- data can be easily changed or checked within one table, without affecting data from other tables
- data are only entered once and can be related to different aspects of a dataset through assigned table relationships

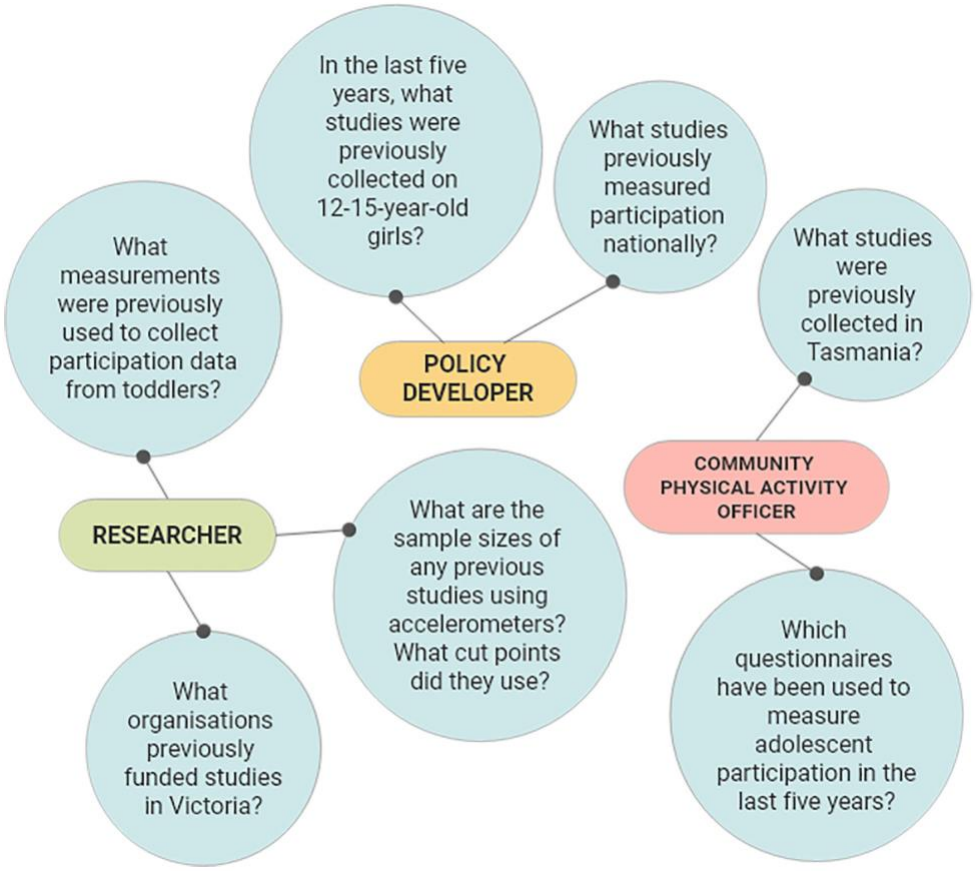


Figure 2.1 Examples of three possible users of the database and what information they might want to locate.

To create a database structure that produces the desired outputs, it is important to understand the required outputs. Even though it was outside the scope of this research project to create a database which could be ready for an end user to operate, it was still

important to structure the database architecture with awareness of the potential user. To understand what end-users might want to get out of the database, end-user scenarios were considered to establish what information might want to be extracted. Some examples of these are illustrated in Figure 2.1.

2.3.4.3 *Organising data*

All metadata were categorised by what elements of the dataset they were describing (e.g., methods, general information, researcher information, sample information). One table for each of the information categories was created.

2.3.4.4 *Relationship structure between tables*

To be able to connect data in the different tables, relationships were established between tables. Simple tables can be created consisting of one set of metadata (e.g., a methods table), then each table was connected by way of simple or complex assigned relationships (e.g., a methods table related to a participant characteristics table).

2.3.4.5 *Trialling the database structure*

After developing an initial data model, 10 random datasets were entered. From the trial run, these considerations emerged:

- data harmonisation needed to occur amongst some of the metadata, as different publications reported data in different ways. For example, participant age was reported as mean age, age range or school grade in different studies.
- each questionnaire structures and formats questions differently, therefore data harmonisation was needed to ensure the questions were searchable and comparable.
- datasets can include multiple data collection waves and each data collection wave can include different participants and a different methodological approach.
- within each dataset, different measurements can be used depending on the participant ages, for example, parent-report for younger children and self-report for older children.

2.3.4.6 *Data normalization*

Once the database was structured and the relationships assigned, it was important to enter data to check for *normalization*. This process checks that all entered data met the requirements of a relational database. These requirements include:

- no repetition in the database
- the data were logically stored
- each table contained a common attribute that can be used to link data between two different tables (referred to as primary and foreign keys)

2.3.5 Contact with data custodians

2.3.5.1 *Identifying data custodian*

Corresponding authors listed in a dataset's associated publication/s were recorded as primary contacts. For the datasets that had no contact person listed, the first author and last author were recorded as potential primary contacts. Some larger datasets had a corresponding website that listed the data custodians.

2.3.5.2 *Sourcing contact details*

Email was the preferred method of communication due to the large number of primary contacts. Internet searches identified a current email address for each primary contact. Some publications were written up to 70 years ago, so some contacts were very difficult to locate due to being retired, not having a publicly available email address, or possibly being deceased. Contacting primary contacts to complete missing data, and making their metadata available, required ethical approval.

2.3.6 Ethics

Ethical approval was provided by the University of South Australia's Human Research Ethics committee (#202035). The approval was only to communicate with contacts to find missing metadata (e.g., to ask how participation was measured). There was the potential that some surveys were copyrighted and unable to be widely disseminated. When contact was made, it was highlighted that metadata were likely to become

publicly available, and that the data custodians should communicate with me if they had any issues. Following legal advice, all communication with contacts was recorded.

2.3.7 Communication with primary contacts

All extracted information was transferred to a project-specific *Microsoft Excel* (version 16.56) spreadsheet, with missing information highlighted. This was emailed to the primary contact in conjunction with a generic email providing information about the research, metadata, and ethical approvals. If no response was received within two weeks, then a follow-up email was sent. If there was no response to the second email, then the next potential contact was emailed. This process continued for up to three potential contacts per dataset. All communication was logged in a communication register as per legal advice.

2.3.8 Missing data

Some metadata were still incomplete due to primary contact non-response, an inability of the contact to access the dataset, or because irrelevant information was returned. Such datasets were classified as incomplete. To include these datasets in the analysis, important missing data were estimated using guidelines developed by the supervisory team (see Table 2.3).

Table 2.3 Guide for the replacement of certain missing data during data extraction.

Missing metadata	Replacement metadata
Year of data collection	The year prior to the publication year was used
Age of participants	If only school year (grade) was provided, then these were the ages used: Reception/prep/foundation year = 5 years Thereafter, age = Year + 5, e.g. Year 1 = 6 years
Number of participants per age	The total number of participants was divided by the number of ages, and this was allocated to each individual age. For example, Total sample = 250 (age range 11-15) Therefore, the age breakdown was calculated as Number of participants at each age = (250/5) = 50
Number of participants per gender	The total number of participants was divided by 2 and this was allocated to each gender. For example, Total sample = 250 Therefore, the gender breakdown was calculated as Number of boys = 125 Number of girls = 125

2.3.9 Data analysis

A descriptive analysis of the metadata was performed to summarise previous research and identify research gaps. To perform the analysis, queries were generated in *Microsoft Access* to allow records to be combined among tables and for a descriptive summary. Whenever the data queries were more complex and involved specific Structured Query Language (SQL) demands, data were transferred to *Microsoft Excel*, and this was used instead. The type of results that were calculated included:

- number of research publications
- number of studies and datasets
- coverage of data collected, which refers to:
  - historical spread showing the years of data collection (by datasets, participants, and measurement occurrences)

    - geographical spread showing the location of data collection (by dataset, participants, and measurement occurrences)
- total number of participants
- amount of research by each research design
- who facilitated the research, which refers to:
    - the researchers who published research
    - amount of data collected by each organisation/institution
    - organisations that funded the research

2.3.9.1 *Creation of matrices*

Matrix charts were used to visually represent the measurement occurrences for each of the datasets. This was used to analyse distributions and coverage of data. Once the required data had been selected in *Microsoft Access*, it was then transferred to *Microsoft Excel* to organise. A different program, Canopy (2.1.9.3717),[151] was used to create each of the matrix charts. This program uses Python computer language to create a matrix, following the format of a heat map chart. A consistent scale and value range was selected to visually illustrate the data. Figure 2.2 is an example of how to interpret a matrix chart. The Y-axis shows the age of the participants, and the X-axis shows the years of measurement. The colour scale represents the combined number of participants included across all the datasets collected within a particular year of measurement. Therefore, each square represents the total number of participants per age (0-18 y) on whom participation data were collected.

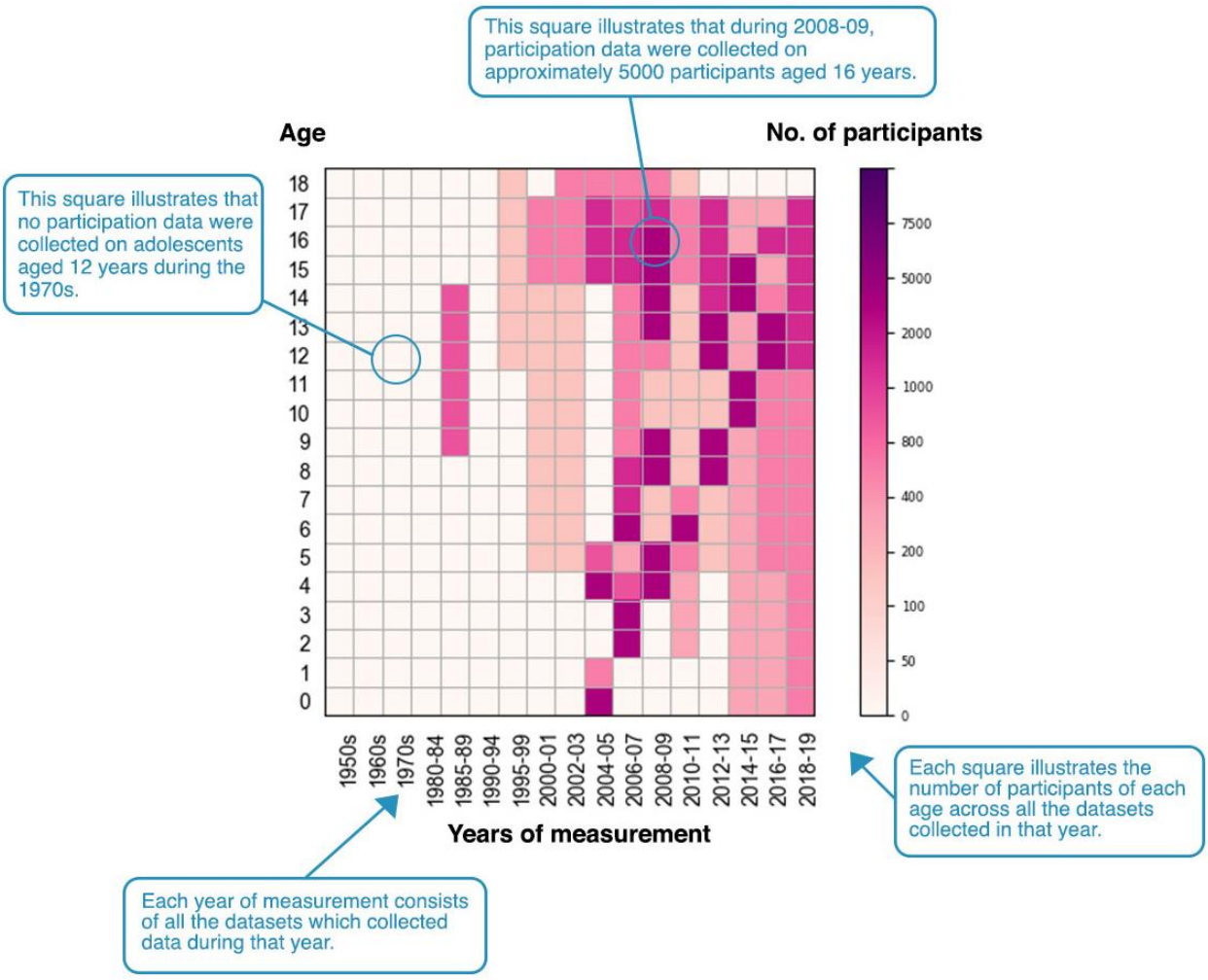


Figure 2.2 An example of how to interpret the matrix charts showing the historic coverage of data collected on Australian children's and adolescents' participation in physical activity and sedentary behaviours.

2.4 Results

The systematic search identified an extensive number of datasets. The metadata from these studies were descriptively analysed and are presented in this section. The results describe the characteristics at each of the different levels: studies, participants, and datasets.

To improve understanding, the metadata were described in terms of the overall coverage, amount of research collected, methods used, and how the research was facilitated. All results are presented in the following order:

- results of the systematic search process
- research publications output
- overview of the research found
- results in relation to the:
  - methodology
  - coverage
  - research facilitation.

2.4.1 Results of study selection

The search returned a total of 22,587 records; however this was reduced to 12,090 following de-duplication (Figure 2.3). Following abstract level screening, 916 articles were retained. A further 319 articles were excluded following full-text screening, leaving included 597 records.

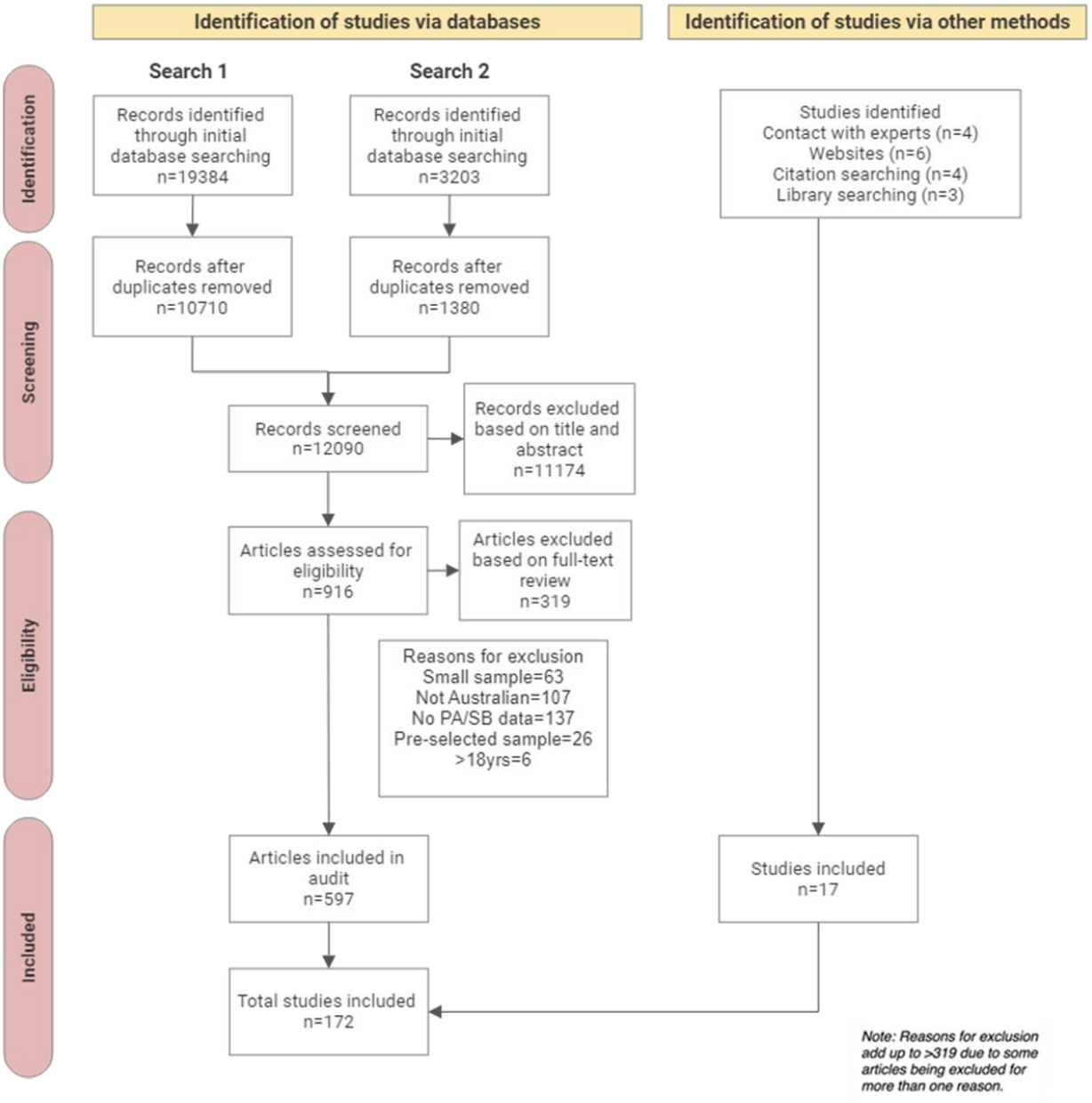


Figure 2.3 Prisma flow chart showing the systematic search to identify existing datasets consisting of participation data on Australian children's and adolescents' physical activity and sedentary behaviours.

PA = physical activity, SB = sedentary behaviour

Overall, the search identified 172 studies, with 155 (90%) identified through the systematic search and 17 (10%) grey literature.

2.4.1.1 *Missing data*

A total of 13 full texts were not located and were excluded from the study. Considerable metadata were missing following communication with data contacts. Some missing data were replaced as per the protocols described in Section 2.3.8, with other missing data unable to be replaced mainly due to the inability to determine the questions used to measure participation levels. Table 2.4 below illustrates the missing data that were excluded from analysis.

Table 2.4 Metadata which were unable to be found or replaced.

Metadata unable to be replaced	No. of studies (% of total studies)
Sample size	8 (5%)
Year/s of data collection	1 (1%)
Geographic representation	1 (1%)
Location of data collection	1 (1%)
Sampling frame	34 (20%)
Measurement used	0 (0%)
Type of measurement	1 (1%)
Specific measurement details	1 (1%)
Mode of administration	8 (5%)
Data custodian / data availability	149 (87%)
Research team	3 (2%)
Funding source	41 (24%)

2.4.1.2 *Research productivity*

A description of existing physical activity and sedentary behaviour research on Australian children and adolescents were expressed in terms of publication trends (Figure 2.4). A total of 597 publications, conducted between 1965 and 2019, were included, with an initial publication rate of 1 per decade in the 1960s that increased to 370 per decade in the 2010s.

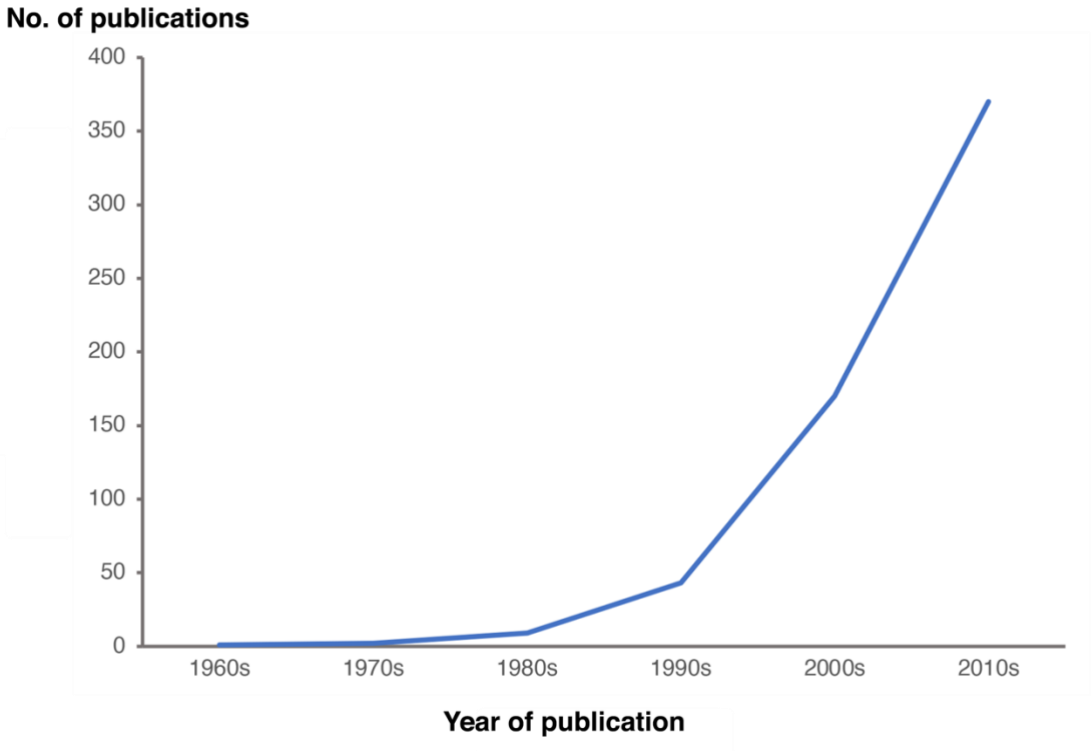


Figure 2.4 Number of publications on Australian children's and adolescents' physical activity and sedentary behaviour per decade.

From the 597 included publications, 165 different journals were identified. The most common journal for publications on child and adolescent physical activity and sedentary behaviour research was the *Journal of Science and Medicine in Sport* (16%) (Table 2.5). Notably, this journal originated in 1998, in comparison to some of the other journals with a more recent start date. A total of 299 people have published research as a first author, with one researcher, Jo Salmon, first author of the most publications (3%) (Table 2.6).

Table 2.5 Top ten journals with the highest number of publications on Australian children's and adolescents' participation in physical activity and sedentary behaviours over the last 70 years.

Journal name	No. of publications (% total publications)
Journal of Science and Medicine in Sport	93 (16%)
International Journal of Behavioral Nutrition and Physical Activity	39 (7%)
BMC Public Health	24 (4%)
Preventive Medicine	22 (4%)
Medicine and Science in Sports and Exercise	18 (3%)
Journal of Physical Activity and Health	18 (3%)
Obesity Research and Clinical Practice	15 (3%)
Pediatric Exercise Science	13 (2%)
Australian and New Zealand Journal of Public Health	11 (2%)
Health Promotion Journal of Australia	10 (2%)

Table 2.6 Frequency of authors with highest number of publications as first author within the existing datasets on Australian children's and adolescents' physical activity and sedentary behaviours.

First authors	No. of publications (% total publications)
J Salmon	15 (3%)
L Hardy	14 (2%)
J Dollman	10 (2%)
T Olds	10 (2%)
A Carver	9 (2%)
C Hume	9 (2%)
D Lubans	9 (2%)
R Telford	9 (2%)

2.4.2 Overview of studies identified

The following sections describe the included studies with all metadata combined and described (see Appendix 3 for table of all included studies). The results are described

separately in terms of (a) *studies* or published reports of surveys, (b) *datasets* associated with these surveys, and (c) *participants* in the surveys. The earliest study reported on data collected in 1951 with the most recent study with data collected in 2019. Across this time, spanning 68 years, there were 41 years in which data were collected, and 27 years for which we found no data. A total of 13 (8%) studies reported on data collected nationally, 154 (90%) on data collected at a state level, and an additional five studies (3%) on data collected from more than one state and/or territory (but not all states/territories). However, only five of these national studies have been collected recently (2014 to 2019).

The 172 studies reported on 190 different datasets and generated 597 publications. There were 18 studies comprising more than one dataset because different study methods were used (e.g., collecting pedometer data for a single sub-group). A total of 16 datasets used national samples, 169 used state-based samples (89%), and five datasets (3%) used samples comprising more than one state/territory. Regarding the participant characteristics, most datasets (48% or n=143) collected data on 5- to 12-year-olds, with 42% (n=124) on 13- to 18-year-olds and 10% (n=29) on 0- to 4-year-olds. There were four datasets which consisted of data on only 0- to 4-year-olds. Further, there were only 4 datasets which consisted of participants of all ages, from 0- to 18-year-olds. Twelve datasets collected data for a single sex, with 11 of these collecting data for girls only.

The 190 datasets reported on a total of 751,237 participants, which averages to 11,047 participants per year over the 68-year period. Comparatively, the average Australian population (0-18y) was 4,638,936, calculated by averaging the yearly population from ABS data.[152] Therefore, data was collected from approximately 0.2% of Australian children and adolescents per year. Regarding the number of participants per age range, 5–12 years had the highest number of participants with 385,944 (49%), followed by 372,763 (48%) aged 13-18 years, and 23,368 (3%) aged 0–4 years. Across all datasets, there was a total of 379,353 girls (51%) and 367,077 (49%) boys.

Table 2.7 Characteristics of existing datasets measuring participation in physical activity and sedentary behaviours of Australian children and adolescents.

Characteristic	Type	Sub-type	Studies	Datasets	Participants	% Mean pop.
Total			172	190	751,237	0.26%
Source	Sys. search		155 (90%)	170 (89%)		
	Grey literature		17 (10%)	20 (11%)		
Methods	Surveys		127	143 (75%)		
	Devices		24	26 (14%)		
		Ped.	7	8 (4%)		
		Acc.	13	13 (7%)		
		Both	1	2 (1%)		
		Field obs.	3	3 (2%)		
	Mix. methods		21	21 (11%)		
Design*	CSS		138	154 (81%)	330,933 (46%)	
	SCSS		19	20 (12%)	373,861 (51%)	
	Long.		15	16 (8%)	21,711 (3%)	
Coverage*	National		13 (8%)	16 (8%)	102,615 (14%)	0.03%
	Single State		154 (90%)	169 (89%)	616,189 (84%)	
	≥2 states		5	5 (3%)	11,196 (2%)	
Geographical area^	ACT		5	6 (3%)	27,937 (4%)	0.59%
	NSW		47	49 (26%)	184,598 (25%)	0.17%
	NT		0	1 (0.5%)	15,259 (2%)	0.51%
	QLD		19	20 (11%)	52,806 (7%)	0.09%
	SA		20	21 (11%)	251,109 (34%)	0.96%
	TAS		3	4 (2%)	26,857 (4%)	0.29%
	VIC		39	40 (21%)	118,032 (16%)	0.14%
	WA		21	23 (12%)	62,941 (9%)	0.21%
Age*	0-4		28	29 (10%)	23,368* (3%)	0.04%
	5-12		132	143 (48%)	385,944* (49%)	0.34% (5-18y)
	13-18		113	124 (42%)	372,763* (48%)	
Sex^	Both		161	179		
	Female only		10	10	12,376	
	Male only		1	1	133	
	Female total				379,353 (51%)	
	Male total				367,077 (49%)	
Year*	1951-1999		48	48 (23%)	100,254 (13%)	0.05%
	2000s		83	92 (44%)	202,096 (27%)	0.39%
	2010s		61	70 (33%)	453,952 (60%)	0.90%
Research team^		Govt.	26	30 (16%)	403,931 (56%)	
		NGO	20	25 (14%)	128,619 (18%)	
		Uni.	127	130 (70%)	192,959 (27%)	
Funding^		Govt.	74	82 (46%)	534,703 (70%)	
		Industry	6	6 (3%)	12,060 (2%)	
		NGO	36	40 (22%)	142,045 (19%)	
		NHMRC/ARC	35	35 (20%)	51,792 (7%)	
		Uni.	16	16 (9%)	23,898 (3%)	

Abbreviations used: CSS= cross-sectional study, SCSS= serial cross-sectional study, Long.= longitudinal, Ped.= pedometer, acc.= accelerometer, Field obs.= field observations, Govt.= government, NGO=non-government organisation, Uni.= university, NHMRC/ARC= National Health and Medical Research Council/Australian Research Council, %mean pop.= average number of participants per year expressed as a percentage of the average relevant population per year, * = Equals more than the total due to studies crossing two or more categories, ^ = totals do not equal 100% due to missing data

2.4.2.1 *Methodological approach of studies*

Firstly, the datasets are described in terms of their research design. Most datasets were collected using a cross-sectional design (81% or n=154) (Figure 2.5). The first cross-sectional dataset conducted nationally was in 1985 (Australian Health and Fitness Survey). The first serial cross-sectional dataset was in 1971 (Sydney Greater Metropolitan Area Household Travel Survey) and consisted of another three data collection waves in 1981, 1991, and 2003. The first and only national longitudinal study began in 2004 (The Longitudinal Study of Australian Children) and consisted of two cohorts aged 0–1 and 4–5 years and is ongoing. The total number of participants involved in this national longitudinal dataset was 10,090 at the first data collection, which equates to 1% of all participants in all datasets.

Secondly, the datasets were described in terms of the measurement techniques used. Three-quarters of the datasets collected data using surveys and few datasets used devices (14%) as illustrated in Figure 2.5, with eight datasets using pedometers, 13 datasets using accelerometers, and one using both. The first dataset utilising a device to measure physical activity participation was in 2000 (NoName_Vincent) and used a Yamax MLS-2000 pedometer. Accelerometers were first utilised in 2002 to collect two different datasets: the Health, Eating and Play study used an Actigraph Manufacturing Technology Inc Model 7164 and Switch-Play used a Model AM7164-2.2C.

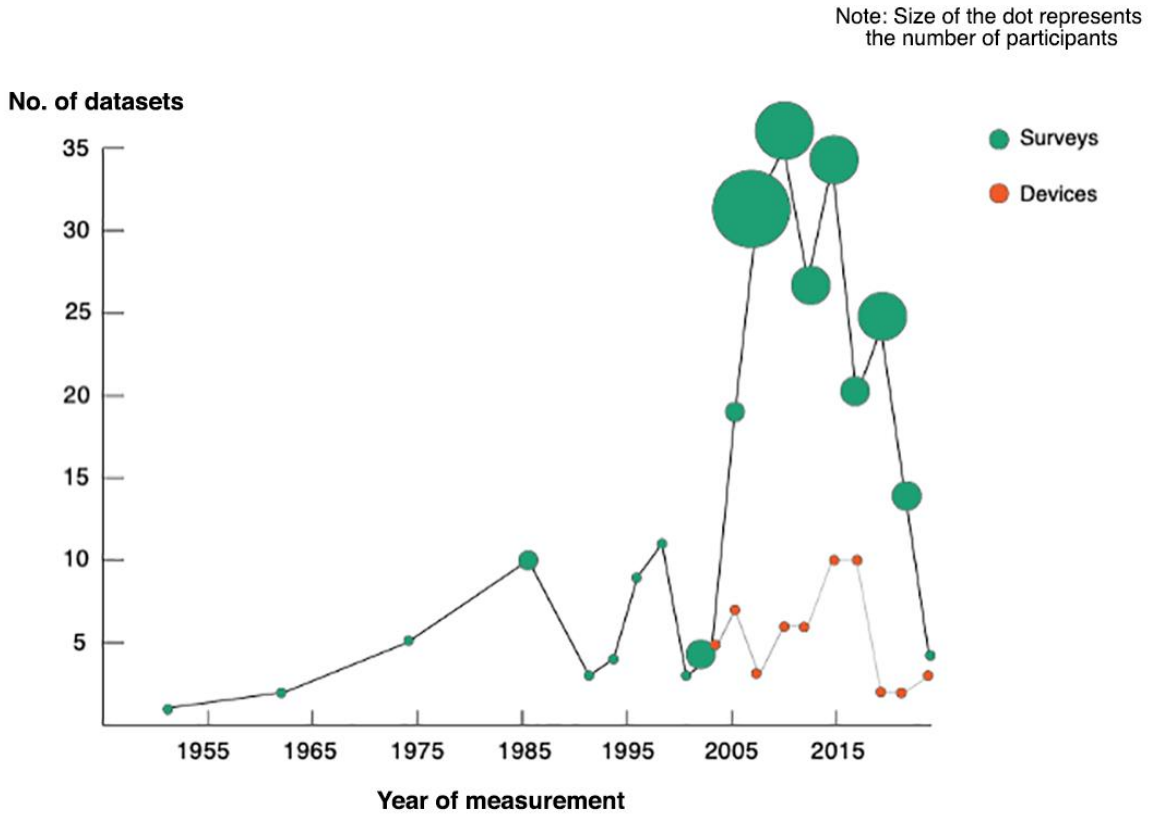


Figure 2.5 Chart illustrating the number of datasets collected using two different measurement approaches. The size of the dot represents the participant numbers.

2.4.3 Coverage

2.4.3.1 *National coverage*

Only a few datasets were collected nationally, consisting of 8% of all datasets and 14% of all participants. The first national survey was the Youth Say Project in 1973. Annual data collection covering children of all ages (0–18 years) was initiated in 2015 with the AusPlay survey. Figure 2.6 illustrates the scope and magnitude of the data which have previously been collected nationally.

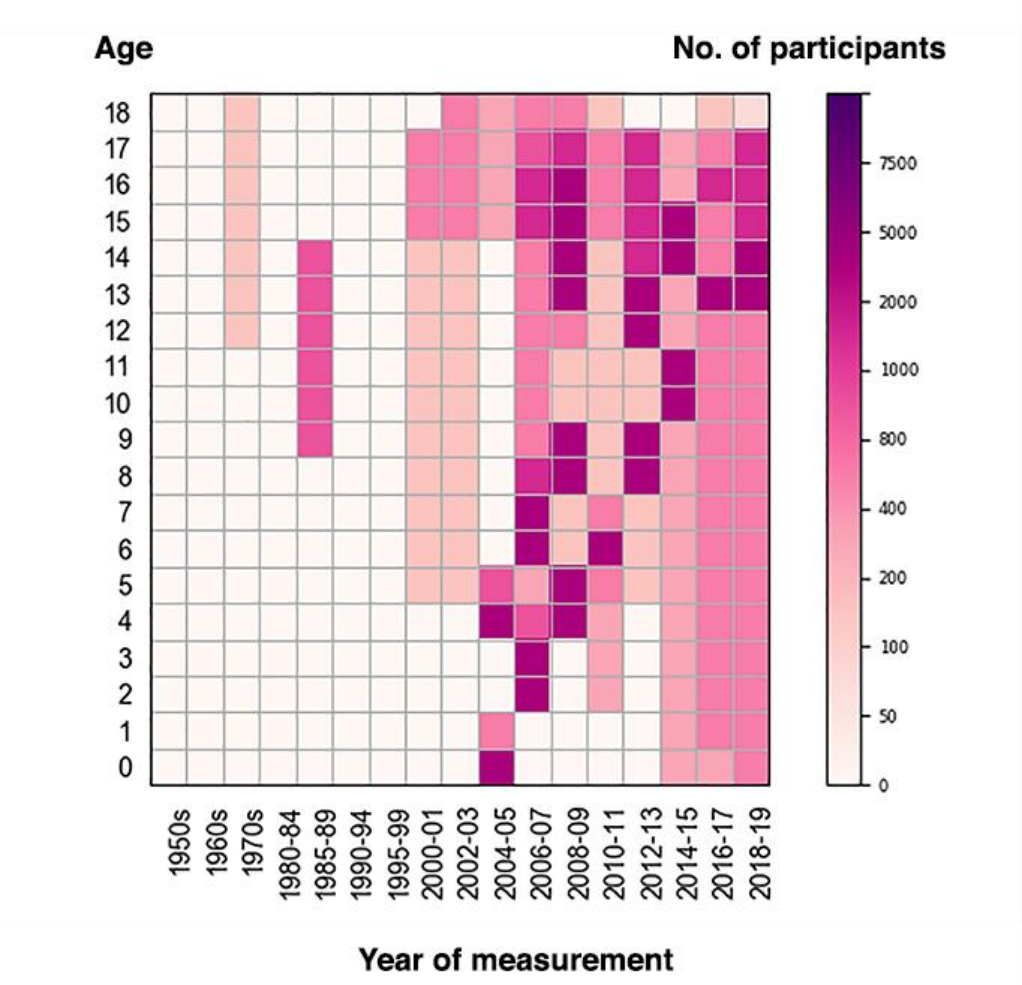


Figure 2.6 Matrix illustrating the number of participants per age which have previously been involved in nationally collected datasets.

2.4.3.2 *Historical coverage*

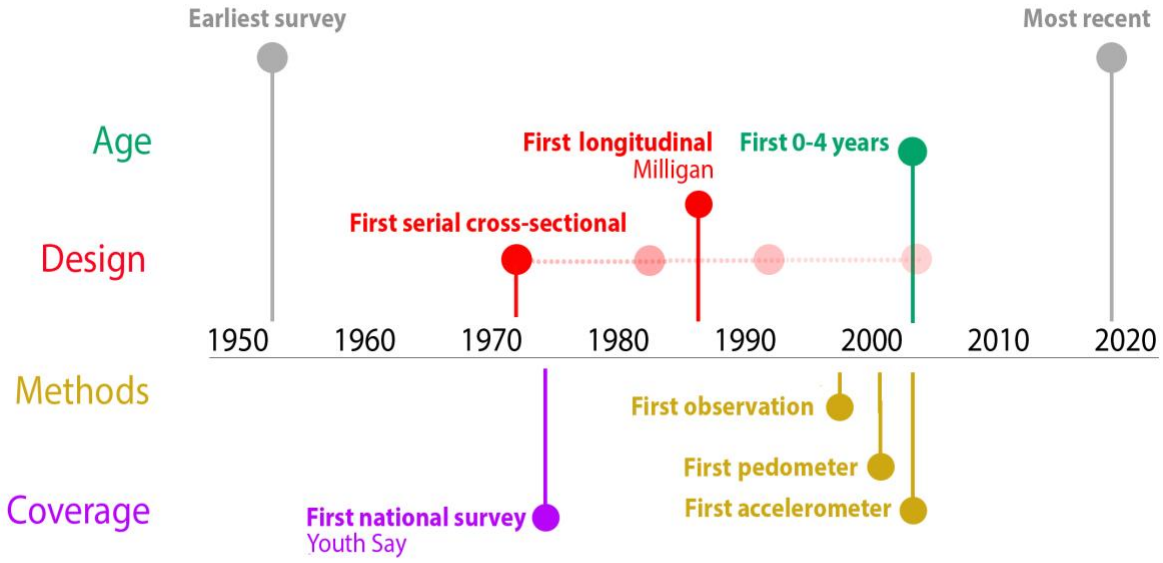


Figure 2.7 Timeline of research collected on Australian children's and adolescents' participation in physical activity and sedentary behaviours.

The included datasets spanned 1951 to 2019, as illustrated in Figure 2.7. Initially, few datasets were collected, with only one in the 1950s and three in the 1960s. A total of only 48 datasets (23%) collected data in the 20th century (1950–1999) (Table 2.7), with an increase in the number of datasets henceforth. More recently there has been a considerably larger research output, with 92 datasets in 2000s and 70 datasets in 2010s. Furthermore, a considerable number of datasets (n=153) collected their first wave of data between 2000 and 2019. Put another way, the average research output was equivalent to 1 dataset every 5 years for the first 30 years. This increased between 1982 and 1999 to an average research output of one dataset every 6 months, and between 2000 and 2019 to one dataset every 1.5 months. This increase is evident in Figure 2.8, illustrating the number of participants per age (x-axis) for each year of measurement (y-axis). The darker squares illustrate a higher number of participants for the specific age, compared to the white squares which illustrate that no data were collected. A

significant finding from this matrix is the lack of data collected on young children (0-4y).

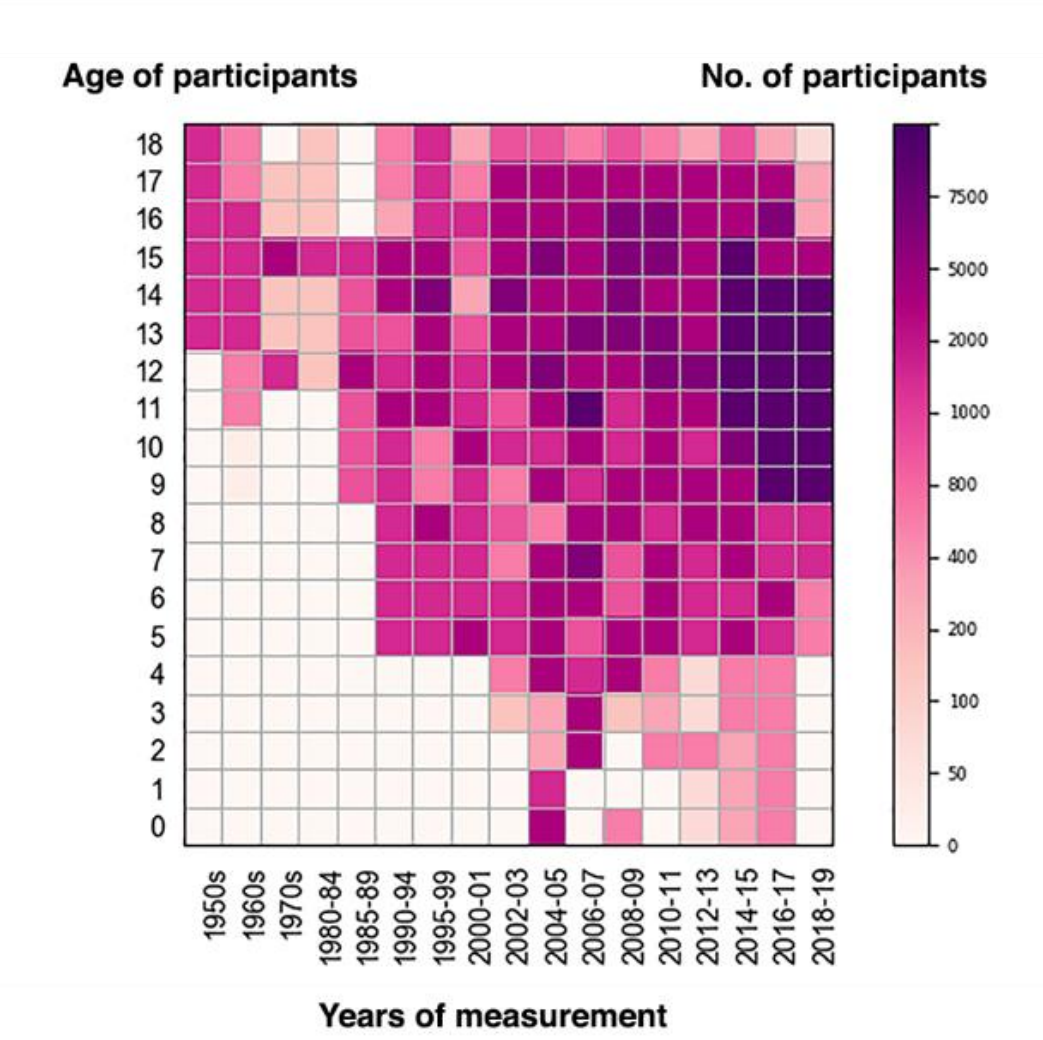


Figure 2.8 Matrix illustrating the number of participants per age involved in all previous research.

2.4.3.3 *Geographical coverage*

Most datasets (26%) came from NSW, followed by VIC with 21% (Table 2.7). Despite most datasets coming from NSW, more participants were from South Australia (SA) than elsewhere (34%), followed by New South Wales (NSW) (25%). Furthermore, Northern Territory (NT) had the fewest participants (2%), along with the Australian

Capital Territory (ACT) and Tasmania (TAS) (4% each). However, when comparing the mean sample per year to the mean population per year, SA had the highest sampling with 0.96% of their population per year. ACT was the second highest with 0.59% of their population, in contrast Queensland (QLD) only had sampled 0.09% of their population per year, and NSW only 0.17%. Figure 2.9 illustrates the number of participants (x-axis) with data collected within each geographical area (x-axis) and years of measurement (y-axis). The white squares are particularly important to use as an indicator of the research gaps, notably a lack of data has been collected within NT and TAS.

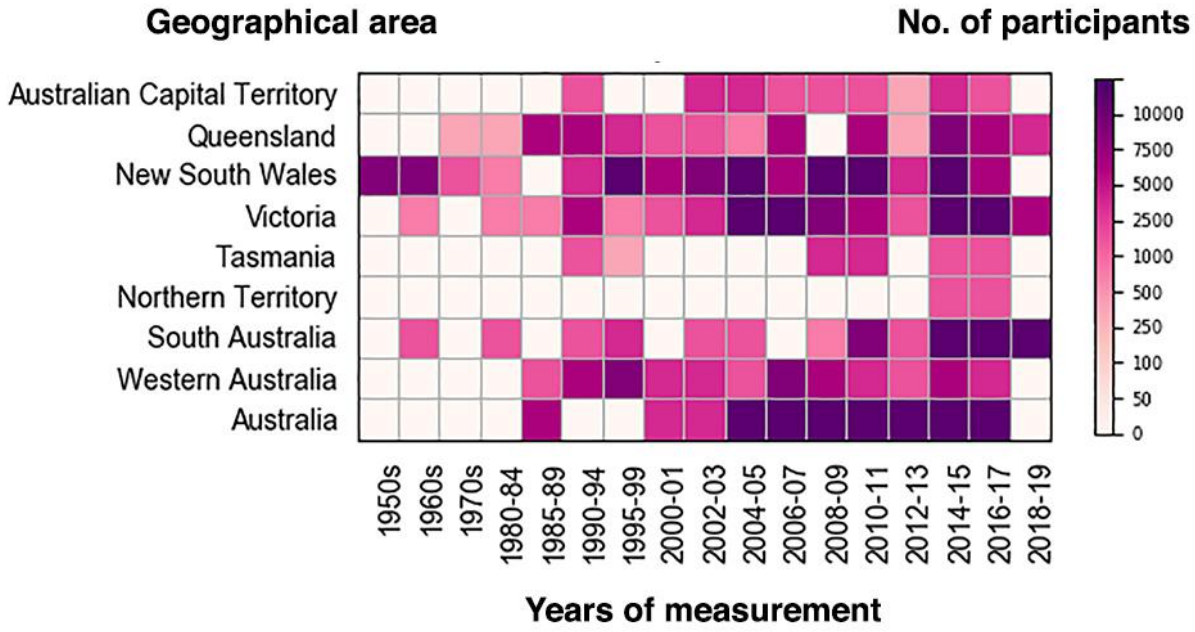


Figure 2.9 Matrix illustrating the number of participants per geographical location and year of measurement involved in all previous research.

2.4.4 Research facilitation

2.4.4.1 *Who conducted the research?*

Exploring the various organisations and researchers who collected the data found a total of 64 organisations; not-for-profit, government, and universities. More than two-

thirds of datasets (70%) were collected by 27 different universities, as illustrated in Figure 2.11. The organisation that collected the highest number of datasets was Deakin University based in VIC, with a total 27 datasets (14%). The Australian Bureau of Statistics collected the most national datasets with 10 datasets (5%).

2.4.4.2 *Dataset funding*

There were five types of organisations who funded the datasets: non-government organisations, universities, NHMRC/ARC, government, and industry. Almost half of all datasets were government funded (46%), mostly by government agencies such as national and state-based health departments (Figure 2.10).

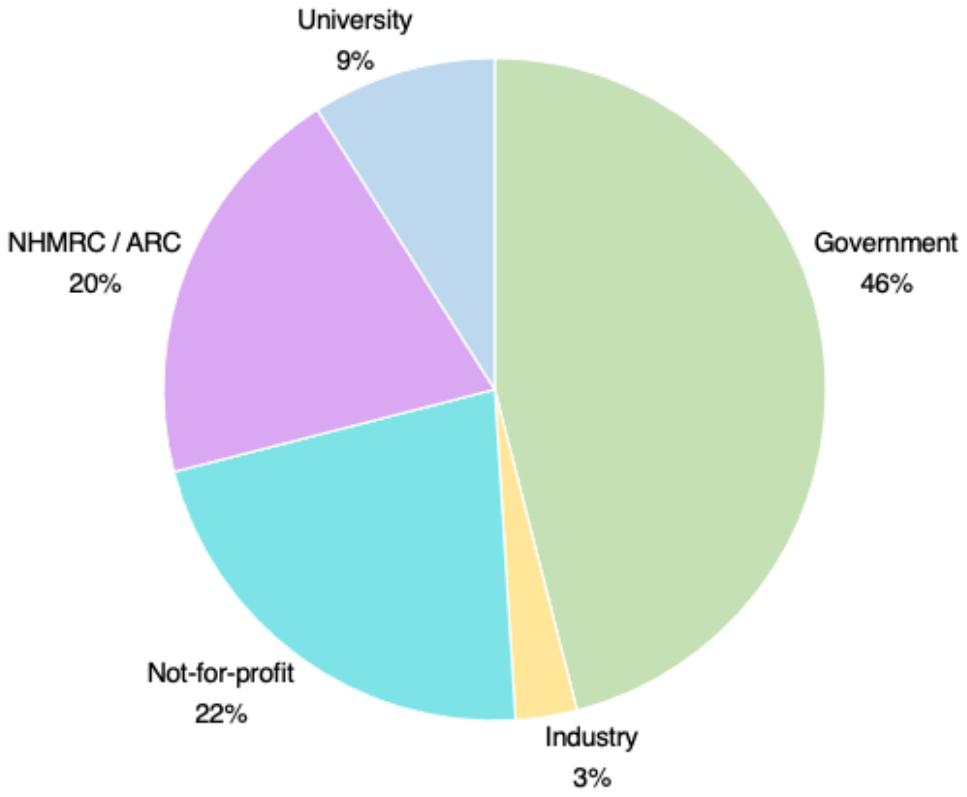


Figure 2.10 The proportion of datasets on children's and adolescents' participation in physical activity and sedentary behaviours funded by each organisation.

2.5 Discussion

This study aimed to conduct a comprehensive audit of existing datasets on Australian children's and adolescents' physical activity and sedentary behaviour and was the first comprehensive audit of datasets conducted. Using a systematic search strategy, 597 relevant publications yielded 172 studies, 190 datasets, and 751,237 participants. The first dataset, *Growing up in an Australian City*, was facilitated by a group of students from the University of Sydney interested in learning more about the lives and interests of adolescents. The cross-sectional study was conducted in 1951, using a survey to collect data from 8,705 participants aged 13-18 years. Since this dataset was collected, slow growth in publications occurred until it accelerated around the 2000s, resulting in a large pool of data that could currently be underutilised. The existing datasets include diverse characteristics collected using different methodologies, locations, and participant age ranges. However, there was an evident bias towards some common characteristics, with a typical dataset following a cross-sectional design (80%), collecting state-based data (89%), using surveys (75%) and assessing school-aged participants (90%). While these similarities have the potential for identifying data that could be used to estimate trends, they also highlight significant research gaps, needing to be addressed in future research.

2.5.1 Implications

Over the last 68 years, 190 datasets have been collected, suggesting that there could be a considerable amount of data available for further analysis of trends, research gaps, geographical differences, and other potential inequalities. An examination of metadata detected clear research gaps, which makes it challenging to monitor the physical activity participation of Australian children and adolescents and their adherence to national physical activity guidelines. Difficulty estimating prevalence rates could have a consequential impact on policy development, monitoring of interventions, and ultimately increases in physical activity participation. A closer look at the Australian physical activity and sedentary behaviour research exposes how these research gaps and inconsistencies could influence participation estimates.

2.5.1.1 *Methodologies*

The datasets identified are predominantly cross-sectional. Only one-fifth of all datasets were longitudinal or serial cross-sectional, providing beneficial information on age-related and cohort effects. The first longitudinal dataset collected physical activity data in 1988 on Western Australian 11-to 12-year-olds (NoName_Milligan). Longitudinal studies, particularly across the transitional adolescent period, have been identified by Farod and collegues[153] as a research gap.

The majority of datasets used subjective methods, with only one quarter using a mixture of subjective and device-based measures. The first use of a non-subjective method (observation), which met our inclusion criteria, was in 1999, with the first pedometer study in 2000 and accelerometer study in 2002. Despite introducing this technology in 2000, a surprising 75% of studies have used questionnaires. Even though the use of accelerometers for physical activity measurement is more valid and reliable than self-report measures[59], there are feasibility and scaling issues that limit their use for larger-scale monitoring. Other limitations of using accelerometers for population surveillance were highlighted by Pedišić and colleagues[59] and included possible tampering with devices, a higher percentage of missing data, lack of standardised measurement approaches, cost and inability to measure muscle-strengthening activities, among others.

Different measurements used to collect the existing datasets can result in incommensurable data, making inter-group comparisons and temporal trend analysis problematic. However, since many datasets used surveys, there is some potential for comparable data. A closer examination of the questions used to collect the data and other dataset characteristics would be needed before conclusions could be made.

2.5.1.2 *Research gaps*

Mapping of the datasets revealed research gaps. Of particular importance were the few existing datasets that capture participation of the 0–4 age group. Only 23,368 participants were in this age range at the time of data collection, at 3% of the total number of participants across 29 different datasets. More recently, a national serial

cross-sectional survey has been implemented, including collecting annual data on participants within this age range through to 18 years (2015–2019). However, this study (AusPlay) only collects data on physical activity participation and not sedentary behaviours. More data would provide a better understanding of participation during the early years, especially since current prevalence estimates indicate low participation rates during this crucial neurodevelopmental stage.[154] Evidence suggests that physical activity during early childhood is positively associated with adiposity, bone strength, motor development, psychological health and cardiometabolic health along with the generation of healthy habits.[8, 153] There is also evidence of moderate tracking of physical activity levels from early to middle childhood.[155] The high number of school-age participant data is because these children are more easily accessed, as 92% of all school-age students attend school on any given weekday.[156] In contrast, only 57% of 0- to 4-year-olds are enrolled in a care facility.

Another notable research gap was evident when describing the geographic representation of the existing datasets. Most surveys were state-based, with only 16 national datasets (8%) representing 14% of all participants available. Only one of these was longitudinal. There is also a degree of geographical lumpiness in state-based data. Most of the datasets have been collected along the east coast of Australia, where much of the population resides, with 49 (26%) and 40 (21%) datasets collected in NSW and VIC, respectively — roughly consistent with their population shares (32% and 26%).[157] However, SA had the largest number of participants of any state or territory, with 34% of the total participants from 21 datasets, despite SA representing only 7% of Australia's population.[157] Only one study collected data from children and adolescents living in the NT. This is particularly not surprising as this area has the highest proportion of Australians living in remote and very remote areas.[158] The NT is especially interesting because of its large Indigenous population (30% vs. <3% nationally) and because it has the highest rates of childhood obesity in Australia at 12.9% for 2- to 17-year-olds.[159]

2.5.1.3 *Future implications*

Globally, many countries now regularly collect data to monitor youth activity levels using consistent methodologies over time. As previously mentioned, countries such as Canada[68] and the US[66] conduct regular national monitoring and surveillance. Comparatively, Australia conducts one national survey collecting data yearly, namely AusPlay; however, it only measures participation in organised physical activity and has a limited ability to monitor adherence to national physical activity guidelines. Two other serial cross-sectional national surveys are conducted every few years, the National Secondary Students' Diet and Activity Survey (NaSSDA) and National Health Survey (NHS); however, these only collect data on adolescents aged 12 and above.

Australian studies are also unevenly distributed across time (Figure 2.11). The earliest identified dataset was in 1951, and only 12% of all participants were involved in data collection for the remainder of the 20th century. The bulk of the data was collected from 2000 onwards, with the highest research output equivalent to one new dataset every 18 days, illustrating the considerable amount of unused data for tracking participation and public health measures. No extant datasets stretch back to the 1951–1990 period, which saw a rapid increase in the prevalence of overweight and obesity[160] and where anthropometry and fitness data were emphasised. Historical datasets provide useful information for tracking temporal trends in physical activity participation and relationships between changes in physical activity and changes in fitness and fatness.

Numerous organisations and researchers were involved in the identified research studies, potentially resulting in some positive implications and further limitations. With 64 organisations, 299 researchers (first authors), and five different types of funding sources contributing to this research, the variability in study characteristics is not surprising. This variability is another limitation, with each facilitator having their own research aims and desired outcomes, irrespective of the overall need for consistency and comparability. The variety of contributors can also positively result in

novel research outcomes. Above all, more transparency by improving access to data and openness around methodologies could promote compatibility for future research.

2.5.2 Strengths and limitations

There may well have been other datasets collected prior to 1951 that were unable to be identified, despite the thorough search techniques used for this audit. The first online journal began in 1990,[161] with printed journals the prominent place to disseminate research beforehand. Print media have been stored in numerous locations around Australia and were challenging to access, making it challenging to identify earlier research that had not been digitised. The strict inclusion/exclusion criteria (e.g., the minimum sample size requirement, the exclusion of data on subpopulations likely to have atypical physical activity patterns) meant that many additional datasets were excluded. Despite the limitations, the main strength of this research was the rigorous systematic search strategy, which included searches of online resources, printed journals and books, theses, newspaper articles, microfilms, and slides.

2.6 Conclusion

An audit of existing datasets collected in Australia measuring behaviours related to physical activity and sedentariness revealed an assortment of existing datasets. In the absence of consistent national surveillance in Australia, a selection of other studies are used to estimate the proportion of children and adolescents who accumulate sufficient physical activity. However, as evidenced by these results, differences emerge in the way the data were collected, resulting in limitations in the comparability of data to establish prevalence rates and tracking of activity levels. However, some common characteristics were detected, suggesting there is a possibility that some data may have been collected using a consistent approach. Further examination of methodologies used in these datasets is needed to assess comparability.

This audit has collated existing research, essentially providing an inventory from which researchers and policy makers, among others, can extract information on datasets of

interest. Ideally, future research could make this data repository operational online, improving the accessibility of data and consequentially the future impact.

CHAPTER 3.

Study 2: The questions

For the first time in our evolution an entire generation of children has the opportunity of living a completely sedentary lifestyle, and multimedia-based entertainment options appear to be progressively eroding the potentially active leisure time of children.

Mark Tremblay, Dale Esliger, Jennifer Copeland, Joel Barnes & David Bassett

Applied Physiology, Nutrition and Metabolism 2008[162]

3. Study 2 – Questions

3.1 Introduction

The previous chapter presented the comprehensive audit of existing datasets on Australian children's and adolescents' physical activity and sedentary behaviour. The purpose of this chapter is to present the next step of this research which explores the survey questions identified from the audit. This chapter outlines the motivation for this research, describes the methods and results, and then discusses the implications and strengths and limitations of this research.

3.2 Background

In our modern world data overload can occur daily, exceeding our processing capacity. Data are collected on the provision of healthcare, traffic surveillance, employment rates, student assessments, along with personal data on activity levels, sleep, and other technology used in the home. Some data are organised and stored, and other data are lost. As seen in Study 1, more data are available than most people know about. The way in which these data are collected and organised can often be overlooked. One method frequently used for collecting data is by asking questions. Google answers 3.8 million searches every minute, requiring extensive classification and organisation systems to store and retrieve information in a data repository.

As summarised in Australia's 2018 Physical Activity Report Card for Children and Young People[11], numerous data on children's and adolescents' physical activity levels or sedentariness are available. Such data show considerable variation in estimated physical activity participation rates. State-based surveys estimate that 34% to 87% of 2- to 5-year-olds, 23% to 63% of primary school children, and 6% to 22% of 15-to 17-year-olds meet the age-specific physical activity guidelines. As presented in Section 1.4.4, much of the variance between prevalence estimates can be explained by age, sex, different reporting methods and scope of the survey questions, however some is unclear. In general, one of the sources of variability could be due to data being

collected using different methods (e.g., different questions). Additionally, data could be collected to answer an alternate research question, besides compliance to guidelines. This impacts data commensurability, making data pooling challenging unless the specific questions and methodological details are provided.

The Active Australia Questionnaire was developed to measure physical activity participation at the population level in Australian adults.[163] This survey has been used extensively, providing a consistent indicator of current physical activity levels as well as temporal trends in physical activity participation.[163] Corresponding measurement of child and adolescent physical activity levels has been less consistent. A 2018 systematic review of child physical activity questionnaires across the globe identified 89 questionnaires.[164] In addition to the large number of surveys, the way that they have been administered has also changed over time. Advances in computer technology have changed how surveys are administered, from on-site pencil-and-paper administration, to computer-assisted telephone interviews (CATI) from the mid-1980s, to online methods which are popular nowadays.[165] Using a different method to administer the same questionnaire may yield different population estimates.[166]

To gain insightful information from previous research it is important to know which questions have been used to measure physical activity participation and sedentary behaviours. An audit of questions would help identify when similar questions have been used across surveys. Consistent questions make for commensurable data, and commensurable data allow temporal trends and geographical differences to be calculated. An audit would also allow for the identification of research gaps and under-researched areas. It may help to slow or stop the creation of new questions.

Therefore, Study 2 involves identifying, extracting, classifying, and analysing all the questions used to measure physical activity participation and sedentary behaviours. Ultimately, the adoption of a standard set of questions will make it easier to compare and combine research findings.

3.3 Aim

The second aim of this program of research was to collate and analyse all the questions used to measure physical activity participation and sedentary behaviours among Australian children and adolescents. The intention was to collate, classify, and describe all these questions in terms of the behaviours they measured and how they have previously been used. A specific classification system was created to classify these questions.

This aim involved several discrete steps:

1. Search for the questions
2. Identification and extraction of questions
3. Creation of a classification system
4. Classification of questions.

3.4 Methods

3.4.1 Question definition

For this research, a question was defined as all the content included alongside an individual question number in a survey. This includes all parameters in any attached ordered list of options, for example using letters or Roman numerals. Any questions alongside a new question number were designated as a new question. This chapter also refers to measurement instances, defined as the occurrences which a question was used to collect data from participants.

3.4.2 Search for all previously used questions

A comprehensive search was conducted to identify all the questions used to measure physical activity levels or sedentary behaviours. This search was conducted in conjunction with the Study 1 audit and involved searching the identified studies to

locate all previously used questions. Only studies that met the inclusion criteria for Study 1 and employed a questionnaire as the measurement technique were searched.

3.4.2.1 *Inclusion criteria for questions*

Questions were included if they:

- were administered in a study that met the inclusion criteria for Study 1.
- measured participation in at least one of the following behaviours:
  - overall physical activity
  - moderate-vigorous physical activity
  - muscle-strengthening activities
  - organised sport
  - physical education
  - active transport
  - active play
  - exercise
  - other physical activity
  - overall sedentary behaviour
  - screen time
  - non-screen sedentary time.

Questions were excluded if they:

- were from a study excluded from Study 1.
- did not measure participation in physical activity or sedentary behaviours.
- measured participation of subpopulations likely to have atypical physical activity patterns (e.g., members of a sports club, children with a disability).
- measured data on participants aged ≥19 years.

3.4.3 Identification of existing questions

Once the included studies were identified a 3-step process was followed to locate the existing questions (Figure 3.1). The aim was to identify the exact wording of the questions previously used. Firstly, full-text publications for each study (from Study 1) were inspected to distinguish if the exact question wording or the name of the survey had been stated. Secondly, online searches using Google Scholar and internet browsers were examined for more information about the study and the included questions. Thirdly, data custodians were contacted if the correct wording of the question was unclear.

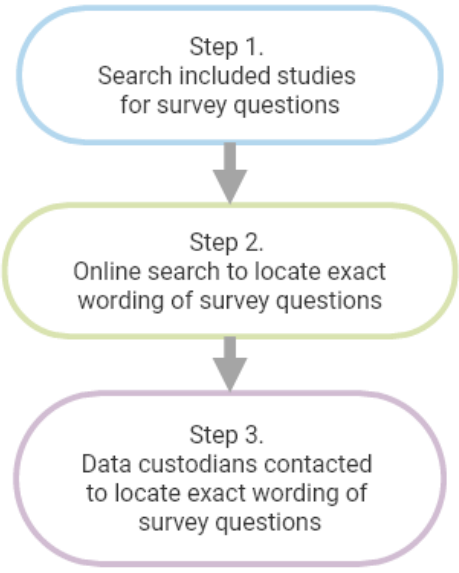


Figure 3.1 Process followed to identify existing questions measuring participation in physical activity and sedentary behaviours.

3.4.4 Question classification

There are a variety of physical activities and sedentary behaviours, as defined in Chapter 1. There is not an appropriate question classification system to determine the behaviours that existing questions capture. However, this was achieved by purposely developing a comprehensive classification system, aptly labelled the Classification

System of Physical Activity and Sedentarism (CS-PAS). The CS-PAS is presented in the following sections.

3.4.4.1 *Classification System of Physical Activity and Sedentarism (CS-PAS)*

A simple system was created to classify what each of the participation questions measured. As seen in Figure 3.2, this system is a parallel single-level classification system in which any element of the question can be classified and assigned a classification number.



Figure 3.2 The Classification System for Physical Activity and Sedentarism (CS-PAS).

Abbreviations used: RT= resistance training, active vg= active video gaming, floor-based= includes activities on the floor such as a baby or toddler actively playing or rough and tumble play for older children, communication= electronic communication inc. email, OSHC= outside school hours care, Handheld= other handheld devices such as tablets, critical window= afterschool time period.

To demonstrate the functionality of this system, consider this example question:

In an average week when you are at school, on how many days do you go to physical education (PE) classes?

Using the CS-PAS (Figure 3.3) to classify this question would result in a classification number of 5-12-1-1-1-3.



Figure 3.3 Example of question classification using the Classification System of Physical Activity and Sedentarism (CS-PAS).

Since every question has a unique code, the CS-PAS has the functionality to calculate the frequency of questions under each of the classifications (e.g., count the number of

3-2/11/13-2-1-2/3/5-3 to get the frequency of questions dealing with active play at school. Or 1-1/2/3/4-1/2/3-5-6/7/9-2/3 for all active transport questions).

3.4.4.2 *Development of the Classification System of Physical Activity and Sedentarism (CS-PAS)*

The development of this system included:

1. Purpose of the classification system
2. Defining each classification
3. Creation of the classification system
4. Review and refinement of the system
5. Implementation

3.4.4.3 *Purpose of the classification system*

The aim of this system was to classify and organise the numerous questions that have been used to measure participation in physical activity and sedentary behaviours. It was important to create a simple system without a fixed structured hierarchal system. This would provide more flexibility when classifying questions, allowing a question to be classified by the location of the activity (e.g., without having to complete a prior classification of the question's mode).

This type of system could be used by different individuals and understanding how could help to define the purpose. Possible users include a researcher seeking to classify a question to check its suitability for their research study, or an individual wanting to evaluate participation in a specific behaviour within their intervention. The main behaviours that are intended to be classified are consistent with those outlined in Chapter 1 and in Table 3.1.

3.4.4.4 *Defining categories and creating the system*

Table 3.1 Domains of physical activity and sedentary behaviours and their definitions.

Domain	Definition
Active play	*A form of gross motor or total body movement in which young children exert energy in a freely chosen, fun and unstructured manner.*[29]
Active transport	*Human powered transport modes.*[31]
Sport	*Physical activity which should involve either physical exertion or physical skill, a structured or organised setting, and some level of competition against others or a defined goal.* [33]
PE	*The curriculum area that engages students in worthwhile learning experiences to develop skills, knowledge, self-efficacy and dispositions that will enable young people to live a healthy and active lifestyle.*[34]
Exercise	*A subset of physical activity that is planned, structured, repetitive, and done to improve or maintain physical fitness.*[35]
Screen time	*The time spent on screen-based behaviours.*[36]
Non-screen sedentary activities	*The time spent in sedentary behaviours that do not involve the use of screens.*[36]

It is important to identify all the different activities that questions might ask about. The main physical activities and sedentary behaviours, as outlined above, were included in the system as the first category (domain). Other important categories should allow for the classification of what, how, where, when, and who. Each category comprised a comprehensive list of options representing all the different physical activities or sedentary behaviours. A number was assigned to each category to classify each question by a sequence of numbers (six numbers for physical activity and 5 numbers for sedentary behaviour-based questions).

3.4.4.5 *Review and refinement of the question classification system*

A random selection of questions was classified using this system to review its functionality. Minor refinement was required until the final categorical system was completed.

3.4.5 Question classification

To achieve a clearer picture of the existing physical activity and sedentary behaviour-based questions, all questions identified in Section 3.4.3 were classified using the CS-PAS. This proceeds in two stages:

1. The identified questions were extracted and entered in the database using *Microsoft Access*.
2. Questions were classified and provided with a classification number that defined the specifics around what each question measured.

3.4.5.1 *Compiling questions*

All the questions identified were extracted and compiled in the database constructed in Study 1. To compile these questions in *Access*, these points were considered:

- questions were very different with various structures, formats, response options, introductions, etc.
- questions were administered differently, including CATI, paper-based questionnaires, and face-to-face interviews.
- there were often variants of the one main question.

3.4.5.2 *Compiling different types of questions*

The questions identified were in many different formats. Below are three examples of some questions measuring sport participation:

1. Playing sport

We want to find out all the sports you have played regularly in the last year. Please include all sports you played with an organised team, group or club, or for your school, in the last year. Don't put in sports you have done as part of your P.E. classes but don't forget the sports you played during the last summer.

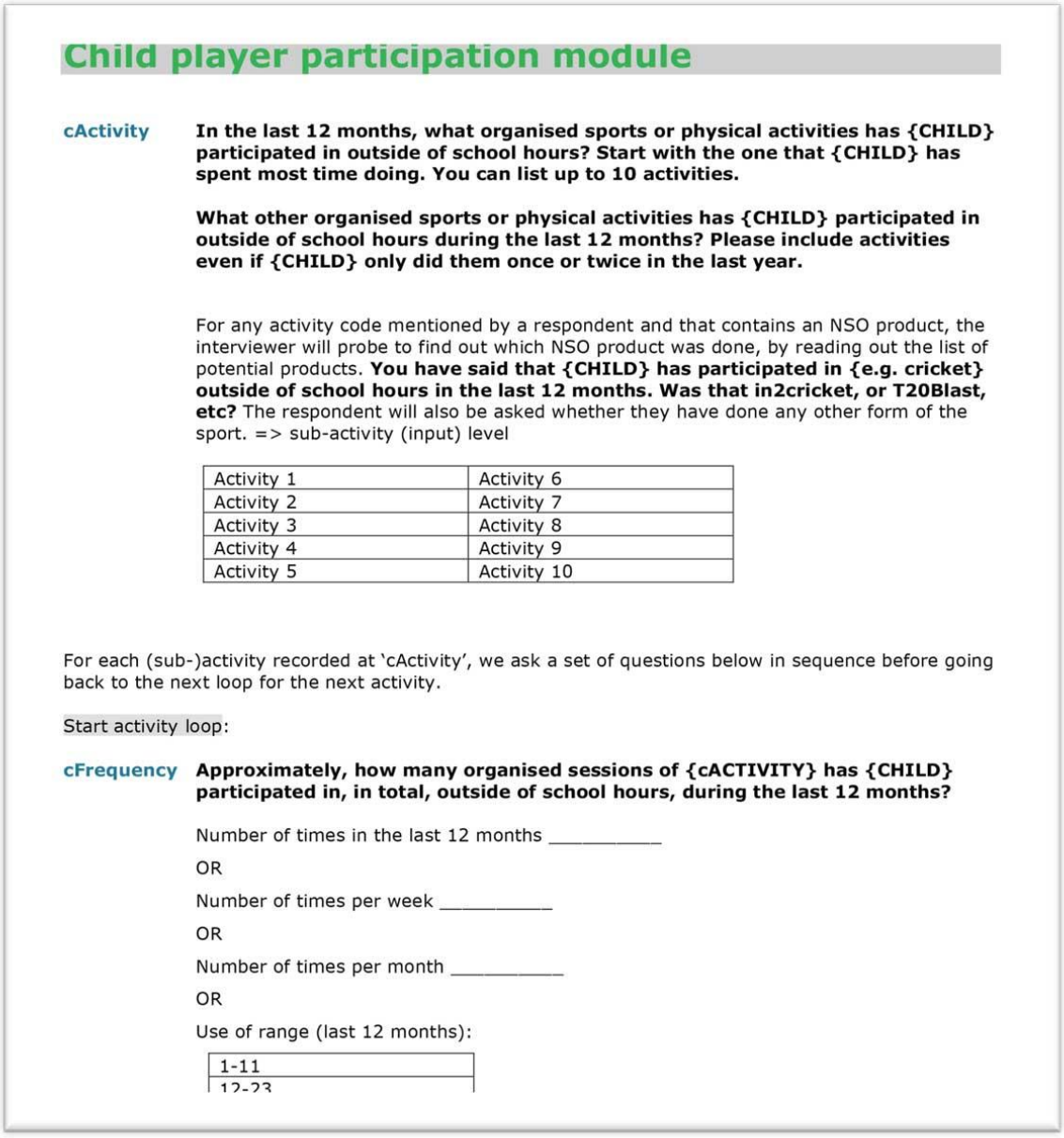
Write the name of the sport in the first column and then fill in the other columns across the line with numbers. Do this for all the sports you have played in the last year.

SPORT	What time of year do you play this sport?	Who do you play this sport for?	How good are you at it compared to others of your age?	Do you like playing this sport?	Will you do it again?
Name of Sport	Summer.....1 Winter.....2 Both.....3	Club.....1 School..... 2 Both.....3 Neither..... 4	Better.....1 Same.....2 Worse..... 3	Lots.....1 Some.....2 Little..... 3	Yes.....1 No.....2
e.g. Golf	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
e.g. Swimming					
	☐	☐	☐	☐	☐
.....					

South Australian Health and Fitness Survey 2004 & 2013 (Booth, Rowlands & Dollman, 2019)

16. (a) What games or sports do you play regularly?.....
(b) What games or sports do you watch regularly?.....

Growing up in an Australian City Survey (Connell, Francis & Skilbeck, 1957)



Child player participation module

cActivity **In the last 12 months, what organised sports or physical activities has {CHILD} participated in outside of school hours? Start with the one that {CHILD} has spent most time doing. You can list up to 10 activities.**

What other organised sports or physical activities has {CHILD} participated in outside of school hours during the last 12 months? Please include activities even if {CHILD} only did them once or twice in the last year.

For any activity code mentioned by a respondent and that contains an NSO product, the interviewer will probe to find out which NSO product was done, by reading out the list of potential products. **You have said that {CHILD} has participated in {e.g. cricket} outside of school hours in the last 12 months. Was that in2cricket, or T20Blast, etc?** The respondent will also be asked whether they have done any other form of the sport. => sub-activity (input) level

Activity 1	Activity 6
Activity 2	Activity 7
Activity 3	Activity 8
Activity 4	Activity 9
Activity 5	Activity 10

For each (sub-)activity recorded at 'cActivity', we ask a set of questions below in sequence before going back to the next loop for the next activity.

Start activity loop:

cFrequency **Approximately, how many organised sessions of {cACTIVITY} has {CHILD} participated in, in total, outside of school hours, during the last 12 months?**

Number of times in the last 12 months _____

OR

Number of times per week _____

OR

Number of times per month _____

OR

Use of range (last 12 months):

1-11
12-23

AusPlay Questionnaire 2019 (Australian Sports Commission, 2019)

Figure 3.4 Examples of sport participation questions from three different surveys.

All variations needed to be considered when compiling the questions. The main section of the question was prioritised, as this was the content mainly measuring participation. All possible questions measuring participation in physical activity and sedentary behaviours in computer-assisted and face-to-face questions were included, ignoring the inbuilt processes (logic checks, skip patterns, validations, etc.).

3.4.5.3 *Question entry*

For entry into *Microsoft Access*, the questions were broken down into the stem of the question, and then the possible answers to the question. Stem questions and responses were entered separately into the database as occasionally the stem of a question would remain the same between datasets, while the possible response options would be altered. Some questionnaires consisted of a lengthy introduction and/or explanation of physical activity at the start of the questionnaire. This was not able to be entered alongside each of the associated questions, therefore was excluded. However, any brief clarifications were included along with each question stem. This process was designed to reduce the amount of data entry required and to simplify the analysis.

To gain crucial insight into the coverage of a question it had to be directly connected to the dataset which used it. The questions were entered alongside the other metadata, with table relationships used (as discussed in Section 2.3.4) to relate the questions to the other descriptive information. This involved relating questions to:

- number of participants, including their age and sex
- geographic representation
- chronology (the years it was used)
- location of the data collection

Some studies consisted of more than one data collection wave and/or cohort and did not use the same questions for each wave and/or cohort. Therefore, in the database each question needed to be connected to the specific participants, year, and location metadata, not just the overall metadata for a dataset. An example of how a study has altered the questions used within each data collection wave, has been outlined in Figure 3.5.

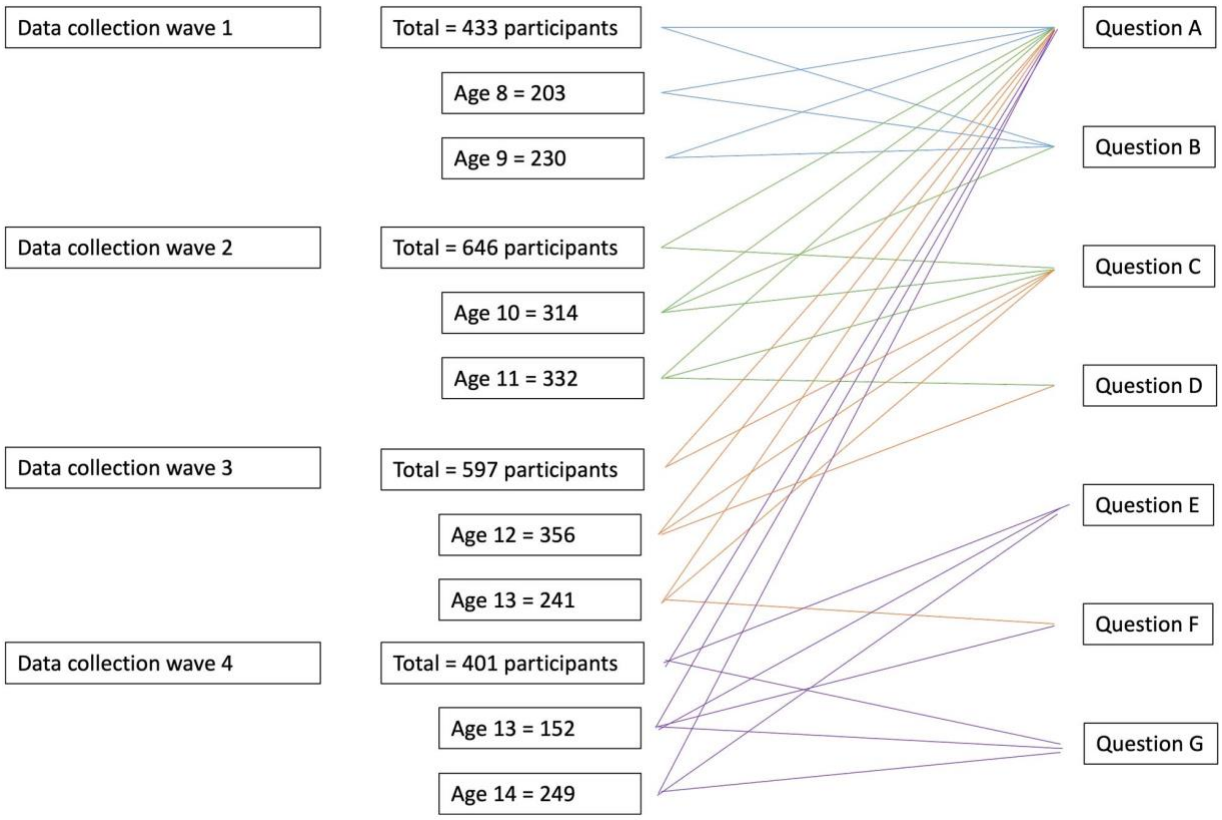


Figure 3.5 Example of how questions are used with different participants within the one study across four data collection waves.

For all this information to be entered into the software and analysed accurately, each data collection wave and/or cohort details needed to be separately entered and then related to the applicable questions in a separate table. Below is an example of how the questions were entered into the database (Figure 3.6), using the example questions presented in Figure 3.4. All questions were compiled in *Microsoft Excel* to complete the question classification using the CS-PAS.

Question main ID	Question main
1	We want to find out all the sports you have played regularly in the last year. Please include all sports you played with an organised team, group or club, or for your school, in the last year. Don't put in sports you have done as part of your PE classes but don't forget the sports you played during the last summer.
2	*We want to find out all the sports you have played regularly in the last year. Please include all sports you played with an organised team, group or club, or for your school, in the last year. Don't put in sports you have done as part of your PE classes but don't forget the sports you played during the last summer.* Who do you play this sport for?
3	What games or sports do you play regularly?
4	In the last 12 months, what organised sports or physical activities has {child} participated in outside of school hours? Start with the one that {child} has spent the most time doing. You can list up to 10 activities.
5	Approximately, how many organised sessions of {activity} has {child} participated in, in total, outside of school hours, during the last 12 months?

1. Questions entered into tables

Question component ID	Question component
1	List sport or game
2	Club, School, Both, Neither
3	Number of times in last 12 months

2. Question ID created by combining the question main and component

Question ID	Question main ID	Question component ID
1	1	1
2	2	2
3	3	1
4	4	1
5	5	3

3. Question related to sample

Dataset ID	Data collection wave	Sample number	Question ID
1	1	1	3
1	1	4	3
2	1	1	2
2	2	1	2
2	3	1	2
2	3	1	1
3	3	1	4
3	1	4	4
3	1	1	5

Sample description table

Dataset ID	Data collection wave	Sample number	Age	Gender	Year of data collection	Location	Sample size
1	1	1		Both	1960	Victoria	3048
1	1	4	8	Both	1960	Victoria	3048
2	1	1		Both	1990	Queensland	1259
2	2	1		Both	1992	Queensland	1220
2	3	1		Both	1994	Queensland	1102
2	1	4	12	Both	1990	Queensland	1259
2	2	4	14	Both	1992	Queensland	1220
2	3	4	16	Both	1994	Queensland	1102
3	1	1		Both	2016	Tasmania	234
3	1	4	4	Both	2016	Tasmania	102
3	1	4	5	Both	2016	Tasmania	132

Sample number 1 = total sample size, sample number 4 = age of participants

Figure 3.6 The process followed to enter each question into the relational database using Microsoft Access.

3.4.6 Question classification

The question classification system described in Section 3.4.4.1 was applied to all the questions to categorise what each question measured. This involved classifying all the questions according to; the domain, what, how, where, when, and who. Any ambiguous questions were discussed with supervisors who collectively agreed on which category(ies) they should be assigned to.

3.4.7 Question analysis

Questions were administered to respondents using different methods to collect data from different participants (age and gender), locations and years of measurement. With variable metadata collected for each question it was complex to descriptively analyse these questions. With a vast number of questions, the level of detail needed to analyse the measurement instances of every question was not able to be completed, therefore specific levels of analysis were completed. The questions were analysed in three ways:

- index questions
- question instances
- measurement instances.

These three approaches are described in Figure 3.7.

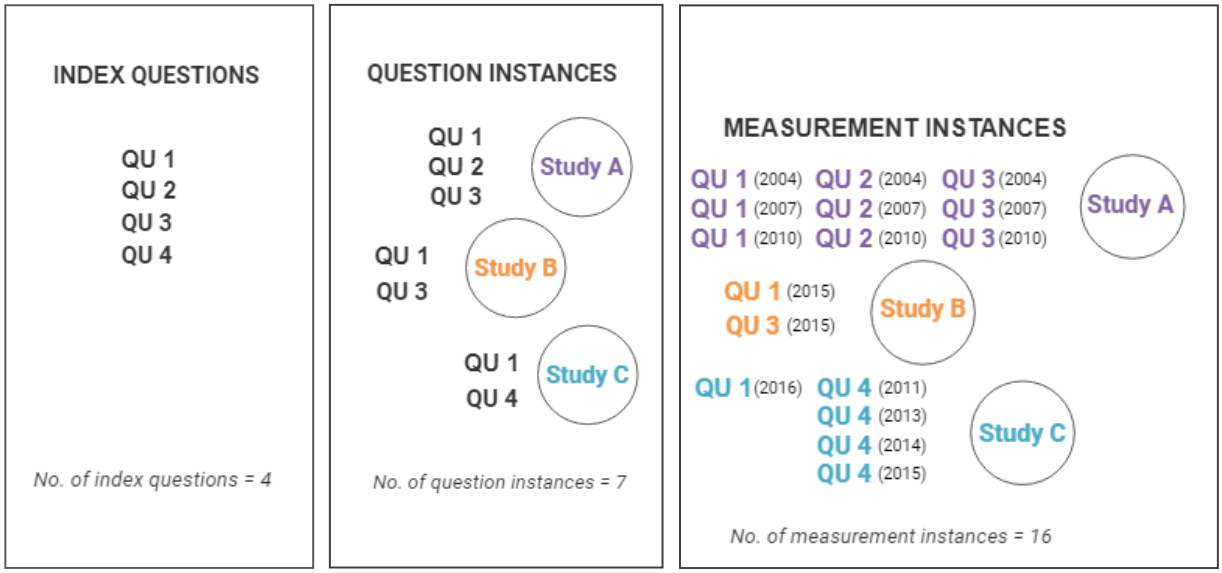


Figure 3.7 An example illustrating the definitions of the different levels of analysis used in this chapter.

An *index question* refers to unique questions located by the search. These questions were identified by combining all the questions found and reviewing them for repetition and closeness.

A *question instance* refers to each time an index question is used in a study. There are more question instances than index questions because several studies may use the same index questions. This level of analysis identifies the questions used per study and applies the study metadata to the group of questions.

A *measurement instance* refers to each time an index question is used. There will be more measurement instances than question instances because a study may use the same questions across a number of waves.

The measurement focus of the questions was classified using the CS-PAS then descriptively analysed. This helped to identify research gaps and concentrations. Further analysis of the questions provided information concerning the coverage of the questions and any possible consistencies and compatibilities of existing questions. The analysis was performed across both *Microsoft Access* (to complete queries and combine

different descriptors on the questions) and *Microsoft Excel* (to combine this information with the question classifications). The type of results that were calculated include:

- total number of surveys and questions
- number of questions used per domain
- historical coverage of the questions and the domains they measured
- geographical coverage of the question and the domains they measured
- number of related questions

The Corrected Covered Area (CCA)[167] was calculated to determine the amount of overlap of existing questions. CCA was calculated as:

- $CCA = (N - r)/(rc - r)$

where N is the total number of questions (counting duplicates), r is the number of index questions, and c is the number of years for which data are available. CCA is usually expressed as a percentage.

In addition, a descriptive exploration of the question characteristics was conducted to document question structure and content differences.

3.5 Results

This section presents the descriptive analysis of existing questions measuring physical activity and sedentary behaviours of Australian children and adolescents. As discussed in the previous section the questions were extracted from the studies identified in Study 1, and then analysed to provide further information about question characteristics, scope, and coverage. The results are structured into five sections:

1. Question selection process
2. Description of the index questions
3. Classification of the measurement focus
4. Description of question instances

5. Description of measurement instances.

3.5.1 Results of the question selection process

An overview of the 3-step identification process has been provided in Section 3.4.3. Figure 3.8 presents the results of this process for which searching through publications and contacting data custodians was completed to identify questions. From the studies identified in Study 1 which used survey questions to collect data, a total of 730 questions were found. A number of questions had been repeated and some altered and reused, using slightly different wording, yet measured the same behaviour. The questions were screened for repetition and to ensure they met the inclusion criteria. Any questions which were deemed to be the same were given the same question identification number. Questions could not be located from 52 of the studies (35%) which used self-, parent-, or proxy-report, for the following reasons:

- data custodians not responding to communication.
- data custodians not being able to locate the questions (often due to data being collected many years ago, or they reported they were too busy to assist).
- unable to find or communicate with the data custodian (sometimes due to the data custodian being retired or deceased).

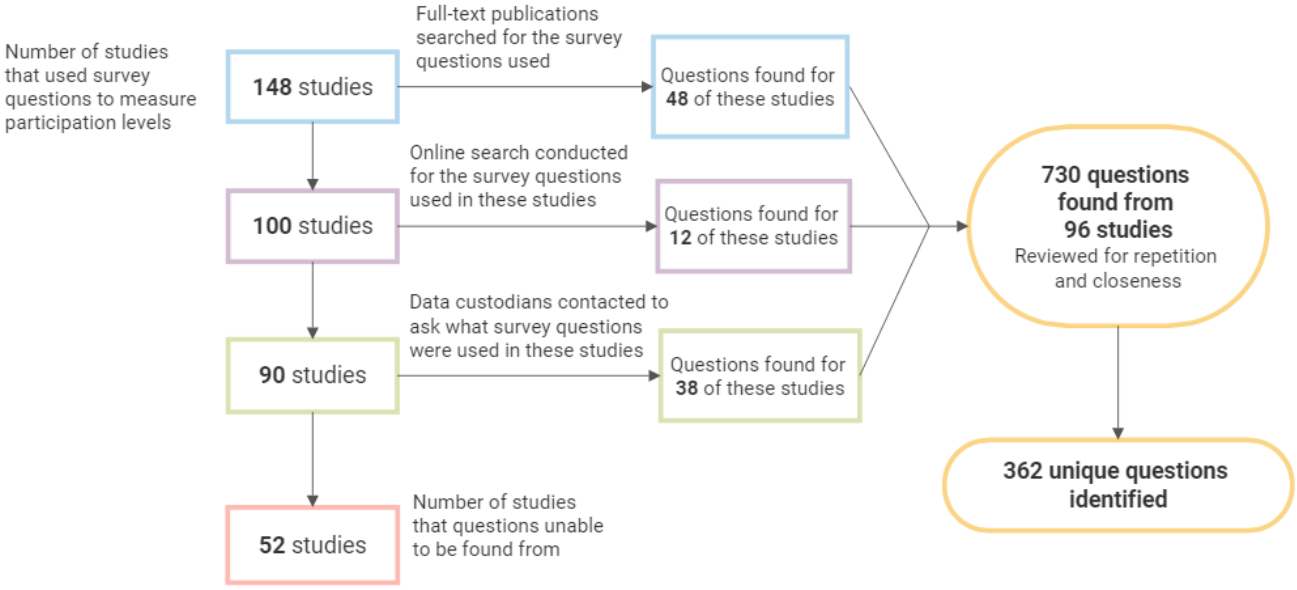


Figure 3.8 Process followed for identification of existing questions measuring physical activity and sedentary behaviours from the database of datasets.

3.5.2 Description of distinct questions

This section describes the various characteristics of the 362 index questions identified (Figure 3.8). Some of these results will be used further in the next chapter, Study 3. The characteristics described include:

- type of questions
- question elements
  - instructions
  - clarifications
  - response categories
- recall timeframe
- temporal change of the questions.

3.5.2.1 *Type of questions*

Various question types were identified as illustrated in Table 3.2, along with an example from the existing questions. All the questions were closed-ended questions, with many multiple-choice questions.

Table 3.2 Type of questions identified measuring physical activity and sedentary behaviour.

Question type	Example (Question, answer, survey name)
Dichotomous questions	Q: Outside of school, do you play any organised sports for your local clubs or recreation centres? (i.e., such as netball, water polo, rowing, volleyball, athletics, tennis, swimming, squash, cycling) A: Yes/No *(Womensport West Sport)*
Simple closed-ended questions	Q: In an average week, when you are in school, on how many days do you go to physical education classes? A: ____ days per week *(Amherst Health and Activity Study (AHA) Student Survey)*
Multiple-choice questions	
Rating questions	Q: How many days in the past week have you done any vigorous or moderate physical activity for a total of at least 60 minutes? (This could be made up of different activities during the day like cycling or walking to and from school, playing sport at lunchtime or after school, doing an exercise class, doing housework etc.) A: 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 7 days, No days in the last week. *(SSHB Student Health Survey 2017)*
Likert questions	Q: How often does your child travel to childcare/preschool by walking, riding bicycle/tricycle, public transport? (bus/train/tram) A: Frequently, sometimes, occasionally, rarely/never *(Physical and Nutritional Home Environment Inventory)*
Checklist-question	Q: During the past year (12 months), did you do any of these activities? (check all that apply) A: sports teams, dance/martial arts class, art/music class, none of these *(ISCOLE Diet and Lifestyle Questionnaire)*

3.5.2.2 *Question elements*

Instructions were present at the start of some questions to assist the respondent's recall of the desired information. However, many questions had no instructions. Instructions were more likely to be present for questions designed to be administered using

interview techniques. These consisted of a brief introduction at the start of the question to *set the scene*, or an explanation situated within the question explaining how to complete it. For example:

The following questions are about the ORGANISED sports and games that you do at school, before and after school and on weekends during the WINTER school terms (terms 2 and 3). DO NOT INCLUDE SCHOOL HOLIDAYS. Please think about a normal week and write in the table below:

- *the sports or games you usually do (including training),*
- *how many times per week you usually do them, and*
- *the usual amount of time you spend doing them.*
- *If you do not do any organised activities, please write "zero" in the first row of the table.*

Adolescent Physical Activity Recall Questionnaire (APARQ)[168]

The question clarity refers to the inclusion of explanations, definitions, and examples within a question. Explanations of key question concepts, definitions of the behaviour/s or providing examples, could help respondents recall the desired information, or enhance understanding of the question being asked. Few questions included a picture to help visualise the question (e.g., as a person illustrated as sweating and puffing) to prompt respondent recall. For example:

Physical activity is any activity that increases your heart rate and makes you get out of breath some of the time. Physical activity can be done in sports, school activities, playing with friends, or walking to school. Some examples of physical activity are running, brisk walking, rollerblading, biking, dancing, skateboarding, swimming, soccer, basketball, football, & surfing. (NaSSDA, 2018).[168]

There are different possible response options that were used, namely categorical and numerical options. In this set of questions, categorical response options included nominal answers such as yes/no and ordinal answers such as frequently, sometimes, occasionally, or never when reporting the frequency of active travel. Numerical responses were the most common, such as when reporting how many days a respondent was physically active.

3.5.2.3 *Recall timeframe*

Survey questions consist of varying timeframes across which respondents are asked to recall their participation. Outlined in Table 3.3, the two main recall timeframes ask respondents to report their behaviours over a single day (24%) or week and weekend (47%). When a survey question included a single-day recall timeframe, it was more commonly a *usual* day than the previous day (e.g., *yesterday*). In comparison, when a survey question included a 7-day recall, this was more commonly the *previous* week or weekend.

Table 3.3 An analysis of the recall timeframes included in the questions measuring physical activity and sedentary behaviours.

Recall timeframe		**Total**
Day		
	Average/ typical/ normal/ usual	58 (16%)
	Yesterday	30 (8%)
Week/weekend		
	Average/ typical/ normal/ usual	79 (22%)
	Last week/ previous 7 days	90 (25%)
Last 2 weeks		9 (3%)
Last month		3 (1%)
Last 6 months		1 (0.3%)
Last 12 months		24 (7%)
School term		1 (0.3%)
Summer/winter		12*
No time frame		67 (19%)
Total		**362**

*Summer/winter timeframe is not included in the total count due to always used in conjunction with another timeframe.

3.5.2.4 *Question evolution*

As previously discussed in Chapter 1 (Section 1.5.1), social, environmental, cultural, and political determinants may have influenced physical activity and sedentary behaviours over time. Figure 3.9 provides an overview of how the question content has changed

over time by presenting the question, which has the earliest year of measurement compared to the question most recently asked for each domain. As seen in the timeline, the first question was used to measure *regular* sports participation in 1951, namely the Growing up in Australia study. This progressed to the most recent question, which includes a specified timeframe (12 months) and more informal sports such as rollerblading. Many of the earlier questions likewise asked respondents to recall their *regular* participation, compared to the most recent questions, which mainly consisted of recall timeframes of *last week* or *last 7 days*.

The earliest overall physical activity question was used to collect data before developing Australia's physical activity and sedentary behaviour guidelines. In comparison, the most recent question captures more dimensions of the activity (e.g., intensity, duration) to measure compliance with guidelines.

A difference was also evident between the screen-time questions. The question with the earliest year of measurement consisted of measuring the time spent viewing only one screen device, compared to the more recent question being more complex and requiring measurement of viewing time over multiple screen devices. In addition, another difference was observed across the more recent questions, more dimensions of the behaviour were asked to be recalled, and more clarification about what activities were to be recalled was included.

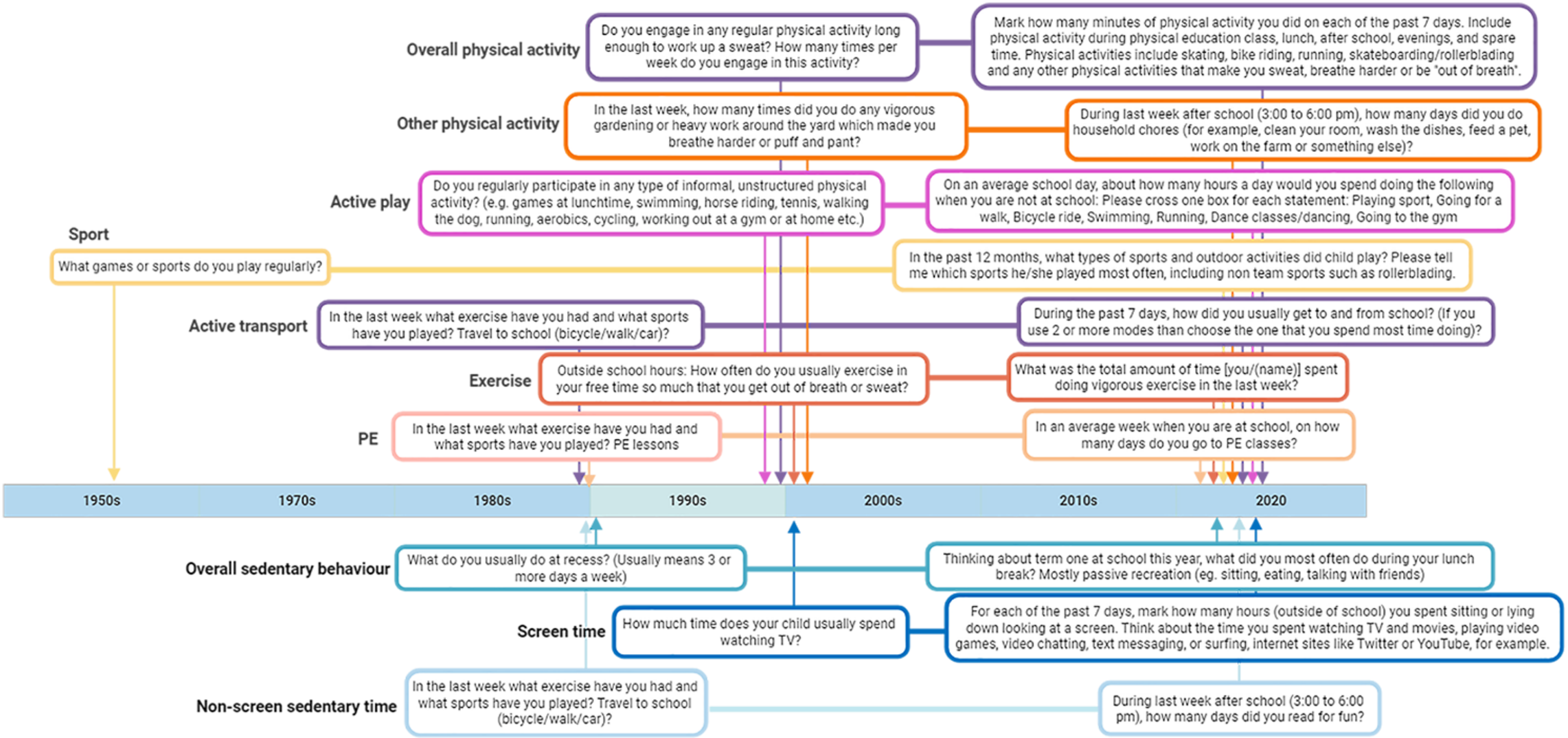


Figure 3.9 Timeline illustrating the first and the most recent question measuring participation in each domain of physical activity and sedentary behaviour.

3.5.3 Measurement focus

A total of 362 questions were classified using the CS-PAS. Table 3.4 presents the different behaviours which were measured by the existing questions. The table is structured the same as the CS-PAS, with physical activities in the top half and sedentary behaviours in the bottom half. This table illustrates the number of questions which have been used to measure participation of each domain of physical activity and sedentary behaviour, and the proportion of each. For example, the number of existing questions able to measure active transport is 47 which makes up 16% of all the physical activity questions. Some questions consisted of multiple components and measured more than one behaviour, therefore were provided with more than one classification according to each domain measured.

More questions were classified as measuring physical activity (66%) than sedentary behaviours (34%). The following sections describe the different physical activities and sedentary behaviours which the existing questions measure, presenting the findings in Table 3.4 as pie charts (Figure 3.10 and Figure 3.11).

3.5.3.1 *Questions measuring physical activity*

As identified through the CS-PAS, two-thirds of the questions measured physical activities. Sport was measured by the most questions (22%) and PE the least (4%). Considering the other descriptors of what the questions measure, most questions did not ask further detail about *what* activity that participants were being asked to recall (67%), however, when a question did specifically ask about an activity, walking was the activity most frequently asked about (11%) (Table 3.4). Organised activities (32%) were measured more than non-organised (24%). In terms of the setting (referred to as *where*), outdoor activities were of interest (22%), with a surprising lack of questions (0%) measuring participation whilst at childcare, outside school hours care or extracurricular.

Table 3.4 Classification of existing questions using the Classification System of Physical Activity and Sedentarism (CS-PAS).

	DOMAIN	No. (%)	WHAT	No. (%)	HOW	No. (%)	WHERE	No. (%)	WHEN	No. (%)	WHO	No. (%)
PHYSICAL ACTIVITIES	1. Active transport	47 (17%)	1. Walk	31 (11%)	1.Organised	82 (32%)	1.School	28 (10%)	1.PE class	10 (4%)	1.Team	17 (7%)
	2. Sport	61 (22%)	2. Run / jog	4 (1%)	2. Non-organised	63 (24%)	2.Extracurricular	0 (0%)	2. Recess	6 (3%)	2.Individual	2 (1%)
	3. Play	59 (21%)	3. Cycle	18 (6%)	3. Anyhow	114 (44%)	3.OSHC	0 (0%)	3. Lunch	6 (3%)	3.Anyone	231 (92%)
	4. Exercise	55 (20%)	4. Skate / scoot	6 (2%)			4.Childcare	0 (0%)	4. Class time	4 (2%)		
	5. PE	10 (4%)	5. Chores	7 (2%)			5.Outdoor	61 (22%)	5. School hours	93 (40%)		
	6. Other	10 (4%)	6. RT	2 (1%)			6.Other	15 (5%)	6. Before school	2 (1%)		
	7. Any	37 (13%)	7. Active VG	2 (1%)			7.Anywhere	169 (62%)	7. After school	107 (47%)		
			8. Tummy time	0 (0%)					8. Other	0 (0%)		
			9. Kindergym	2 (1%)					9. Anytime	2 (1%)		
			10. Floor-based	2 (1%)								
			11. Playground	5 (2%)								
			12. Other	21 (7%)								
			13. Anything	191 (66%)								
SEDENTARY BEHAVIOURS	8. Screen	106 (74%)	14. TV/ movies	53 (27%)	4. Recreational	41 (26%)	8.Computer / laptop	44 (29%)	10. School	1 (1%)		
	9. Non-screen	26 (18%)	15. Communication	4 (2%)	5. Non-recreational	21 (13%)	9.TV	46 (31%)	11. Critical window	7 (4%)		
	10. Any	11 (8%)	16. Gaming	38 (19%)	6. Anyhow	97 (61%)	10.Phone	5 (3%)	12. Class	75 (39%)		
			17. Recreation	31 (16%)			11.Handheld	2 (1%)	13. School break time	75 (39%)		
			18. School-related	26 (13%)			12.Other	51 (34%)	14. School hours	18 (9%)		
			19. Passive transport	12 (6%)			13.Anywhere	2 (1%)	15. Other	12 (6%)		
			20. Reading	10 (5%)					16. Anytime	5 (3%)		
			21. Music practice	1 (1%)								
			22. Listening to music	2 (1%)								
			23. Other	20 (10%)								
			24. Anything	1 (1%)								

Abbreviations used: RT= resistance training, active vg= active video gaming, floor-based= includes activities on the floor such as a baby or toddler actively playing or rough and tumble play for older children, communication= electronic communication inc. email, OSHC= outside school hours care, Handheld= other handheld devices such as tablets, critical window= after school time period.

Almost half of the questions asked about participation (*when*) which occurred after school (47%). Few questions asked about *who* the participation was with, with only 7% asking about team-related physical activities.

3.5.3.2 *Questions measuring sedentary behaviours*

Sedentary behaviour was measured by one-third of the questions. Screen time was measured by the most questions (74%) and overall sedentary behaviour the least (4%). The sedentary behaviour questions classification results in Table 3.4 illustrate that type of behaviour (referred to as *what*) most asked about was watching TV or movies (27%). Recreational behaviour (*how*) was specifically asked about in 26% of the questions and non-recreational 13%. The least asked about types of behaviours were music practice and listening to music (both 1%). In terms of the setting (*where*) the behaviour occurred, the two most asked about devices were TV (31%) and computer/laptop 29%. Thirty-nine percent ask about sedentary behaviour during class along with school break time also 39%.

3.5.4 Description of question instances

The following sections describe the question instances regarding the mode of administration, number of questions per age range and number of questions per geographic location. These results are presented in Table 3.5 and Table 3.6.

The total number of questions administered across all studies was 531. Most questions were only administered in state-based studies, with only 17% of all questions used in national surveys. Only one question was identified to have been used in the NT outside of national survey data. The majority of questions were employed in studies consisting of only school-aged participants, with a total of 81% of all questions. Few questions have been used to measure participation levels of young children aged 0–4 (5%), with only eight questions (2%) identified as having been exclusively used with this age group.

Table 3.5 Description of question instances used to measure participation of physical activity and sedentary behaviours within each study, illustrated in relation to the age range and geographical location

Category		**Question instances**
Age group (years)		
0–4		25 (5%)
0–12		52 (10%)
0–18		25 (5%)
5–12		117 (22%)
5–18		270 (51%)
13–18		42 (8%)
Total		531
Location		**Question instances**
Australia		87 (17%)
State-based		437 (82%)
	ACT	23 (5%)
	NSW	109 (25%)
	NT	1 (0.2%)
	QLD	10 (2%)
	SA	51 (12%)
	TAS	6 (1%)
	VIC	132 (30%)
	WA	105 (24%)
No location reported		7
Total		**531**

3.5.4.1 *Methodology*

Questions were completed by the child (self-report), parent (parent-report), or by another adult such as teacher (proxy-report). These results are reported in Table 3.6 and include only the index questions used across all the studies, without considering the number of times they were used within each study. Almost two-thirds of the questions were completed using self-report and approximately one third parent-report. Some studies used both self-report and parent-report, particularly if they consisted of participants from more than one age group. The transition from parent-report to self-report occurred at a mean age of 13. Questions were only completed by parent-report when the participants were aged less than 12 years. Interestingly, completing the questions on paper was the dominant method (79%).

Table 3.6 Mode of administration of the questions used to measure Australian children's and adolescents' participation in physical activity and sedentary behaviours.

Mode of administration		Question instances
Self-report		
	Paper-based	285 (54%)
	Online	4 (1%)
	Mixed	29 (2%)
Parent- & proxy-report		
	Paper-based	133 (25%)
	CATI/ Phone	20 (4%)
	Online	0
	Mixed	15 (3%)
Interview		
	CATI/ Phone	8 (2%)
	Face-to-face	30 (6%)
No mode reported		7 (2%)
Total		**531**
Mode of administration per age		
Self-report		
	0–4	0
	5–12	91 (17%)
	13–18	42 (8%)
	5–18	200 (38%)
Parent- & proxy-report		
	0–4	24 (5%)
	0–12	48 (9%)
	0–18	23 (4%)
	5–12	29 (5%)
	5-18	70 (13%)
	13–18	0
No mode reported		4
Total		**531**

3.5.5 Description of the measurement instances

The following sections describe the measurement instances of each question. The measurement instances of each measurement focus (number of times each domain has been measured) is also reported in these next sections. This section also reports the measurement instances of the distinct surveys identified (number of times the distinct surveys have been used). These results are presented in Table 3.7 and visualised using dot plots, graphs and charts.

Across this 68-year span, a total of 362 index questions were used to measure physical activity and sedentary behaviours 1271 times (measurement instances). Most of the research occurred from the year 2000 onwards, with 97% of all the measurement instances conducted post-2000. More than half of all measurement instances were during the 2010s; over this time questions were used 710 times (56%). In comparison, between 1950 and 1999, questions were used only 43 times (3%), about one every year, whereas questions were asked 52 times per year in the 2000s and 79 times per year in the 2010s.

Table 3.7 Number of times physical activity and sedentary behaviour was measured in the last seven decades.

Category	Measurement instances
Year of data collection	
1951–1999	43 (3%)
2000s	518 (41%)
2010s	710 (56%)
Total	**1271**

3.5.5.1 *Survey frequency*

Across all the included studies, the number of surveys used to measure participation in physical activity and sedentary behaviours were identified. Some surveys were designed with the sole purpose of collecting data on physical activity and sedentary behaviours, whereas other surveys also measured related topics (e.g., education, health status, child development). Ninety-six surveys were identified (Table 3.8), with some surveys used by two or more studies to measure participation levels. Surveys used more than once in the included studies have been presented in Table 3.8. Some studies employed a complete survey to collect data, whereas others only used a selection of questions. An example of a study that has used more than one survey to collect data is the Longitudinal Study of Australian Children (LSAC) which used 23 different surveys, including at least one question measuring either physical activity or sedentary behaviour. Occasionally, a study reported that it employed only a selection of a

specified survey or modified a survey. If it was not clearly stated which questions were used or how the survey was modified, then this survey use was not included in Table 3.8.

Table 3.8 Surveys which have collected data across multiple studies (>1) measuring participation in physical activity and sedentary behaviours.

Survey name	No. of studies
Adolescent Physical Activity Recall Questionnaire (APARQ)	6
The Children's Leisure Activities Study Survey (CLASS)	6
Adolescent Sedentary Activity Questionnaire (ASAQ)	5
Healthy Together Children's Evaluation Student Questionnaire	4
Active Australia	2
Bone-Specific Physical Activity Questionnaire (BPAQ)	2
Eating and Physical Activity Questionnaire (EPAQ)	2
NSW Population Health Survey	2
Preschool-aged Children's Physical Activity Questionnaire (Pre-PAQ)	2
Womensport West Student Questionnaire	2
Young People's Activity Questionnaire (modified) (YAQ-II)	2

3.5.5.2 *Temporal measurement of the different domains*

The cumulative number of questions used to measure each domain has been illustrated in Figure 3.10. This figure illustrates the measurement instances of each domain, colour-coded to visually present how research has accumulated over time. The y-axis consists of the number of measurement instances and the x-axis consists of the years of measurement. As previously demonstrated in Study 1, there has been an increase in the amount of data collected since 2000, which is likewise evident for the existing questions. Prior to 2000, the few available questions mostly measured physical activity participation rather than sedentary behaviour. After 2000, overall physical activity and screen time were most measured, with sports participation and active play the next

most measured domains. Since this time, an increase in the number of questions measuring each behaviour has occurred.

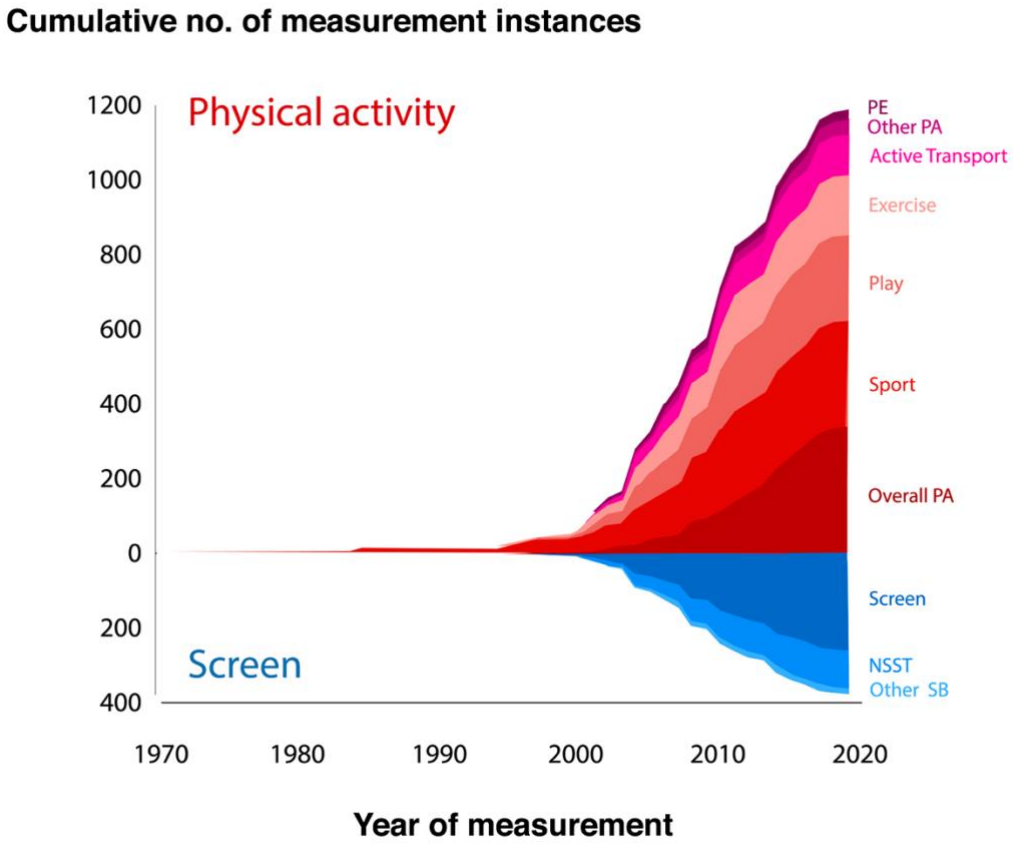
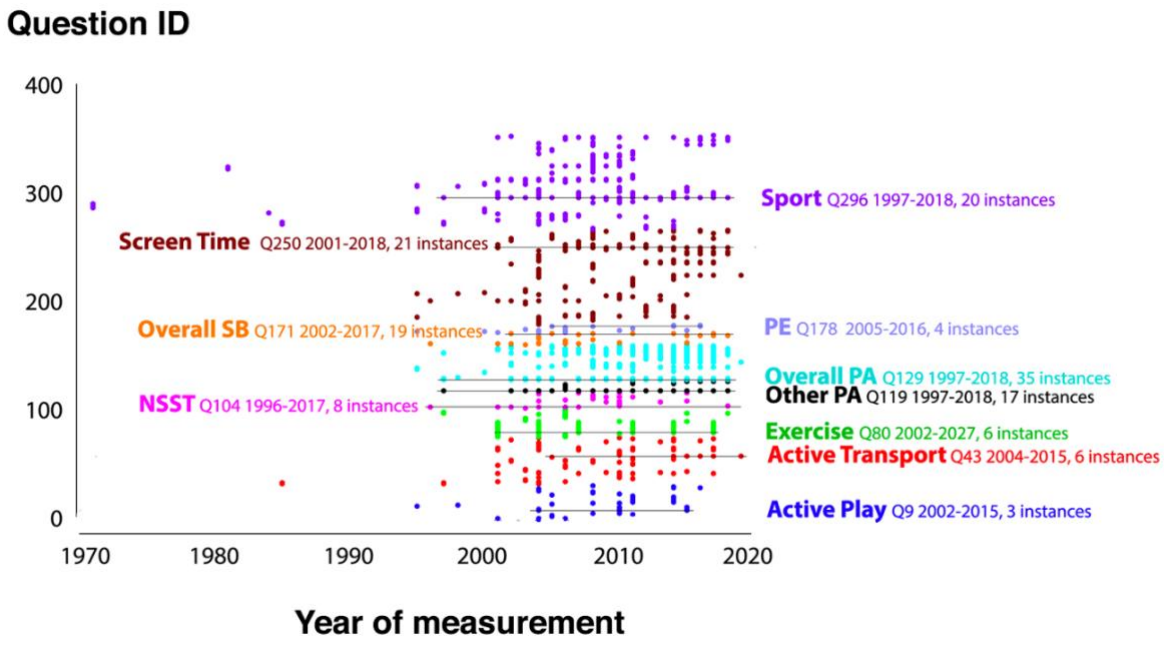


Figure 3.10 Cumulative number of questions for each domain of physical activity of sedentary behaviours.

SB- sedentary behaviour, NSST- non-screen sedentary time, PA- physical activity.

Figure 3.11 illustrates the measurement instances of each index question. The y-axis consists of the question identification numbers and the x-axis consists of the years of measurement. Each dot represents a measurement instance. A closer look at the plotted instances showed the questions for each domain (colour-coded) which had been repeated over time. As seen in Figure 3.11, the question identification numbers with the highest number of measurement instances have been included in writing. The associated questions are included within the associated table. Overall physical activity

consisted of a question (Question ID 129) which had been repeated the highest number of times with 35 instances. Comparatively, active play had less repeated questions, question ID 9 had been repeated only 3 instances.



Qu ID	Question
119	In the last week, how many times did you do any vigorous gardening or heavy work around the yard which made you breathe harder or puff and pant? What do you estimate was the total time you spent doing vigorous gardening or heavy work around the yard in the last week?
129	The next question excludes household chores or gardening. In the last week, how many times did you do any vigorous physical activity which made you breathe harder or puff and pant? (eg: football, tennis, netball, squash, athletics, cycling, jogging, keep-fit exercises and vigorous swimming)What do you estimate was the total time you spent doing this vigorous physical activity in the last week?
9	This question is about the non-organised physical activities that you do during the WINTER school terms (terms 2 and 3). Please think about a normal week and write in the table below the activities you usually do, how many times each week you usually do them and the usual amount of time you spend doing them. Recess: Name of activity
43	On how many days did you walk for at least 10 minutes continuously to get to and from places in the last week?
80	In the last 2 weeks, did [you/(name)] do any exercise which caused a moderate increase in [your/his/her] heart rate or breathing, that is, moderate exercise? (exclude walking you have done for fitness, recreation or sport, household chores, gardening or yardwork)
178	In an average week when you are at school, on how many days do you go to PE classes?
250	Does (child) ever play any type of sport or outdoor physical activity, including non-team sports such as rollerblading, bike riding and skate boarding? On about how many weekend days does [child] spend watching TV, videos or DVDs? On those days, about how many hours does [child] usually spend watching TV, videos or DVDs?
104	During a typical week what other leisure activities do you usually do? Travel by car / bus (to and from school)
171	On an average school day, about how many hours a day do you do the following when you are not at school: homework

Figure 3.11 Measurement instances of each existing question measuring participation in each domain of physical activity and sedentary behaviours. Each dot represents a measurement instance, with the colours depicting which domain participation data was collected on.

The questions with the longest time span of measurement instances for each domain are highlighted along with their question ID, years of measurement and number of measurement instances. These questions are presented in the adjoining table.

3.5.5.3 *Corrected Covered Area*

Table 3.9 Corrected covered area of the measurement instances of each question.

Domain	CCA
Overall physical activity	43%
Active transport	6%
Sport	6%
Active play	7%
Exercise	12%
PE	9%
Other physical activity	9%
Screen time	21%
Non-screen sedentary time	10%
Overall sedentary behaviour	4%

To understand more about the measurement instances the CCA was calculated (Table 3.9). Plotting the measurement occurrences of each question (Figure 3.11) shows how some questions have been used multiple times. The CCA was calculated to determine the amount of overlap of existing questions.[167] A CCA of 100% means that the same questions, and only those questions, were used every time data were collected. A CCA of 0% means that no question had ever been repeated. High CCAs mean that data are highly commensurable, allowing for geographical cumulation and trend detection. Overall physical activity consisted of the highest overlap of questions over time (43%) in comparison to overall sedentary behaviour which had the lowest CCA with only 4%.

Furthermore, the most frequently used overall physical activity questions were analysed further. Table 3.10 presents the measurement instances for three repeated questions along with the details relating to their measurement instances including the study they were used in, years of measurement and the age range of the participants for each. Three questions were repeated a total of 70 times within 22 different studies and might be useful for temporal trend analysis.

As stated above, some questions have repeatedly been administered. Re-administering questions with the same methodological approach provides the opportunity to temporally track participation rates.

Overall, the most frequently used overall physical activity question was:

"Over the past 7 days, on how many days was your child physically active for a total of 60 minutes or more per day?"

This question was used a total of 35 times over a 14-year span (2004–2018) measuring the physical activity of children and adolescents aged 5 to 18 years.

Table 3.10 Measurement instances of the three key questions measuring overall physical activity participation across the various age groups over the last two decades. Each measurement instances is highlighted along with the study details, location of study and the age range of the study.

Dataset	Dataset title	Location	Age
ACTGHS	ACT General Health Survey	ACT	5-18y
ACTPANS	ACT Physical Activity and Nutrition Survey	ACT	Grade 6
ASSAD ACT	Australian Secondary Students Alcohol and Drug Survey ACT	ACT	12-17y
ASSAD NT	Australian Secondary Students Alcohol and Drug Survey NT	NT	12-17y
ASSAD QLD	Australian Secondary Students Alcohol and Drug Survey QLD	QLD	12-17y
ASSAD SA	Australian Secondary Students Alcohol and Drug Survey SA	SA	12-17y
ASSAD TAS	Australian Secondary Students Alcohol and Drug Survey TAS	TAS	12-17y
ASSAD VIC	Australian Secondary Students Alcohol and Drug Survey VIC	VIC	12-17y
ASSAD WA	Australian Secondary Students Alcohol and Drug Survey WA	WA	12-17y
CAPANS	Western Australian Child and Adolescent Physical Activity and Nutrition Survey	WA	9-16y
FITGALS	Factors Influencing Transition in Girls' Active Leisure and Sport Study	VIC	11-13y

Dataset	Dataset title	Location	Age
GGG	Triple G	VIC	11-17y
ISCOLE	International Study of Childhood Obesity, Lifestyle and Environment	SA	9-11y
NaSSDA	National Secondary Students' Diet & Activity Survey	AUS	12-17y
NNPAS	National Nutrition and Physical Activity Survey (5-18y)	AUS	5-18y
QCPHTS	Queensland Child Preventive Health Telephone Survey	QLD	5-17y
SAMSS	South Australian Monitoring and Surveillance System	SA	5-17y
SPANS	NSW Schools Physical Activity and Nutrition Survey	NSW	Grade K-10
SSHBS	School Students Health Behaviour Survey (ASSAD survey)	NSW	12-17y
VCHWS	Victorian Child Health Wellbeing Survey	VIC	5-12y
WA HWSS	WA Health and Wellbeing Surveillance System	WA	5-18y

YEAR	2018/19			2016/17			2014/15			2012/13			2010/11			2008/09			2006/07			2004/05		
AGE RANGE	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**	**0-4**	**5-12**	**13-18**
Over the past 7 days, on how many days were you physically active for a total of 60 minutes or more per day?									ASSAD NT															
		QCPHTS	QCPHTS		QCPHTS	QCPHTS		QCPHTS	QCPHTS		QCPHTS	QCPHTS		QCPHTS	QCPHTS									
														GGG	GGG									
					VCHWS			VCHWS	ASSAD VIC		VCHWS			FITGALS	FITGALS		FITGALS	FITGALS						
					WA HWSS	WA HWSS		WA HWSS	WA HWSS		WA HWSS	WA HWSS		WA HWSS	WA HWSS		CAPANS	CAPANS						
Over a typical week, on how many days have you done physical activity for a total of at least 60 minutes or more per day?		ACTPANS	ACTGHS			ACTGHS		ACTPANS	ACTGHS											ACTPANS				
						ASSAD TAS			ASSAD TAS															
						ASSAD WA						NaSSDA			ASSAD WA			NaSSDA						
					WA HWSS	WA HWSS		WA HWSS	WA HWSS		WA HWSS	WA HWSS												
How many days in the past week have you done any vigorous or moderate physical activity for a total of at least 60 minutes)?*		ACTGHS	ACTGHS		ACTGHS	ACTGHS		ACTGHS	ACTGHS															
		ACTPANS				ASSAD ACT		ACTPANS	ASSAD ACT						ASSAD ACT		ACTPANS	ASSAD ACT		ACTPANS				ASSAD ACT
						SSHBS		SPANS	SSHBS						SSHBS			SSHBS						SSHBS
									SALSA															
						ASSAD QLD			ASSAD QLD					ISCOLE	ASSAD QLD									
					SAMSS	ASSAD SA		SAMSS	ASSAD SA		SAMSS			SAMSS										
															ASSAD TAS			ASSAD TAS						ASSAD VIC
		WA HWSS	WA HWSS		WA HWSS	WA HWSS		WA HWSS	WA HWSS		WA HWSS	WA HWSS			ASSAD WA									
						ASSAD WA			ASSAD WA					NNPAS	NNPAS									

*Also includes this question: Physical activity is any activity that increases [your heart rate and makes you get out of breath some of the time. Physical activity can be done in sports, school activities, playing with friends, or walking to school. Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?

3.5.5.4 *Geographical coverage*

The geographic coverage of the existing questions was uneven. Figure 3.12 illustrates the number of times questions measuring each physical activity and sedentary behaviour have been used, showing an uneven coverage across most states. Nationally, the behaviours most often surveyed were exercise and sport, whereas overall physical activity participation has only been asked about six times. The NT has only used one question to measure overall physical activity participation, employed within the Australian Secondary School Drug and Alcohol Survey. In contrast, QLD appears to have mainly focused on compliance with guidelines as most questions used measured overall physical activity levels. Tasmania, on the other hand, has a comprehensive approach to measurement, showing a more even coverage across most behaviours.

	AT	Sport	Play	Exercise	PE	Other physical activity	Overall physical activity	Screen	Non-Screen	Overall sedentary behaviour
AUS	29	68	47	72	1	2	6	34	5	2
ACT		1		4	1		17	10		6
NSW	53	68	87	6	5	17	70	47	33	20
NT							1			
QLD	2	4	3	2			18	4		3
SA	9	20	19	3	1	8	3	24	3	6
TAS	3	3	3	3			9	4		4
VIC	29	39	51	31	8		22	39	19	9
WA	11	42	26	13	9	8	57	48	9	7

Figure 3.12 Chart illustrates the geographic spread of questions per domain across Australia.

AUS = Australia, ACT = Australian Capital Territory, NSW = New South Wales, NT = Northern Territory, QLD = Queensland, SA = South Australia, TAS = Tasmania, VIC = Victoria, WA = Western Australia, AT = active transport, PE = physical education

3.6 Discussion

This study involved the first comprehensive search identifying all the existing questions measuring participation in physical activity and sedentary behaviours of Australian children and adolescents. Over the last 68 years, 362 index questions measured physical activity and sedentary behaviours, used in 1271 instances. The first identified question measured regular sports participation within a self-report paper-based survey called *Twenty Questions*. Administered to 8705 participants aged 13–18 years as part of the NSW *Growing up in an Australian City* study, this question contributed to learning more about the interests of Sydney adolescents in the 1950s.

An extensive yet diverse range of questions has been used to capture activity-related behaviours. When considering the average time spent on activity-related behaviours, the questions were disproportionately spread, particularly evident when comparing screen time and non-screen sedentary time. Screen time along with overall physical activity were of most interest, likely due to measuring compliance with guidelines, however, physical activity during PE or non-screen sedentary time were of least interest. The temporal pattern of measurement instances demonstrated a noticeable increase around the year 2000, with 97% of measurement instances evident post 2000. There were many unique (index) questions (362), and only a modest overlap was found. However, some questions were identified which had been repeated, with one question measuring overall physical activity participation identified to have been repeated 35 times across different studies. This demonstrates continuity in some domains of physical activity and sedentary behaviour over time. However, many questions have not been repeated, possibly due to researchers designing and modifying questions to meet the specific research objectives.

3.6.1 Implications

Many questions exist with varying characteristics and measurement focus, with few questions that have been used repeatedly across the last few decades providing information that could be used to detect trends. However, less overlap

was found with specific domains of physical activity and sedentary behaviours, limiting the ability to investigate changes in activity participation over time. A description of the existing questions, how they were administered, and the temporal pattern of measurement instances provides a better understanding of inconsistencies surrounding past and present participation levels, along with research gaps at both a state and national level.

3.6.1.1 *Question characteristics*

Different recall timeframes were identified across the existing questions. A recall timeframe is the specified period of time that a survey question pertains to. No single timeframe was dominant, and timeframes varied mainly across a day or a week, with either *last/previous* or *usual/typical/average*. Regarding this finding, Olds[60] identified large discrepancies in compliance with guidelines, depending on the method used. Within the existing questions, nine different timeframes were used, potentially contributing to the measurement inconsistencies and variance in prevalence estimates, limiting the data available for trend analysis.

Considering the question content over time, a change was observed when comparing the first question used for each domain with the most recent question. Many of the first questions embodied consistent traits, capturing *regular* participation within a simple question while including fewer, if any, examples of the types of behaviours being measured. These questions were identified prior to guideline development. Post-guideline development, the questions asked for more specific recall of behaviours, with noticeable use of the term *past 7 days* or *past week*. There was also an evident increase in the complexity of the questions, likely due to the challenge of capturing the multitude of activities that can accrue to determine compliance to guidelines. From observing the mapped questions, more dimensions of the behaviour were asked to be recalled, and more clarification about what activities were to be recalled were included. While some questions guided respondents through the recall process, others separated the recall into different days. Overall, with an increasing complexity of questions the cognitive load related to answering them have also increased, and consequently the respondent burden.

3.6.1.2 *Methodological approach*

Self-report and parent-report were the most common ways the questions were administered, with parent-report more frequently used for younger children (0–4 years) and self-report for older children and adolescents. A closer look at the studies across a large age range highlighted that self-report tended to be administered from around age 13. Previous research found that parent-report is more accurate than self-report for children aged ten and under.[49] Within this research, across all the self-report studies the youngest age identified to use this method was age 7, within the Western Australian Child and Adolescent Physical Activity and Nutrition Survey 2003 and 2008. Before these questions were administered, the study measured the test-retest reliability of self-report for this age, demonstrating it was negligible to strong (Kappa = 0.098 to 0.827), however the validity of the questions were not measured.[169, 170] In total, 12 studies administered self-report surveys for children younger than 10 (even though it has been identified that these children are too young to accurately self-report), potentially due to barriers to administering questions via parent-report. This could impact the accuracy of results.

3.6.1.3 *Temporal change in measurement*

Change has occurred in the questions over time, impacted by different policy, social and political changes. Most domains were initially measured in the 1980s and 1990s, prior to the release of the guidelines. Internationally, within the 1980s, the Young Finns Study and Amsterdam Growth Study were pivotal in examining long-term tracking of physical activity into adulthood. The findings of these studies provided more evidence for the importance of physical activity for children and adolescents. The US was the first country to release national physical activity guidelines for children in 1994, following the advice provided by the International Consensus Conference on Physical Activity Guidelines.[15, 16] Shortly after, the National Heart Foundation of Australia released a similar set of recommendations for Australian children and adolescents in 2001[16], with the first official Australian guidelines released in 2004.[17]

This period in Australia also saw more political interest in the activity levels of the community, with the development and funding of Active Australia: A

National Participation Framework.[171] This policy, launched in 1996, was designed and collaboratively administered to help Australians be more active, encouraging participation in sport, recreation, fitness and outdoor education. Despite a reported decrease in funding and the upcoming 2000 Olympics in Sydney, community-based physical activity received more funding than it had previously in recent years.[171] The shift in focus would have likewise increased research in this space.

An increase in measurement around the year 2000 was noticeable. The development of guidelines would have focused research on the health benefits of participation in physical activity and sedentary behaviours, and emphasised the need for more research.[171] Throughout the 2000s, the amount of research conducted continued to increase, not only to provide more evidence needed to shape the guidelines, but also to monitor children's and adolescents' compliance with the guidelines. The measurement needs altered to account for this, making the questions more complex and increasing the respondent burden to capture this level of detail.

3.6.1.4 *Question reuse*

Despite the large number of questions identified, some questions have been reused over the last few decades. The findings illustrated only a moderate overlap of questions, ranging from 4% (overall sedentary behaviour) to 43% (overall physical activity). A select few questions measuring compliance to guidelines were found to have a good overlap across different studies, with the potential for the collected data to be used to detect trends. Few complete surveys had been reused, demonstrating that researchers are choosing to use individual questions rather than asking respondents to complete an entire survey to assess participation rates. Similar findings were described in a review conducted by Sallis in 1991, in which a growth in the variety of questions used to measure participation was noted.[172] New questions are designed to meet specific research objectives rather than measuring the whole gamut of domains, however reliability and validity data on each created question are not always collected.

3.6.1.5 *Future implications*

Considerable change has occurred over the past 68 years. Historically, social patterns, environmental influences, and policy decisions have influenced the activity-related behaviours of children and adolescents. Evidenced through the changes occurring in lifestyle and technology, especially from the 2000's onwards, coincides with the increasing number of questions used across all domains measured. Potential reasons for this include a lack of a clear definition of a domain or changing ways the activity has been expressed socially (e.g., screen time). As discussed in the introduction, to capture participation in various domains accurately, measurement needs must evolve to capture participation more accurately. This will be increasingly required in future years as various social trends change children and adolescents' activities. Although measurement is progressively incorporating more technology (accelerometers, wrist-worn activity trackers), questions still hold their place with the ability to track activity prior to technology.

Currently, there is a lack of a clear and overarching system that can classify, store, and make survey questions more accessible for such research. Possibly, survey developers are unaware of the vast number of questions that have been previously used leading to the creation of yet more questions, either from scratch or by modifying existing ones. Other possible explanations for altering questions could be due to updated guidelines, change in funding source for a research project which could alter the measurement focus, researcher bias, improvements to questions, change in how a domain is defined, and environmental changes which influences measurement needs. It appears that most survey developers are unaware of the vast number of questions that have been previously used, leading to the creation of yet more questions, either from scratch or by modifying existing ones. The increase in new questions creates difficulties when comparing and combining existing research. Better information management of existing questions could increase clarity and ease in reproducing ready-made questions, allowing for more consistency between datasets.

3.6.2 Strengths and limitations

There may well have been other questions previously used across this time, despite the thorough search conducted in Study 1. The inclusion criteria of this search, particularly the sampling requirements of the included studies (e.g., no subpopulations included, sample size requirements), may have limited which questions were included. It was difficult to access the questions used by some of the included studies due to, for example, the non-response of data custodians and the inability of data custodians to locate the questions. Additional questions potentially existed but had not been published prior to the commencement of this audit.

Despite these limitations, one of the main strengths was the comprehensive search conducted in Study 1 to identify the studies from which these questions were located. The databasing software was also advantageous, providing the ability to relate the dataset metadata with each question entered, resulting in the ability to acquire relevant metadata for each question.

3.7 Conclusion

This research was conducted with the overarching aim to address the inconsistencies in population measurement of child and adolescent activity-related behaviours. Many questions with varying characteristics and measurement focus exist and have collected considerable geographic and historical data. However, more focus on measurement, particularly assessing compliance with guidelines, was evident over the past two decades. Although promising, a modest overlap of questions over time demonstrates that data remain largely incommensurable. Overall, some acknowledged inconsistencies need to be addressed, including geographical disparity, lack of questions measuring participation of younger children (0–4 y), and comprehensiveness of measurement of different behaviours, which could lead to more precise measurement of compliance to guidelines. More importantly, clearer guidelines and standardisation in measurement in physical activity and sedentary behaviours across all age groups will improve prevalence estimates. Since current estimates are relatively low, clearer measurement will assist in providing more

accurate information to inform essential interventions and policies, which can assist in increasing participation rates and the accumulation of health benefits for Australian children and adolescents.

CHAPTER 4.

Study 3: The Delphi

Childhoods are changing, what it is to be a child is changing and now is a good time to rethink how we are responding.

Mary Kellett

Rethinking Children and Research Attitudes in Contemporary Society 2010[173]

4. Study 3 – Question recommendations

4.1 Introduction

The purpose of this chapter is to address the third aim of this thesis, to create a set of recommended questions to measure children's and adolescents' participation in physical activity and sedentary behaviours. A diverse range of survey questions are used to measure current activity levels, and to help identify areas where improvement is needed. In addition, measurement is conducted to fulfil different objectives and priorities. With no standard measurement approach, it is difficult to measure and compare participation across time and across jurisdictions. To address this issue, experts were engaged through a Delphi survey to provide recommendations on which existing survey questions could be used to measure participation rates of children and adolescents. The highest-ranked questions were identified, and expert feedback thematically analysed to provide further insight into measurement needs for population surveillance. I will begin by further exploring the rationale for this research, and then by outlining the Delphi methods employed. The following sections relate the results of the Delphi study, and the main findings are interpreted in light of research including the implications, strengths, and limitations.

4.2 Background

Despite progress in the technology of activity monitors (e.g., accelerometers), there is still uncertainty concerning their use to measure compliance to guidelines at a population level. Recent improvements have made wearables more readily available, reliable and affordable. However, some authors[1, 59, 174] have expressed their concern over the readiness of accelerometers for use in large-scale studies, including the lack of consistent protocols. Recently, a group of experts reached a consensus on analytical approaches for accelerometer-determined physical activity and sedentary behaviour in population-based studies to develop a more consistent global approach.[175] Despite these recent developments, self-report and proxy-report remain instruments of choice in large samples for some time. Even when wearable technology is ready for population

surveillance, surveys can still offer vital information on trends that wearables will lack the ability to do for many years.

There is currently no consensus around the best questions to ask to measure physical activity and sedentary behaviour in Australia. Many questions used are inadequate for measuring compliance with national guidelines, therefore the best way forward is to adopt, adapt or create questions that can capture a range of behaviours and measure overall compliance.[1] Since self-report and proxy-report are the most viable approaches to population measurement, improvements need to be made in this area. It is important to create some consensus around what measurement could be used going forward, and due to the disparity in the questions currently used, involving the people who will use these questions in these decisions is crucial. An online Delphi survey is one approach to bringing together experts from around Australia to be involved in the process.

4.3 Background on the Delphi method

Delphi techniques originated in the 1950s. The Delphi methodology was created with the same purpose as it is currently used: *to obtain the most reliable consensus of a group of experts*.[176] Using experts helps to strengthen the results and improve their uptake for future use.[177]

There are many different Delphi techniques. Most involve experts aiming to reach a consensus or make a decision.[177] There is no standard approach to take when administering a Delphi, but some key features are commonly included, such as the use of questionnaires, a feedback process, and some element of consensus.[178] The process involves data collected from an anonymous group of participants, considered experts on the topic, throughout a series of rounds. Often, the first round collects information from experts through a series of questions, with round 2 seeking each expert's perspectives on the collated information. There are also a variety of ways in which consensus can be reached.

The online Delphi method was chosen for this study to gather opinions on the questions currently used to measure participation in physical activity and sedentary behaviour. The problem was the lack of consensus on which questions could be used to measure the different activity-related behaviours. One source of

this diversity is researcher bias, particularly towards their area of interest, highlighting the need to have a balanced representation of domain experts. Across two rounds, the Delphi experts rated questions according to their suitability for use in surveys. The online method was advantageous due to the geographical spread of participants across Australia.

4.4 Aim

The aim of this study was to create a set of recommended questions which could be used moving forward to measure children's and adolescents' participation in physical activity and sedentary behaviours. The intention was to engage expert opinion using a Delphi survey, resulting in one main recommended question for each of the selected domains, and a series of other possible questions to use when suitable.

This study involved several discrete steps:

1. Selection of key questions for the Delphi questionnaire
2. Identification and description of the coverage and measurement properties of these select questions
3. Conduct a Delphi questionnaire
4. Analysis of the Delphi questionnaire results and presentation of findings.

4.5 Methods

4.5.1 Study design

A two-round online Delphi method was chosen to identify experts' opinions on existing questions measuring physical activity and sedentary behaviours. The domains which questions were identified for include:

- overall physical activity, including:
  - moderate-to-vigorous physical activity
  - muscle-strengthening activities
- active play
- active transport

- exercise
- physical education
- sport
- overall sedentary behaviours
- screen time
- non-screen sedentary time

An online questionnaire was used to collect ratings and feedback from experts on a range of specifically selected existing questions.

4.5.2 Study protocol

Experts were recruited from a range of settings to provide feedback on selected questions measuring physical activity and sedentary behaviours. A Delphi protocol (Figure 4.1) was developed to include important elements of this technique; use of questionnaires, anonymity, expert input, integration of expert opinions, and consensus testing.[177] Selected experts were asked to complete an online questionnaire and provide feedback on a set of questions.

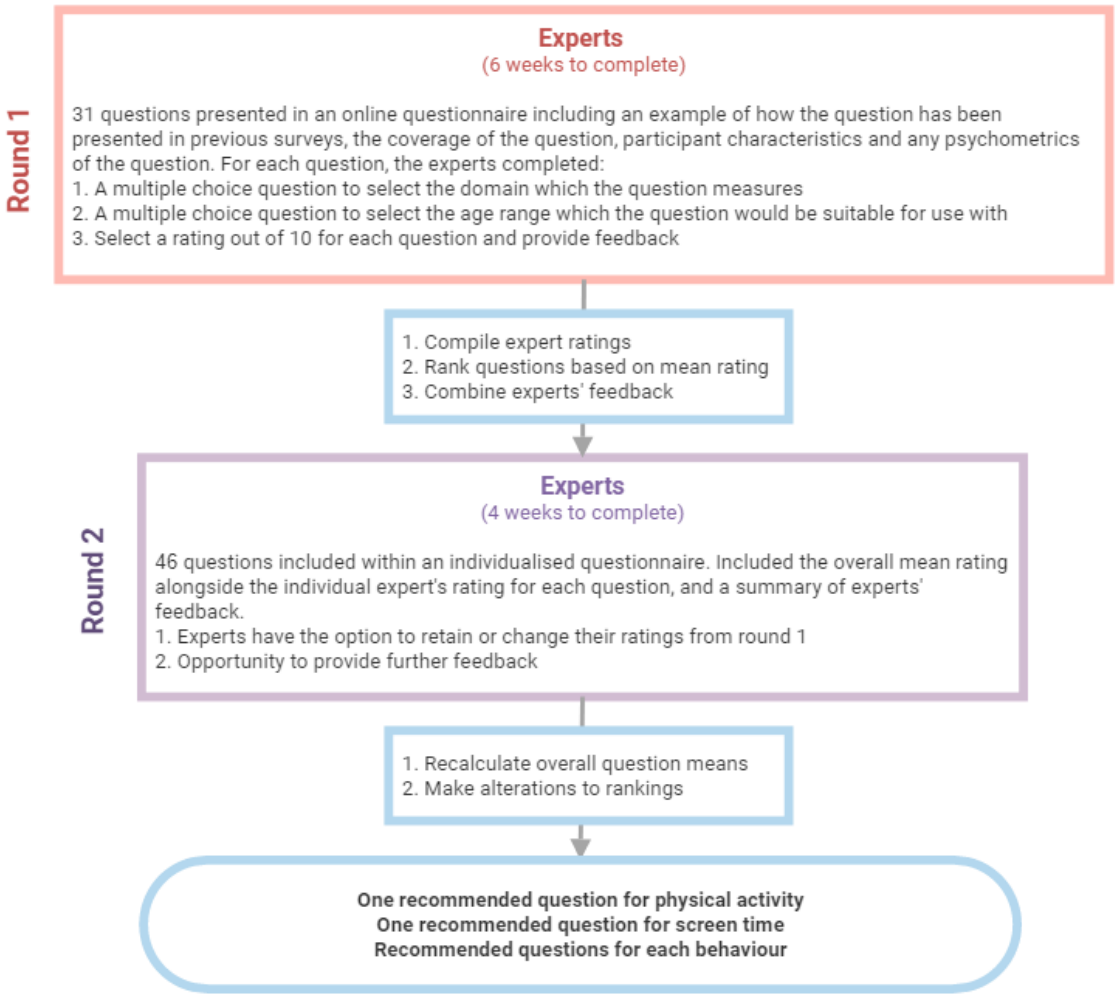


Figure 4.1 The different steps involved in the Delphi questionnaire.

4.5.2.1 *Round 1*

Round 1 started in December 2020 and was closed in February 2021. Due to seasonal commitments and recreational leave, the Delphi experts were provided an extended time to complete this round. The experts were initially provided with instructions on how to complete the questionnaire, background information (e.g., the current Australian guidelines), and how to interpret the summary tables and figures presented alongside each question. Experts were not presented with any definitions for each of the domains (e.g., overall physical activity, active play) to minimise any risk of bias. Initially, experts were asked to provide basic demographic data, outlined in Table 4.1. The first round included 31 selected questions presented to the participants and a summary of the existing metadata describing the measurement occurrences of each question (see Section 4.4.3 for further detail). For each question included in this questionnaire, the experts selected the domain the question measured, the age range which the question

would be suitable for, and rated the question (out of 10) depending on if they would recommend its use to measure participation of the selected age range in the selected domain. The experts were able to provide feedback on each survey question. The selected domains, ages and ratings were compiled for each question, and an overall mean rating was calculated.

Table 4.1 Data collected from the Delphi experts throughout round 1 and round 2.

Expert characteristics	Physical activity and sedentary behaviour response options	Age range response options	Question rating
• name • title • primary occupation • primary place of work • primary state/territory of work • primary area/s of research • number of years involved in research on youth physical activity and/or sedentary behaviours	• overall physical activity • overall moderate-to-vigorous physical activity • overall sedentary behaviours • muscle-strengthening activities • active transport • active play • sport • screen time • exercise • physical education • non-screen sedentary time	• infant (0-1 years) • toddler (1-2 years) • pre-schooler (3-5 years) • children (5-12 years) • adolescent (13-18 years)	• rating out of ten (0 = not recommended, 10 = highly recommended)

4.5.2.2 *Round 2*

Round 2 was conducted between April 2021 and May 2021. Each expert received an individualised questionnaire consisting of 46 survey questions, with each question ranked according to domain and age range. Each survey question was presented along with an overall mean rating and the expert's rating. Experts also received a summary of all the feedback provided per question. To maintain expert anonymity, no identifying information (e.g., names, locations) was provided with the feedback. Experts were able to accept or modify their ratings, provide any further feedback, or suggest other survey questions not included in the questionnaire.

4.5.3 Development of Delphi questionnaire

A large amount of background information was compiled and prepared for the round 1 questionnaire. The questionnaire involved presenting the experts with a summary of the existing metadata for each selected question. This information was presented to the experts in tables and matrices. It included any available psychometric data for each of the questions. The potential respondent burden was a consideration, and attempts were made to keep the background material visually effective and concise. To prepare this material, a number of steps were followed, including:

- selection of questions
- identification and collation of metadata, including state/territory location, year of data collection, and participant characteristics (age, sample size)
- searching for existing data on the reliability and validity of each question
- creation of matrices and tables

4.5.3.1 *Question selection*

Due to the large number of questions identified in Study 2, a smaller selection of appropriate questions was required that could be presented to the Delphi experts. The aim was to find a set of questions that would be able to measure compliance to the guidelines along with questions which captured participation in the different domains. This involved selecting a set of possible questions which measured each domain by using a set of pre-determined criteria (Figure 4.2). These criteria were developed based on the research needs of this area and how best to monitor participation rates. They included how well the question measured compliance with guidelines, the psychometrics of the question, and geographical and temporal coverage.

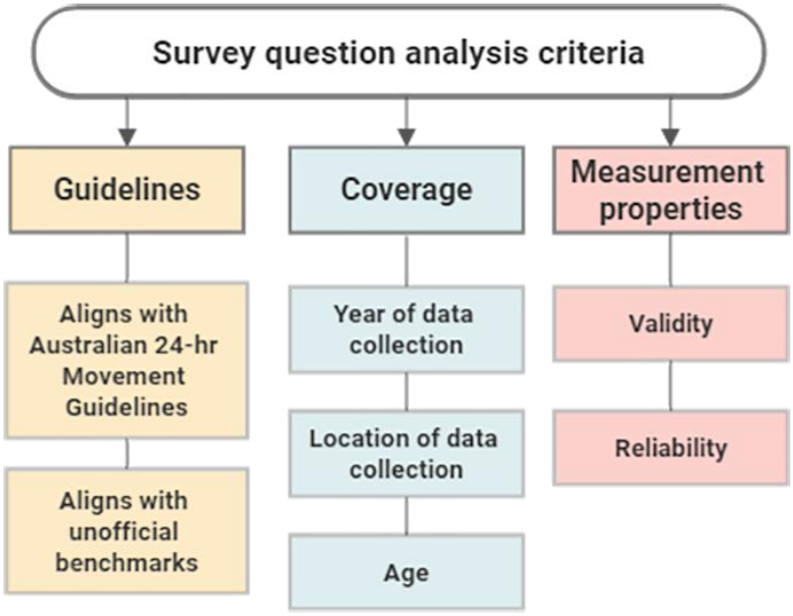


Figure 4.2 Criteria used to analyse the survey questions measuring participation in physical activity and sedentary behaviours.

The process followed to select appropriate questions is outlined in Figure 4.3. Due to the potential high time demand on experts to complete this questionnaire, the aim was to include approximately three questions per domain in the Delphi questionnaire. Each step of this process has been described within the following sections.

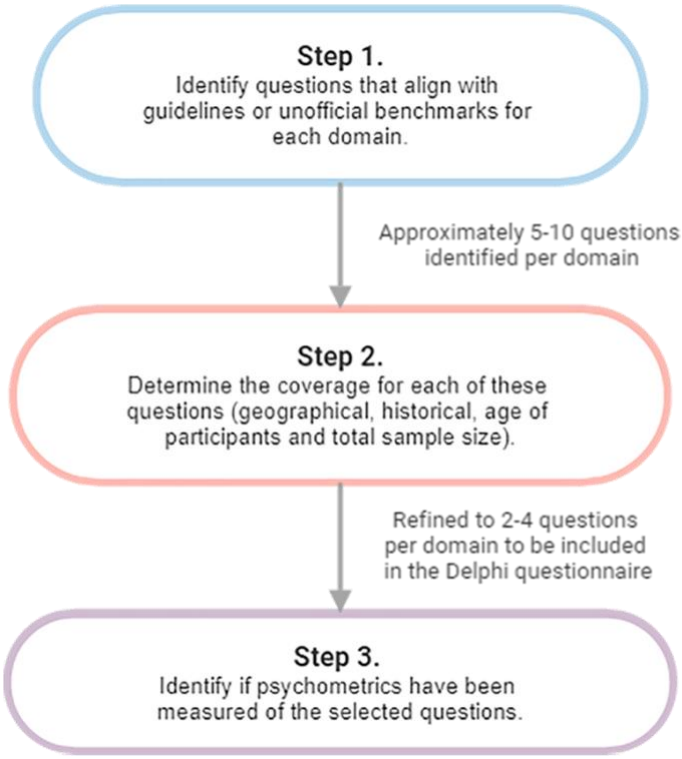


Figure 4.3 Steps followed to select questions to be included in the Delphi questionnaire.

4.5.3.2 *Measurement of guidelines or benchmarks*

As seen in Figure 4.3, the first step was identifying relevant questions to measure national guidelines or unofficial benchmarks (as previously seen in Table 1.1 and Table 1.2, Section 1.1). This step involved searching questions by their domain classification (completed in Study 2) to locate questions that could determine compliance with guidelines. Consultation with the supervisory team occurred throughout this process. Ideally, questions that consisted of the appropriate dimensions to capture frequency, duration and intensity of participation over an appropriate timeframe were highlighted. Many questions did not include the essential assessment dimensions, nor did they have to when measuring the unofficial benchmarks, in which case the closest questions were selected.

4.5.3.3 *Coverage of questions*

The next step involved locating the metadata related to the question coverage. Metadata describing the measurement instances of a question, including the geographic area (i.e., state/territory), the years of data collection, and the total number and age of the participants. These metadata were extracted from the

database created in Study 1 and 2. Questions were selected because they had national coverage, more measurement instances, a greater age range of participants, or had a larger sample size. The temporal and age coverage of questions was visually depicted using matrix charts and included within the Delphi questionnaire for the experts to consider. Examples of how this information was presented in the Delphi questionnaire is in Appendix 5.

4.5.3.4 *Question psychometrics*

A literature search located if any established psychometrics existed for the selected questions. It was often unclear whether a question had been tested for validity or reliability as sometimes surveys are created with previously used and tested questions or, at other times, modified versions of previously used questions or newly created questions. Few publications reported the psychometrics of the questions used, therefore other sources were also searched to locate this information. Searches were also conducted of other publications and reports, in addition to general google searches, to find any existing studies testing the validity and reliability of the questions. The complex process followed is outlined in Figure 4.4. Any identified psychometrics did not influence the selection of questions but were presented in a table for the Delphi experts.

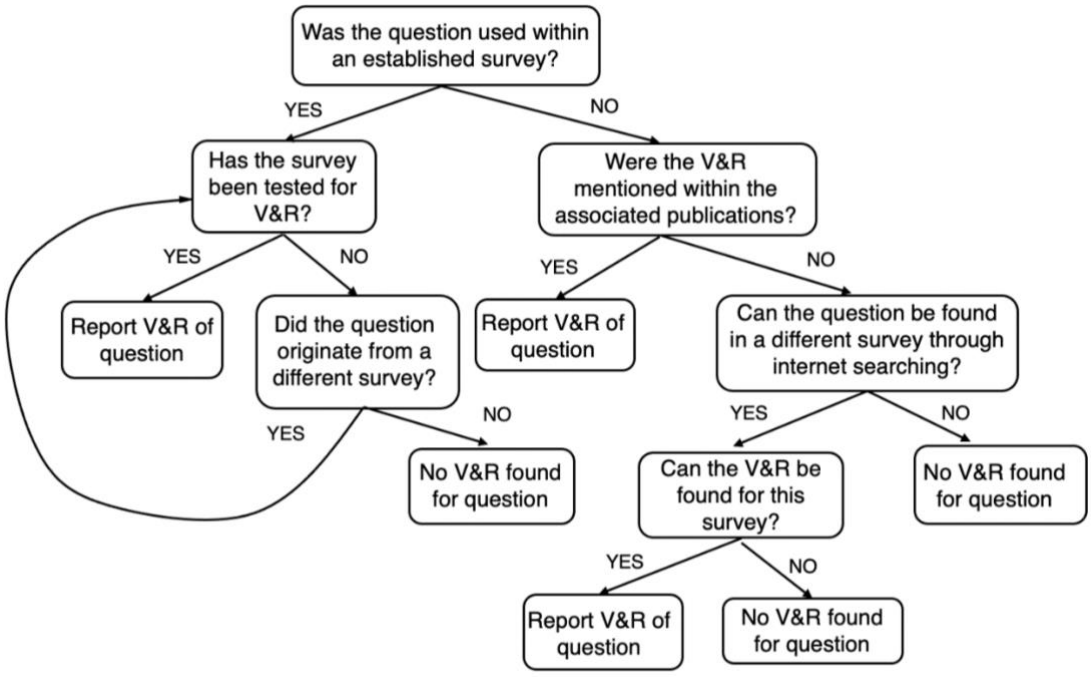


Figure 4.4 Search process to identify validity and reliability of selected questions.

*Abbreviation used: V&R = validity and reliability

4.5.3.5 *Creation of online questionnaire*

The online Delphi questionnaires were created and administered using the online platform, Survey Monkey (https://www.surveymonkey.com). Both round 1 and 2 questionnaires were distributed by emailing the experts an online link, with the option of completing the questionnaire across multiple sittings if necessary. Once completed, the questionnaire data were stored online with the privacy of password-protected access. Most of the questions completed were multiple-choice, allowing participants to select more than one option. Advanced logic branching was applied to the survey to allow each participant to follow a custom path. This required logic to be applied with entire options skipped (not appearing in the questionnaire) depending on what the participant selected. The questionnaires consisted of many figures and tables, each created and formatted using different software programs as required (*Canopy*, *Adobe Photoshop* (Version 22.2), *InDesign* (Version 16.1) and *PowerPoint* (version 16.53).

4.5.4 Ethics

The University of South Australia Human Ethics provided approval for this research (protocol no. 202035).

4.5.5 Recruitment and sample

4.5.5.1 *Eligibility criteria*

The aim was to recruit a group of experts who would be able to provide feedback on questions used to measure participation in physical activity and sedentary behaviours. The inclusion criteria were as follows:

- have published in this area in the last 12 months (e.g., peer-reviewed journal, research report, intervention evaluation)
- provide informed consent.

This inclusion criteria were designed to include experts who are actively contributing to this research area.

4.5.5.2 *Recruitment of participants*

The aim was to recruit 20 experts as per previous literature which recommends 10-18 participants.[176] Potential experts were invited via email, which included a brief explanation of the questionnaire along with an attached information sheet and link to the online questionnaire. Potential experts were invited from the following settings:

- the current AHKA research group members
- previous AHKA research group members
- data custodians contacted in Study 1 of this research project
- recommendations from supervisors, particularly to reach potential experts in the industry sector

Any expert who consented and started the online questionnaire was provided with an optional question asking the expert to recommend two other possible experts, preferably one from academia and one with an industry role. These suggested experts were also sent an invitation to participate via email. All potential experts received a follow-up email after two weeks if no reply was received. To minimise bias towards different domains and jurisdictions, representation of experts from each research area was monitored throughout the recruitment phase (i.e., representation of experts from academia vs industry, and from different research areas).

4.5.6 Data analysis

Characteristics of the experts are reported descriptively, including:

- years of experience
- location of work
- purpose of work (industry or academia, determined from stated job role)

The response rate was calculated as the percentage of experts who consented to participate out of all the potential experts invited. The retention rate for each round was calculated as the number of experts who completed the questionnaire as a percentage of those who started the questionnaire. For a question to be included in round 2, it had to reach a level of consensus in round 1. Questions

were required to be rated a 5 or above on a scale of 1 to 10 by at least 70% of experts for it to be included in round 2.

Experts were asked to determine what domain of physical activity and sedentary behaviour each question measured, along with the age range the question would be suitable for (infant 0–1 y, toddler 1–2 y, pre-schooler 3–5 y, child 5–12 y, adolescent 13–18 y), using self-report or proxy-report. For each included question, a mean rating was calculated for how likely the participants were to recommend that question for measuring the specified domain (out of 10). An overall mean rating was calculated out of 10, and a ranking applied to each question based on the mean rating for each behaviour and age range. Following round 2, a revised mean rating was calculated, including modified ratings provided by the participants. The final question rankings were determined based on the revised mean ratings.

A qualitative exploration of the experts' feedback was conducted using a thematic analysis. For each question, experts' feedback were combined, and key themes identified and presented using a frequency count.

4.6 Results

The results from the Delphi process are presented in this section. The results describe the survey question recommendations provided by the experts and a thematic analysis of the written feedback. Mostly, the results will be collated and presented for each individual physical activity and sedentary behaviour, as the measurement needs for each can differ. In summary, this section will include:

- Delphi expert characteristics
- the results of the question selection for the Delphi questionnaire
- overview of the results of the Delphi questionnaire
- recommendations on survey questions to measure participation levels

4.6.1 Delphi expert characteristics

A total of 90 experts were invited to participate in the Delphi questionnaire, from the current AHKA research group (Group 1), past members of the AHKA (Group

2), data contacts from Study 1 (Group 3), and recommendations from supervisors (Group 4). A total of 38 (41%) consented to participate. A total of 34 experts (89% of those consenting) completed round 1, while 29 (85% of those who completed Round 1) also completed round 2 (Figure 4.5). Experts who provided consent but did not complete round 1 were excluded from round 2. Only the data from experts who completed both rounds of the questionnaire have been included in the analysis.

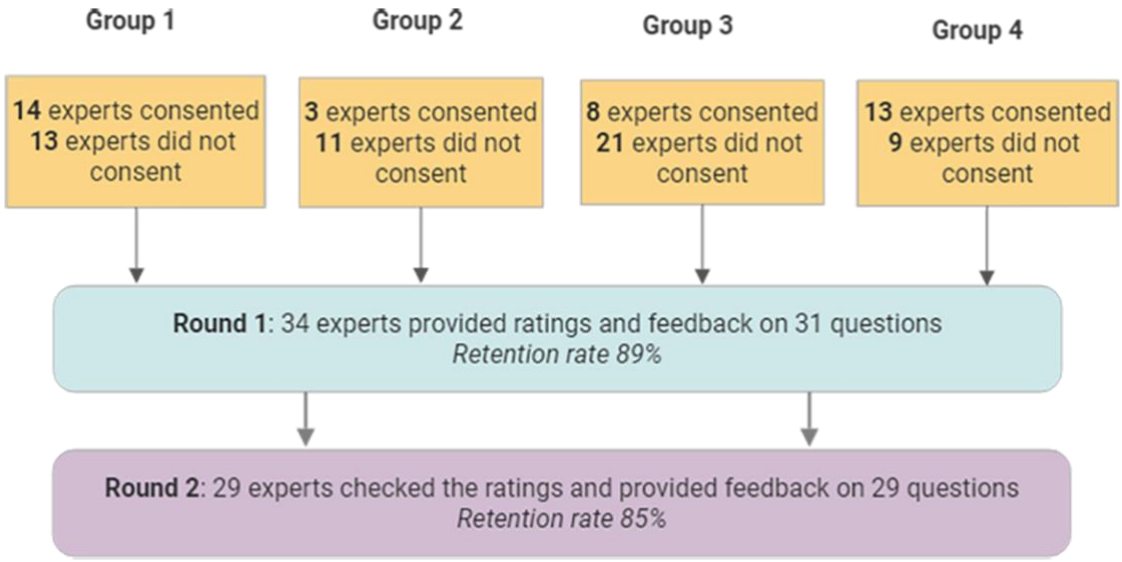


Figure 4.5 Expert consent and retention throughout the Delphi process.

Experts were asked to provide some personal details (experience, place of work, job role, area of research), presented in Table 4.2. Most participants were from an academic setting (72%). Despite there being no participants involved in the Delphi process from NT or ACT, there was a relatively even spread across the remaining states and territories. There were 4 (14%) participants with ≥20 years' experience. Almost a third (n=9, 31%) had 10-15 years' experience, while 5 (17%) had <5 years' experience.

Table 4.2 Characteristics of the Delphi experts.

	No. of experts (% of total experts)
Title	
Professor	4 (14%)
Associate Professor	3 (10%)
Doctor	14 (48%)
Other	8 (28%)
Primary occupation	
Academia	21 (72%)
Industry	8 (28%)
Years of experience	
0-5 years	5 (17%)
5-10 years	8 (28%)
10-15 years	9 (31%)
15-20 years	3 (10%)
20+ years	4 (14%)
Primary state/territory of work	
WA	4 (14%)
QLD	3 (10%)
NSW	7 (24%)
VIC	8 (28%)
SA	5 (17%)
TAS	2 (7%)
Area of research	
Active play	8 (28%)
Active transport	5 (17%)
Exercise	6 (21%)
Non-screen time	4 (14%)
Physical activity	29 (100%)
Physical education	7 (24%)
Screen time	10 (35%)
Sedentary behaviour	15 (52%)
Sport	6 (21%)

4.6.2 Results of question selection

As previously discussed, pre-determined criteria were used to select the questions for this Delphi process. For each question, data on coverage and psychometrics were compiled. A short list of questions was discussed with the supervisory team, and 31 questions were selected to be included in the Delphi questionnaire. Both validity and reliability estimates were found for eight (26%) of the questions. Validity only data was found for one question (3%) and reliability data were found for five questions (16%). No psychometrics were found

for 17 of the questions (55%). The full list of questions with any identified psychometrics are included in Appendix 6.

4.6.3 Results of the Delphi survey

4.6.3.1 *Overview of round one*

The average completion time was 72 minutes; however, this occurred over multiple sessions. Experts assigned a physical activity and sedentary behaviour domain, age range and rating for each question. Two questions were excluded as consensus was not reached since 70% of experts who provided a rating rated the question <5. The number of questions categorised as suitable for measuring each behaviour per age range are presented in Table 4.3. It is important to note that this consists of 29 questions, with some categorised as measuring participation for more than one age or behaviour. For example, an expert may rate a question suitable for measuring overall physical activity participation across multiple age ranges: toddlers, pre-schoolers, children and adolescents. The highest number of questions were suitable for measuring screen time, whereas few were suitable for five different domainss: exercise, muscle-strengthening activities, non-screen sedentary time, PE and sport. Only four questions were suitable for measuring participation levels of infants and pre-schoolers, compared to 31 questions for both children and adolescents.

Table 4.3 Number of questions assigned to each physical activity and sedentary domain by the Delphi experts in round 1.

	Infant	Toddler	Pre-schooler	Child	Adolescent	Total
Active play	1	3	2	4	4	**14**
Active transport				3	3	**6**
Exercise				2	2	**4**
Muscle-strengthening activities				2	2	**4**
MVPA				3	3	**6**
Non-screen sedentary time	1	1		1	1	**4**
Overall physical activity	1	1		5	5	**12**
Overall sedentary behaviour	1	1		2	2	**6**
PE				2	2	**4**
Screen-time		1	2	8	8	**19**
Sport				2	2	**4**
Total	**4**	**7**	**4**	**34**	**34**	**83**

4.6.3.2 *Overview of Round 2*

Round 2 involved presenting the questions to the experts ranked in order of how they rated them in the previous round. Average completion time for this round was 55 minutes, ranging from 7 minutes to just over a week. A total of 29 experts completed this round. A total of 113 changes were made during this round. Table 4.4 illustrates the mean change to the ratings for each domain, with a negative (-) representing a decrease in the mean rating and a positive (+) representing an increase in the mean rating.

Table 4.4 Number of experts who changed their ratings across the questions measuring each physical activity and sedentary behaviour.

Physical activity and sedentary behaviours	Number of changes	Mean change (out of 10)
Overall physical activity	30	0
Overall MVPA	4	-2
Muscle-strengthening activities	9	0
Active play	11	+1
Active transport	14	0
Exercise	4	+1
Physical Education	11	-1
Sport	6	0
Overall sedentary behaviours	4	-1
Non-screen sedentary behaviours	2	1
Screen time	18	-1
Total	**113**	**0**

4.6.3.3 *Delphi expert feedback*

Experts were given the opportunity to provide feedback for each question within round 1 of the questionnaire. Across all questions a total of 458 comments were provided, with the most for screen time. In round 2, opportunities for feedback were also provided for each domain and when any changes were made to question ratings. As seen in Table 4.5, a total of 63 comments were provided in this round, many referring to individual questions, some in relation to how the

domain should be measured and others provided suggestions for other possible questions.

Table 4.5 Number of comments per domain provided by experts across all survey questions measuring physical activity and sedentary behaviours.

Physical activity and sedentary behaviour domains	No. of comments provided by experts	
	Round 1	Round 2
Overall physical activity	78	13
Overall MVPA	19	2
Muscle-strengthening activities	27	7
Active play	51	9
Active transport	41	3
Exercise	12	5
Physical Education	46	8
Sport	28	0
Overall sedentary behaviours	20	0
Non-screen sedentary behaviours	7	3
Screen time	129	13
Total	**458**	**63**

A closer look at the feedback identified that the comments could be related to some key themes. These themes consisted of:

- the dimensions of the assessment
- time frame
- respondent burden
- psychometrics
- clarity
- outcomes measured
- suggested changes
- other

A frequency count was conducted to reveal how often each theme occurred for every question. The frequency counts for each question were collated to give an overall occurrence of themes for each physical activity and sedentary behaviour. These findings are presented per domain within the next section.

4.6.4 Survey question recommendations

This section presents the questions which have been recommended by the Delphi experts. All the results will be presented separately for each different domain. The highest-ranked question for each domain and each age range will be included, along with the coverage (historical and geographical), total participants and participant characteristics, and any identified psychometrics. The full list of ranked questions will be included in Appendix 7. The results of the thematic analysis conducted on the Delphi experts' feedback will also be presented for each domain, along with any suggestions provided to improve the questions used to measure participation levels. An example (Figure 4.6) has been provided outlining how the results are presented for each domain.

1. Written overview of question recommendations per age range.

4.5.4.1 Overall physical activity

The highest rated questions used to measure participation of overall physical activity for infants and toddlers, and for children and adolescents are presented in Table 4.6. There were no questions selected as suitable to measure the participation of pre-schoolers.

Delphi experts' overall mean ratings for round 1 & round 2

2. Table presenting the recommended question (highest rated) for each age range.

Age range	Question	Rd 1	Rd 2
Infants & toddlers (0-2 yrs)	Over the last week, about how much time did your baby spend doing the following activities? b. Being physically active with you (e.g. helping them roll, kicking their legs, move on a mat, etc) c. Having tummy time (on their stomach while awake)	6.2	5.8
Pre-schoolers (3-5 yrs)	No questions		
Children & adolescents (5-18 yrs)	Over the past 7 days, on how many days was your child engaged in moderate to vigorous physical activity for at least 60 minutes each day?	7.2	7.2

3. All the data previously collected by this question has been compiled and presented within two different matrix charts. The first matrix chart shows the number of participants within each state/territory and nationally that have previously responded to this question.

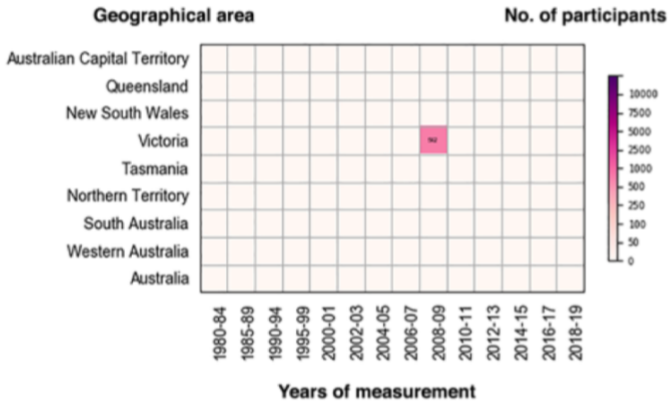


Figure 4.5 Matrix illustrating the number of participants per geographic area who had their overall physical activity measured using the question recommended for infants and toddlers by the[Delphi experts.

3. The second matrix chart shows the number of participants per age and nationally which have previously responded to this question

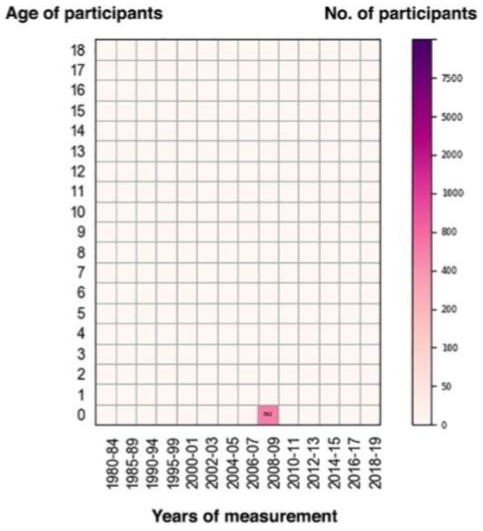


Figure 4.6 Matrix illustrating the number of participants who had their overall physical activity measured using the question recommended for infants and toddlers by the Delphi experts.

4. Written description of the question coverage.

For infants and toddlers, only one question was selected as suitable. As seen in Figure 4.5 and Figure 4.6, this question has only been used in one study to measure physical activity. Conducted in Victoria, the InFANT study used this question in 2008 to collect data on infants. The reliability of the question was tested using test-retest over two weeks.

Following the same structure, the recommended question/s for pre-schoolers, children and adolescents are described and presented. This includes a description of the the question/s coverage and presentation of the data collected within two matrix charts.

5. For each domain, the results of the thematic analysis which was conducted on the Delphi expert feedback is also presented. This is presented in a table identifying the key themes, the number of comments on each theme and an example comment.

Table 4.8 Thematic analysis of expert feedback on questions measuring overall physical activity participation.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	23	*No indication of intensity in this question*
Time frame	15	*Would rather 'usual' week*
Respondent burden	12	*The question is asking the parent but they may not be able to judge how challenging the PA was for the child.*
Rigour	6	*Our study trying to validate this question for change found that it is unreliable.*
Clarity	11	*No definition of PA makes this question open to interpretation.*
Changes suggested	30	*Giving actual examples to parents will help them locate in their memory the types of activities the kids do e.g. sport - example, example play - example example active travel - example recreation - example, example.*
Other	14	*It is the question item I use for my surveys.*

6. Lastly, a written description of the thematic analysis.

The expert feedback from the Delphi questionnaire was provided for six different questions, all measuring overall physical activity. The two most frequently mentioned themes included *suggested changes*, along with *dimensions of the assessment*. Regarding the dimensions, the experts most frequently commented on the absence of a measure of intensity in some of the overall physical activity

Figure 4.6 Example of how the results of the Delphi questionnaire have been presented within this chapter.

4.6.4.1 *Overall physical activity*

The highest-ranked questions used to measure participation of overall physical activity for infants and toddlers, and for children and adolescents, are presented in Table 4.6. There were no questions selected as suitable to measure the participation of pre-schoolers.

Table 4.6 Highest-ranked questions for measuring participation of overall physical activity.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	Over the last week, about how much time did your baby spend doing the following activities? b. Being physically active with you (e.g., helping them roll, kicking their legs, move on a mat, etc.) c. Having tummy time (on their stomach while awake)	6.2	5.8
Pre-schoolers	No questions		
Children & adolescents	Over the past 7 days, on how many days was your child engaged in moderate to vigorous physical activity for at least 60 minutes each day?	7.2	7.2

For infants and toddlers, only one question was selected as suitable. As seen in Figure 4.7 and Figure 4.8, this question has only been used in one study to measure physical activity. Conducted in Victoria, the InFANT study used this question in 2008 to collect data on infants. The reliability of the question was assessed using test-retest over two weeks.

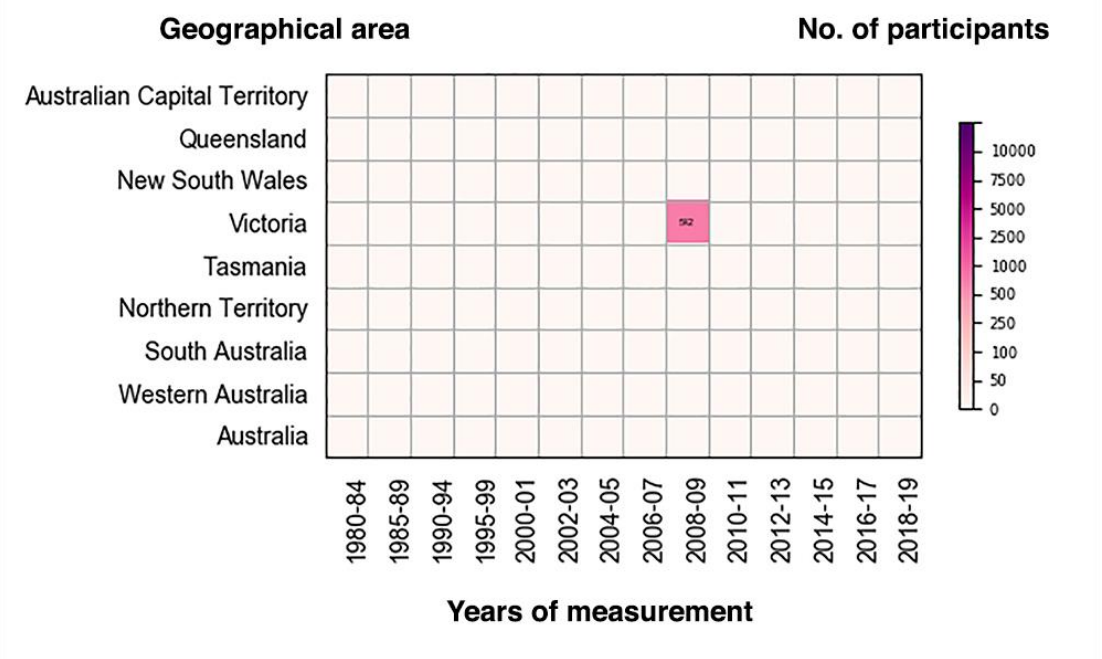


Figure 4.7 Matrix illustrating the number of participants per geographic area who had their overall physical activity measured using the question recommended for infants and toddlers by the Delphi experts.

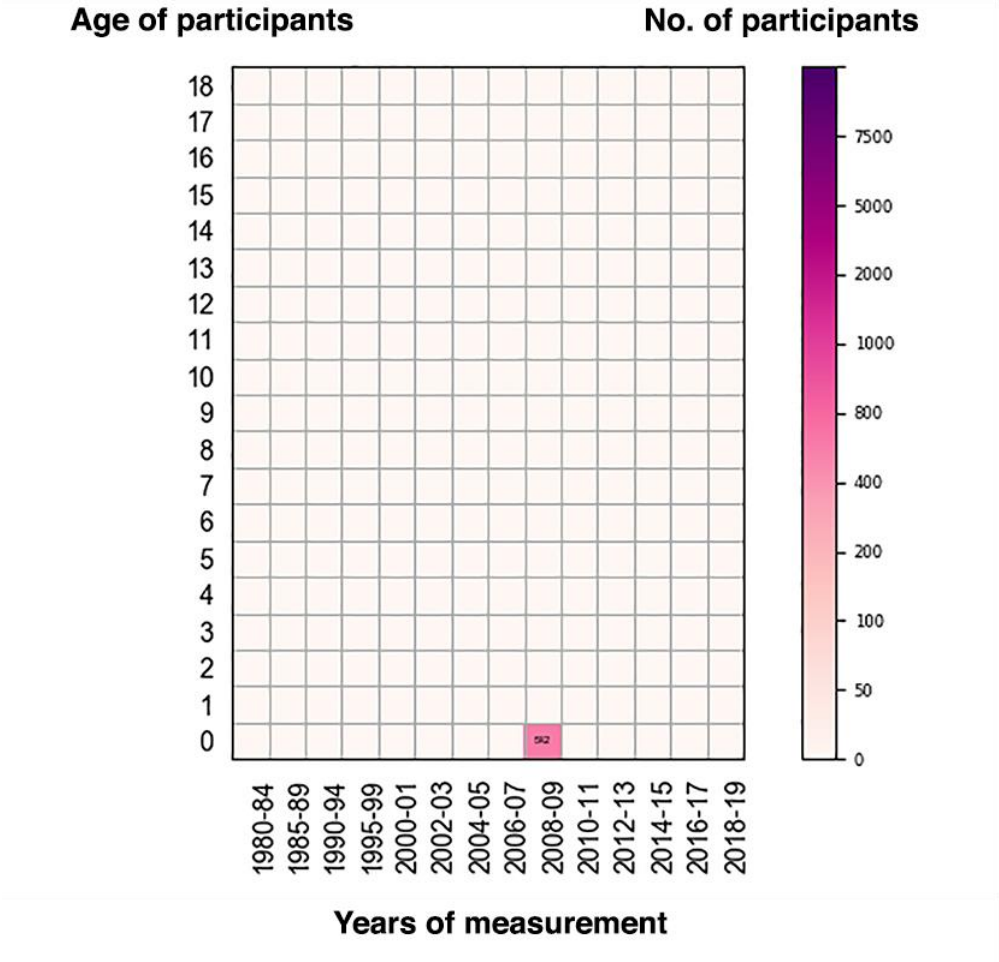


Figure 4.8 Matrix illustrating the number of participants who had their overall physical activity measured using the question recommended for infants and toddlers by the Delphi experts.

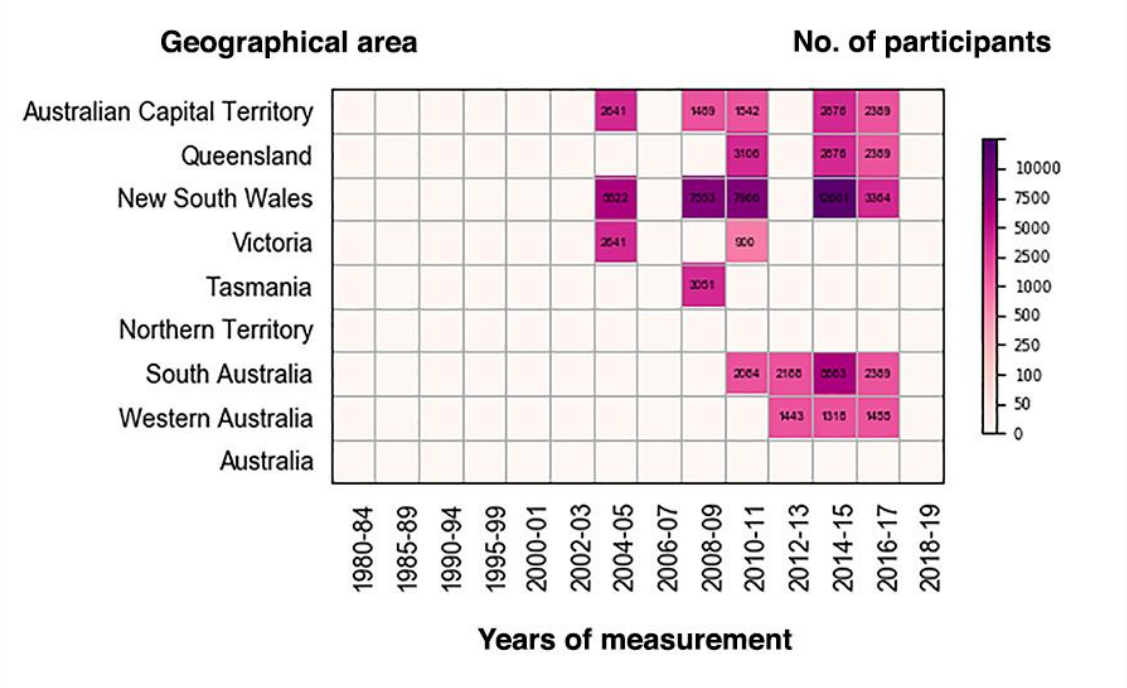


Figure 4.9 Matrix illustrating the number of participants per geographic area who had their overall physical activity measured using the question recommended for children and adolescents by the Delphi experts.

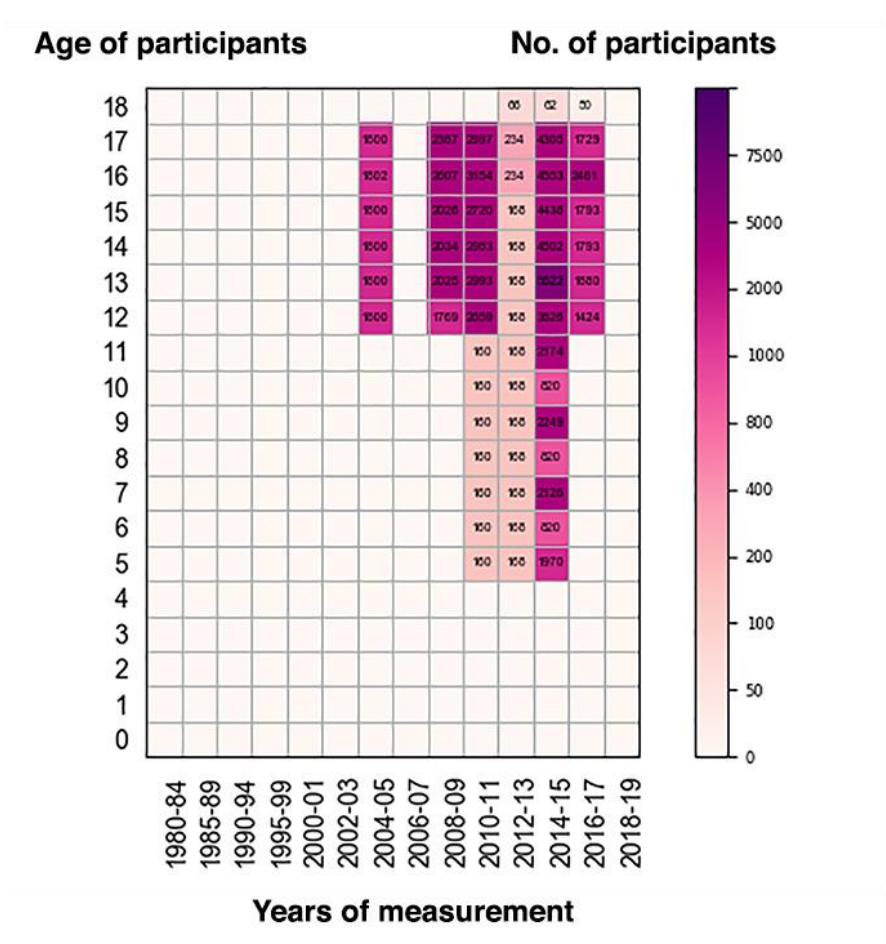


Figure 4.10 Matrix illustrating the number of participants who had their overall physical activity measured using the question recommended for children and adolescents by the Delphi experts.

The question ranked the highest for measurement of participation in overall physical activity for children and adolescents has previously been used on 35 different instances. Overall, Delphi experts provided a mean rating of 7.2 (out of 10), and this question was ranked first from a total of 5 questions. The authors also demonstrated it has reasonable psychometrics, with the concurrent validity (ICC) compared to accelerometry of 0.77, and test-retest reliability of ICC = 0.88 (same day) and 0.53 (<4 weeks).[179] In Australia, this question was first used in 2004 in the NSW, VIC and ACT state-based Australian Secondary Schools Drug and Alcohol Survey (ASSAD) (Figure 4.9). Since this time, it has been used to collect a total of 58,709 responses on participants ranging from 5- to 17- year-olds from 7 different states and territories (Figure 4.10).

Table 4.7 Thematic analysis of expert feedback on questions measuring overall physical activity participation.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	23	*No indication of intensity in this question*
Time frame	15	*Would rather 'usual' week*
Respondent burden	12	*The question is asking the parent but they may not be able to judge how challenging the PA was for the child.*
Rigour	6	*Our study trying to validate this question for change found that it is unreliable.*
Clarity	11	*No definition of PA makes this question open to interpretation.*
Changes suggested	30	*Giving actual examples to parents will help them locate in their memory the types of activities the kids do e.g. sport - example, example play - example example active travel - example recreation - example, example.*
Other	14	*It is the question item I use for my surveys.*

The expert feedback from the Delphi questionnaire, outlined in Table 4.7, was provided for six different questions measuring overall physical activity. The two most frequently mentioned themes included *suggested changes,* along with *dimensions of the assessment.* Regarding the dimensions, the experts most frequently commented on the absence of a measure of intensity in some of the overall physical activity questions. The experts also commented on the timeframe of recall within these questions. There was considerable diversity between these comments, with some experts preferring a *usual* day or week, while others preferred a recall over the *past 7 days*. Furthermore, some participants

commented that a 7-day timeframe was too long for parents to recall the physical activity of infants and toddlers.

Many changes were suggested to improve the survey questions measuring overall physical activity (i.e., compliance with physical activity guidelines). More than a quarter of all feedback provided on this domain consisted of comments on how the questions could be improved. The most frequently suggested improvement was for the questions to include relevant examples of activities the respondents could include when recalling their physical activities. Some experts also remarked that any examples or explanations need to be provided in child-friendly language, especially when the question is completed using self-report. Overall, more clarification is needed either by providing a better explanation and/or definitions of what physical activity is.

4.6.4.2 *Moderate-to-vigorous physical activity*

The question recommended to measure MVPA was the same question as was recommended to measure overall physical activity for children and adolescents (Table 4.8). There were no questions rated as suitable for use with children younger than school age (pre-schoolers, toddlers and infants). A description of the coverage of this question is included above, in Section 4.6.4.1.

Table 4.8 Highest-ranked questions for measuring moderate-to-vigorous physical activity participation.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	No questions		
Pre-schoolers	No questions		
Children & adolescents	Over the past 7 days, on how many days was your child engaged in moderate to vigorous physical activity for at least 60 minutes each day?	7.2	7.2

Table 4.9 Thematic analysis of expert feedback on questions measuring overall physical activity participation.

Theme	Frequency	Example of experts' comments
Dimensions of assessment	7	*..numbers next to the options do not overlap with options and may confuse children.*
Time frame	2	*The time frame for the question is answerable in terms of memory recall.*
Respondent burden	7	*Recall for this question is likely to improve with age - so a good question for 10+ year olds.*
Rigour	1	*Need validation*
Clarity	6	*Description of MVPA useful, also the note that accumulation could be in bouts.*
Changes suggested	7	*Giving actual examples to parents will help them locate in their memory the types of activities the kids do e.g. sport - example, example play - example example active travel - example recreation - example, example.*
Other	12	*Unable to determine compliance to MVPA guidelines from this question.*

Experts provided feedback (Table 4.9) on three questions rated as suitable for the measurement of participation in MVPA. The most common feedback was concerning the *clarity* of the questions and the outcomes measured by the questions (*other*). The experts mainly provided positive comments on the *clarity*, complimenting the use of pictures and clear explanations, however, some of the experts did not like the term *exercise* within one of these questions. Other common feedback was on the inability of one of the questions to measure compliance with the guidelines.

Despite some positive feedback, the primary suggestions for improvement consisted of the need to include examples of possible physical activities to recall and better explanations of MVPA.

4.6.4.3 *Muscle strengthening activities*

Only two questions were considered suitable for the measurement of participation in muscle-strengthening activities (Table 4.10). No questions were selected as suitable for pre-schoolers, toddlers and infants. The highest-ranked had a mean overall rating of 6.1.

Table 4.10 Highest-ranked questions for measuring participation in muscle strengthening activities.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	No questions		
Pre-schoolers	No questions		
Children & adolescents	Some activities are designed to increase muscle strength or tone, such as lifting weights, resistance training, pull-ups, push-ups, or sit-ups. Including any activities already mentioned, in the last week did you do any strength or toning activities?	6.7	6.1

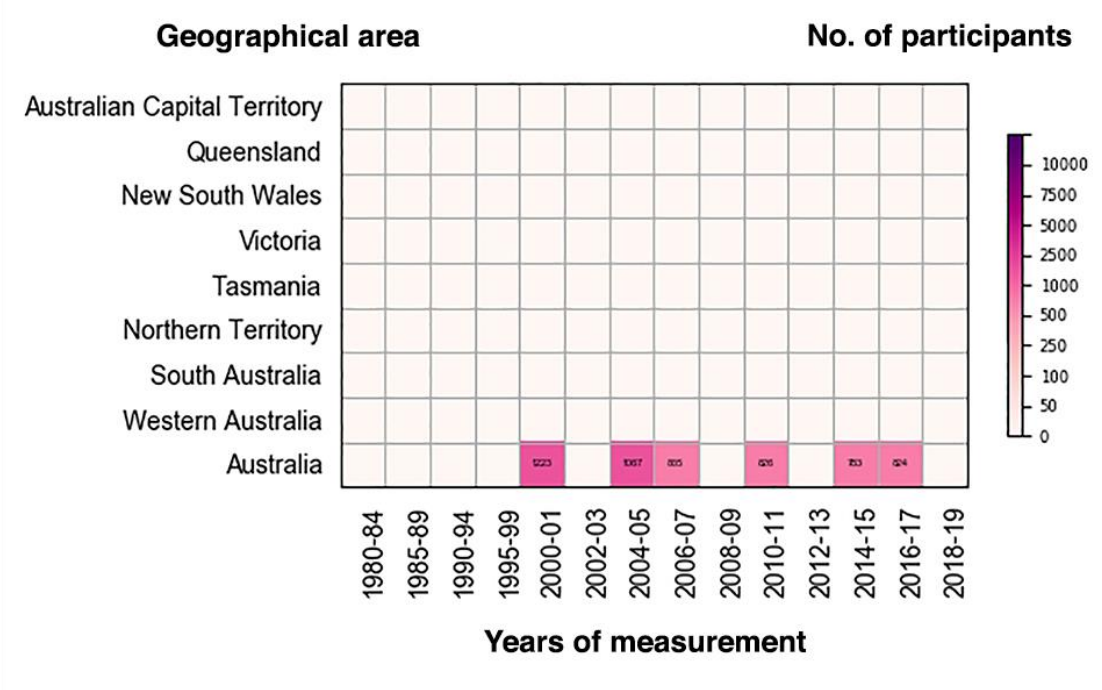


Figure 4.11 Matrix illustrating the number of participants per geographic area who had their muscle strengthening activities measured using the question recommended for children and adolescents by the Delphi experts.

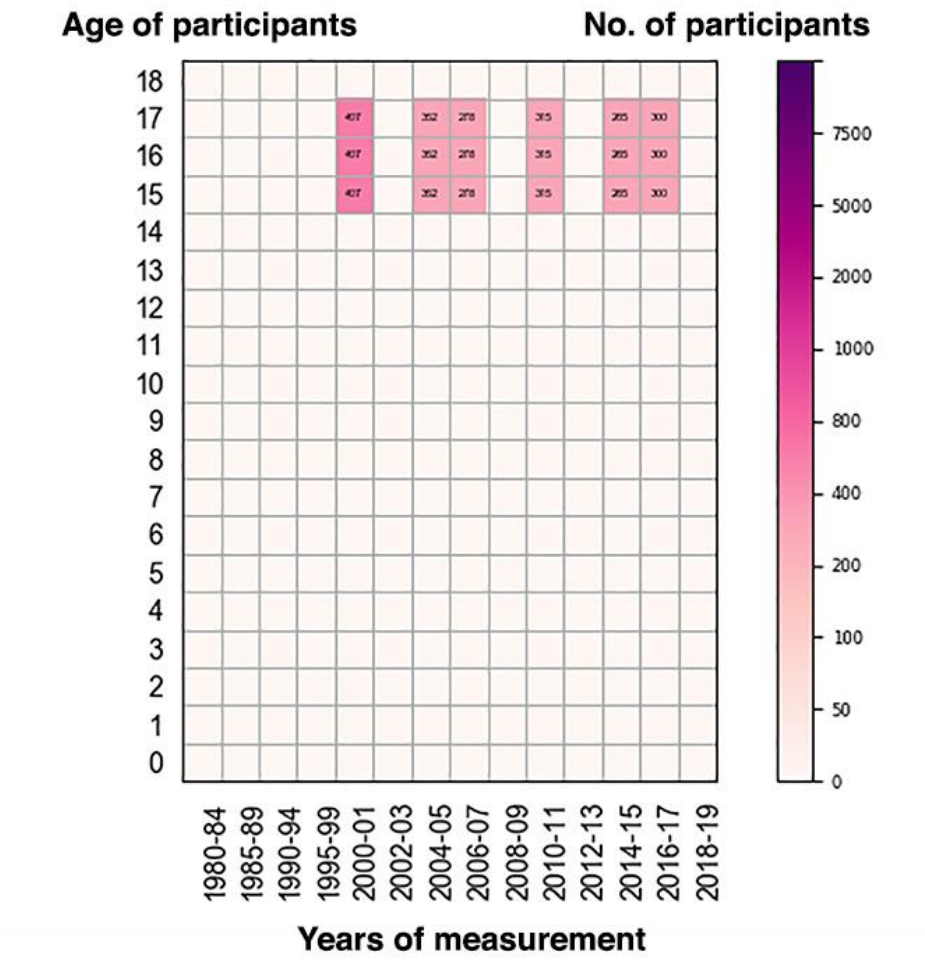


Figure 4.12 Matrix illustrating the number of participants who had their muscle strengthening activities measured using the question recommended for children and adolescents by the Delphi experts.

The first identified use of this question was to measure muscle strengthening activities in the ABS National Health Survey in 2001. Since then, this question has been used nationally on 6 instances (Figure 4.11), collecting data from a total of 5,558 participants aged 15-17 years (Figure 4.12). No psychometrics were located for this question.

Table 4.11 Thematic analysis of expert feedback on questions measuring muscle strengthening activities.

Theme	Frequency	Example of experts' comments
Dimensions of assessment	18	*...little data about how much. Just that they tried one time.*
Time frame	0	
Respondent burden	2	*Simple.*
Rigour	0	
Clarity	9	*Clear easy to understand question.*
Changes suggested	6	*This is just a Yes/No question. If they answer Yes there needs to be a follow-up question asking about the number of days.*
Other	9	*Can't see this being relevant to younger children.*

Thematic analysis was conducted on two questions categorised by the experts as suitable for measuring participation in muscle strengthening activities. Table 4.11 shows the experts' feedback was mainly related to the *dimensions of assessment* (18 comments), concerning the question's inability to capture frequency and duration of participation. Other comments considered the *clarity* of the questions, with some experts noting the questions would be simple to complete, while others regarded the examples as limited and not relevant. A few experts commented that these questions are not relevant to younger or older children.

Changes suggested to improve these questions mainly consisted of the need to include more relevant and age-appropriate examples of muscle-strengthening activities.

4.6.4.4 *Active play*

There were five questions measuring participation in active play, with four considered suitable for children and adolescents, two for pre-schoolers, three questions for toddlers and one question for infants. Table 4.12 outlines the highest-ranked question for infants. The same question was selected for toddlers, pre-schoolers, children and adolescents, however some were rated differently. The highest-ranked question for infants has previously been described in Section 4.6.4.1.

Table 4.12 Highest-ranked questions for measuring participation in active play.

Age range	Question	Rd 1	Rd 2
Infants	Over the last week, about how much time did your baby spend doing the following activities. a. Playing baby games with an adult (e.g. peek-a-boo, pat-a-cake etc) b. Being physically active with you (e.g. helping them roll, kicking their legs, move on a mat, etc) c. Having tummy time (on their stomach while awake)	5.6	5.3
Toddlers	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	6.0	7.7
Pre-schoolers	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	6.0	5.7
Children & adolescents	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	6.0	7.7

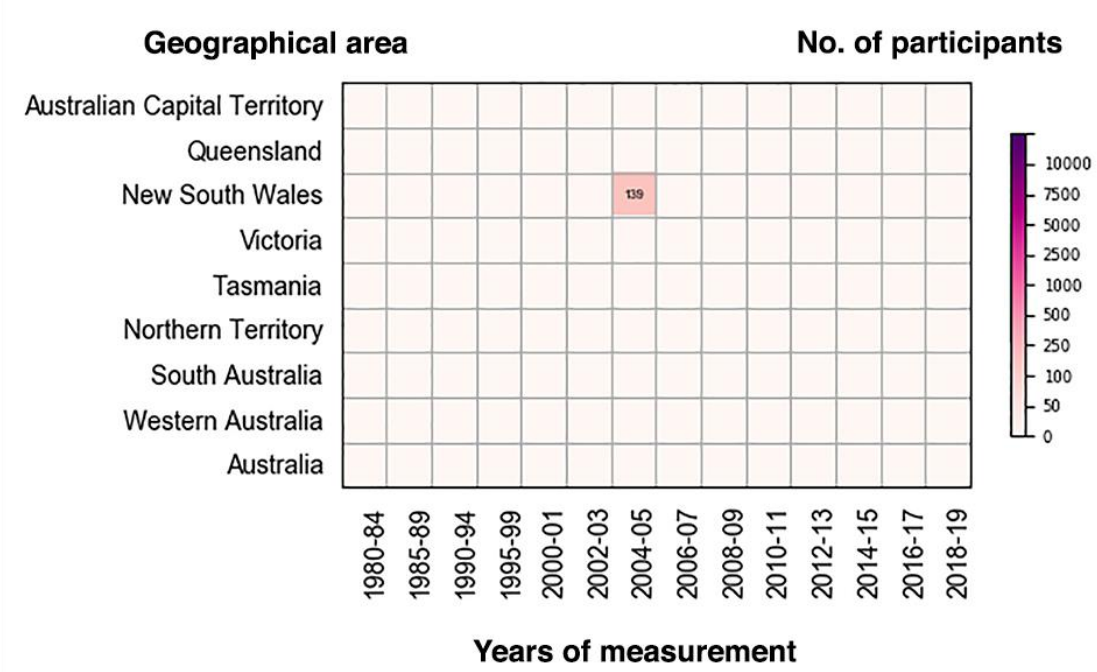


Figure 4.13 Matrix illustrating the number of participants per geographic area who had their active play participation measured using the question recommended for toddlers, pre-schoolers, children and adolescents by the Delphi experts.

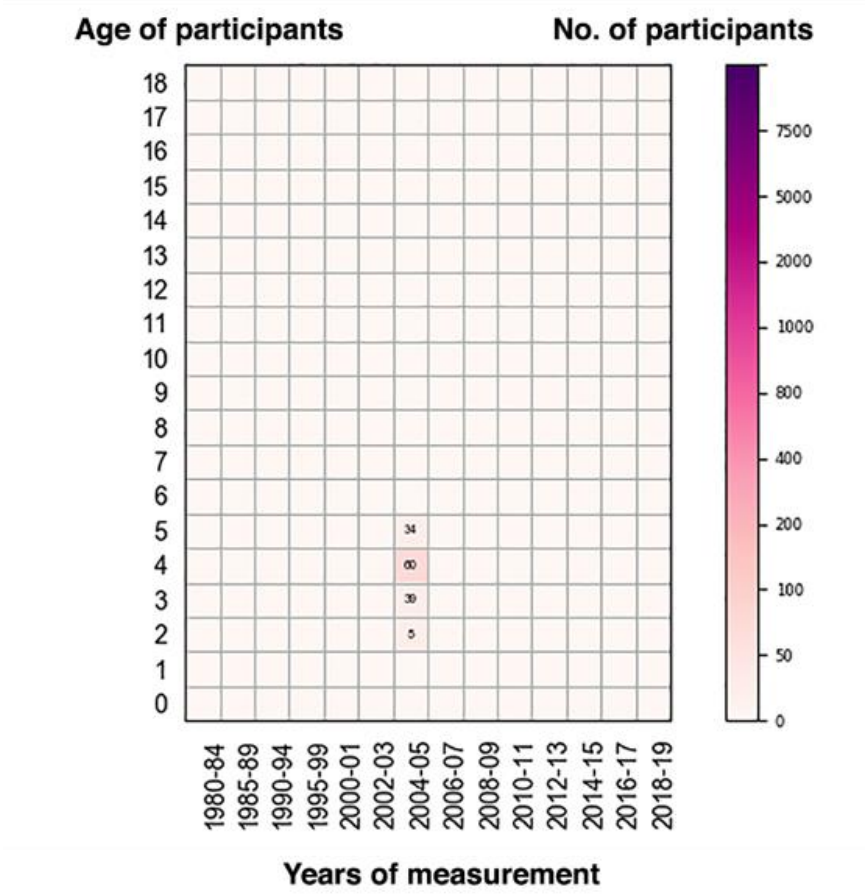


Figure 4.14 Matrix illustrating the number of participants who had their active play participation measured using the question recommended for children and adolescents by the Delphi experts.

The highest-ranked question for toddlers, pre-schoolers, children and adolescents has previously been used to collect data on ages 2–5 years in the Preschool Activity 'N' Dietary Adiposity Study. This study was conducted in NSW in 2004 (Figure 4.13). The question was part of the Physical Activity and Exercise Questionnaire for Children (PAEC-Q) and collected data on 139 participants (Figure 4.14).

Table 4.13 Thematic analysis of expert feedback on questions measuring participation in active play.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	25	*1-hour increments are very crude, and going from zero to 1 hour is a big jump. The responses seem impossible to achieve - who would be active for 10 h/d??.*
Time frame	16	*…asking for the time spent in the activity yesterday can be biased as it could not be a good representation of a child's usual day.*
Respondent burden	9	*I don't think parents can accurately report this amount of time in active play.*
Rigour	3	*Reasonable reliability. Continuous response options may improve accuracy.*
Clarity	4	*Again, giving examples can help parents think about adding up the bouts of time spent doing e.g. playing with friends before school (in school grounds), playgrounds, kicking the footie after school, bike ride, playing with dog in the park etc.*
Changes suggested	14	*Perhaps, changing the question to time spent playing actively in different settings e.g. 'playgrounds; playing actively inside (+some exmples); playing actively outside (+some examples); playing in nature (+ examples); other (for items missed); time spent in care (for the time period of the question to account for data gaps).*
Other	20	*Active play is an underestimated, complex and challenging construct to capture. I feel this required more focus - often absorbed in PA - not easily pulled out and categorised as play.*

As illustrated in Table 4.13, thematic analysis was conducted on five different questions measuring participation in active play. Twenty-five comments were related to the *dimensions of assessment,* with many concerned with the unsuitable response options provided with the questions. Some experts stated the importance of measuring the frequency of active play participation and the duration and intensity.

The need to include broader examples and a better explanation of active play were ways suggested by the experts to improve these questions.

4.6.4.5 *Active transport*

There were three questions recommended for the measurement of participation in active transport for children and adolescents. No questions were considered suitable for pre-schoolers, toddler or infants, given that infants and toddlers would not be able to participate in this type of activity. The highest-ranked question has a

mean rating of 7.7 and was the overall highest-ranked question from the Delphi questionnaire (Table 4.14).

Table 4.14 Highest-ranked question for measuring participation in active transport.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	No questions		
Pre-schoolers	No questions		
Children & adolescents	How does your child travel TO/FROM school in a usual week? (Bus, Car, Cycle, Ferry/boat, Skateboard/scooter, Train, walk) On how many days a week does child use this type of transport to go to school/home from school? How long does this transport take on the way to school/home from school?	7.8	7.7

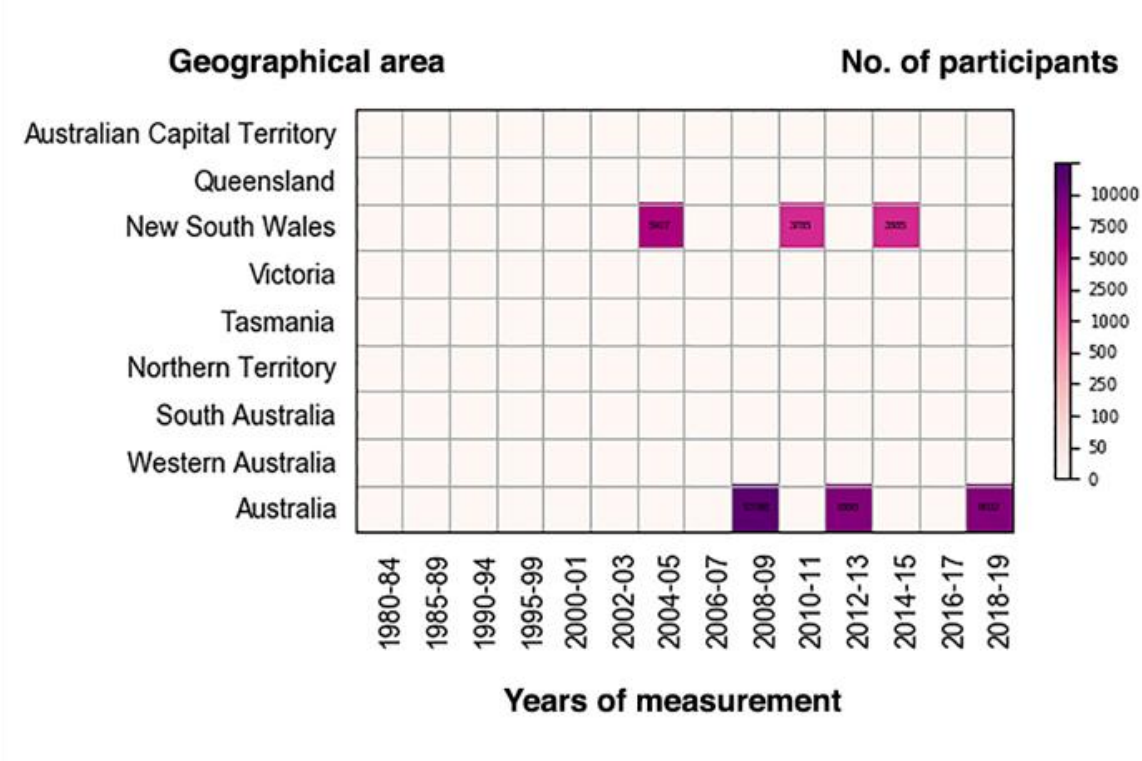


Figure 4.15 Matrix illustrating the number of participants per geographic area who had their active transport participation measured using the question recommended for children and adolescents by the Delphi experts.

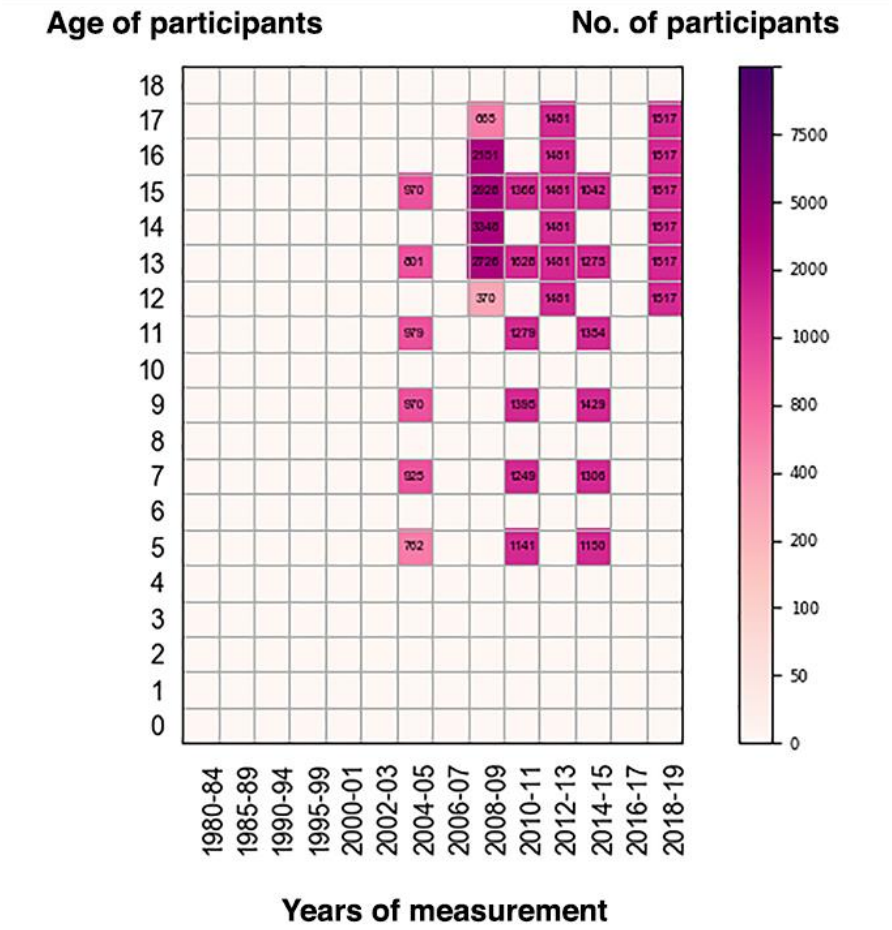


Figure 4.16 Matrix illustrating the number of participants who had their participation in active transport measured using the question recommended for children and adolescents by the Delphi experts.

This question has collected data within national and state-based surveys from a total of 43,255 participants aged 5–17 years (Figure 4.16). The first identified use of this question was in 2004 for the NSW Physical Activity and Nutrition Study (SPANS) and has since been used six times in NSW and nationally (Figure 4.15). Information on the reliability or validity of this question was unable to be found.

Table 4.15 Thematic analysis of expert feedback on questions measuring active transport.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	10	*Problems with those students who take more than one mode of transport to and from school (e.g., walk, then bus to get to school OR walk, train, walk, to get to school).*
Time frame	1	*...it is not anchored to a timeframe (usual week/previous week?).*
Respondent burden	6	*Good, simple and quick question to gather AT.*
Rigour	4	*It would be useful to collect validity and reliability data for this question.*
Clarity	9	*Other active' should use examples relevant to children - e.g. skate, scooter. Likewise 'other inactive' should provide examples.*
Changes suggested	4	*Need to include other modes of transport - scooting and skateboarding.*
Other	8	*...lost marks as only relevant to active transport in the school travel context, not other active transport.*

Participants provided feedback on three questions from this domain, with a quarter of comments regarding the *dimensions of assessment* (10 comments) and a similar amount related to the *clarity* of the questions (9 comments) (Table 4.15). Regarding the *dimensions of assessment,* the experts commented on the question's capability to capture mixed modes of transport and different modes to and from school, along with the measurement of duration or distance. Experts also expressed concern that the questions should include the whole gamut of transportation methods as examples (*clarity* theme).

Four comments were provided to improve the active transport questions. These included the need to change the response options (e.g., include zero days option) and update to ensure they are relevant for pre-schoolers.

4.6.4.6 *Sport*

There were two questions recommended to be used to measure sports participation for children and adolescents. No questions were considered suitable for pre-schoolers, toddlers or infants. The highest-ranked question had a mean rating of 6.1, as illustrated in Table 4.16.

Table 4.16 Highest-ranked questions for measuring participation in sport.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	No questions		
Pre-schoolers	No questions		
Children & adolescents	In the past 12 months, what sort of sports and physical activities have you participated in? Organised competitive team sports, organised competitive individual sports, organised but non-competitive physical activity e.g. aerobics, weight class, circuit training, non-organised physical activity (e.g. playing chasey, going for a swim or brisk walk)	5.9	6.1

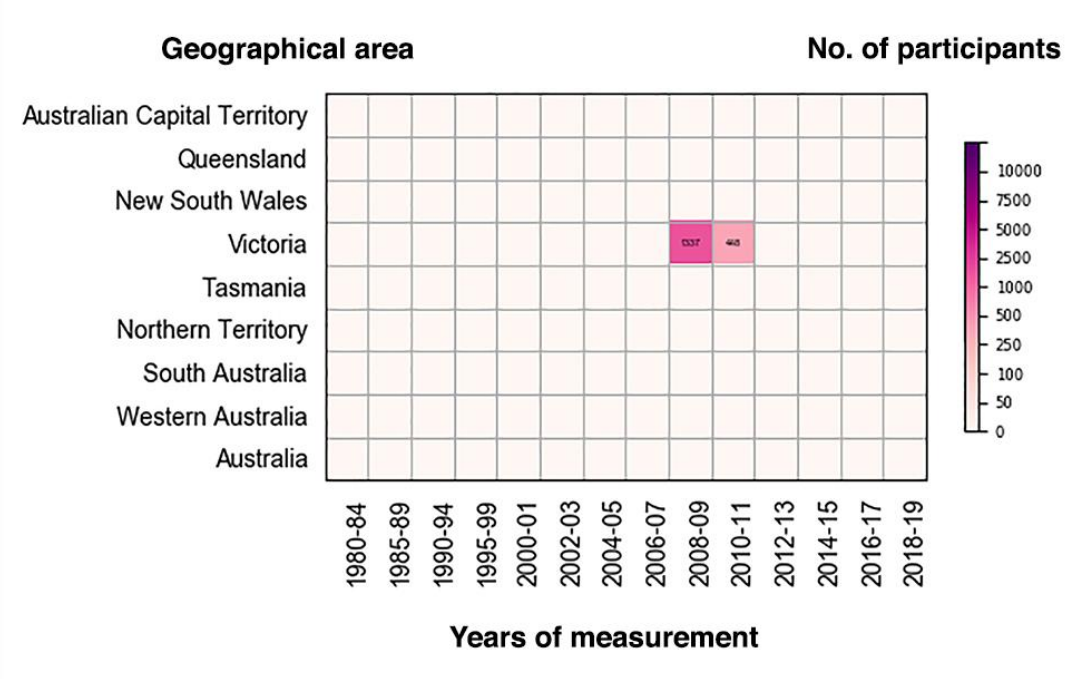


Figure 4.17 Matrix chart illustrating the geographical coverage of the highest-ranked question measuring sport participation.

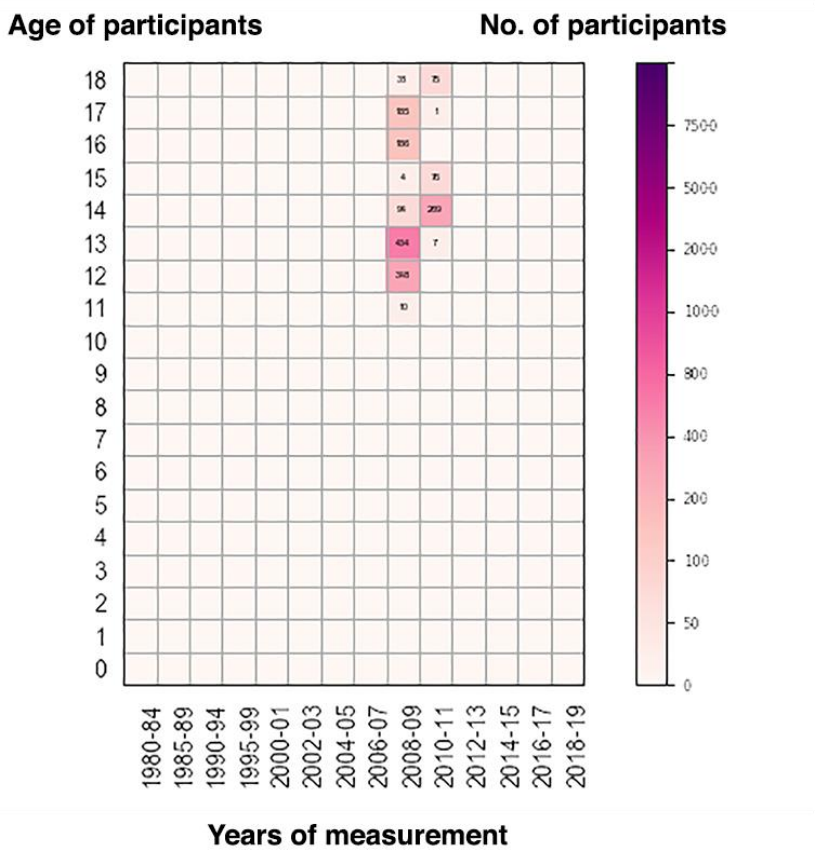


Figure 4.18 Matrix illustrating the number of participants who had their participation in sport measured using the question recommended for children and adolescents by the Delphi experts.

The question was previously included in the Triple G study, measuring sports participation of 900 girls aged 11–17 years from VIC (Figure 4.17 and Figure 4.18). No information on the reliability or validity of this question was found.

Table 4.17 Thematic analysis of expert feedback on questions measuring participation in sport.

Theme	Frequency	Examples of experts' comment
Dimensions of assessment	14	*Ok for frequency of sport participation over a season/year. Needs a duration component.*
Time frame	4	*12 months too long for recall.*
Respondent burden	12	*The instructions are complex - relatively high literacy levels required.*
Rigour	0	
Clarity	2	*The language is too specialised to the public health field. Surveys of children need to use language children use - e.g. 'unorganised physical activity' doesn't need to be in the question. Researchers can group data according to these categories, but should ask questions in the way kids think about PA e.g. play, travel, exercise, sport, active hobbies e.g. bush walking or dance (kids won't always think of dance as exercise, it's just dancing for fun or dancing for a hobby). The bigger actIvities that don't fit easily into a category e.g. bike riding or skating, should be listed in the question to prompt participants.*
Changes suggested	5	*..a digital version with options to click would be easier to navigate.*
Other	9	*It can differentiate between active and non-active children and adolescents.*

Experts provided feedback on two questions about sports participation, as seen in Table 4.17. The experts provided 14 comments on the *dimensions of assessment*, highlighting the importance of including frequency and duration in these questions. Experts were also concerned about the cognitive load required to respond to these questions, particularly as they are asked over a 12-month time frame to account for seasonal variations in sports played (*respondent burden* theme).

Delphi experts suggested some possible changes to the questions, including reducing the timeframe and lessening the respondent burden by administering online versions of these questions.

4.6.4.7 *Physical education*

Delphi experts rated two questions as suitable for measuring PE participation for children and adolescents. There were no questions allocated to pre-schoolers, toddlers and infants, given that they do not attend PE. The highest-ranked question had a mean rating of 5.4, as seen in Table 4.18.

Table 4.18 Highest-ranked questions for measuring participation in physical education.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	No questions		
Pre-schoolers	No questions		
Children & adolescents	How many physical education periods do you usually attend at school each week? During physical education periods, how much time do you spend exercising that makes you out of breath or sweat?	5.9	5.4

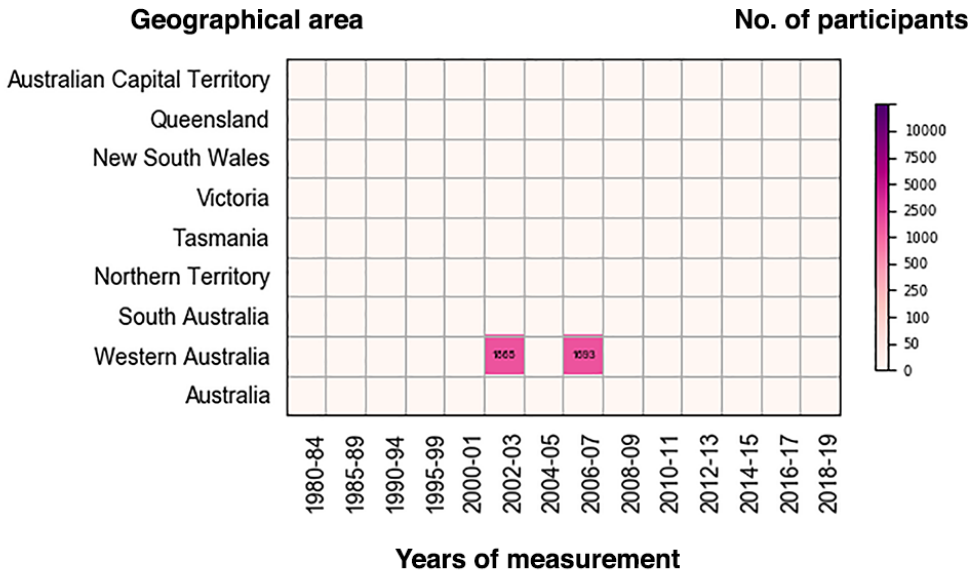


Figure 4.19 Matrix chart illustrating the geographical spread of the highest-ranked question measuring physical education participation for children and adolescents.

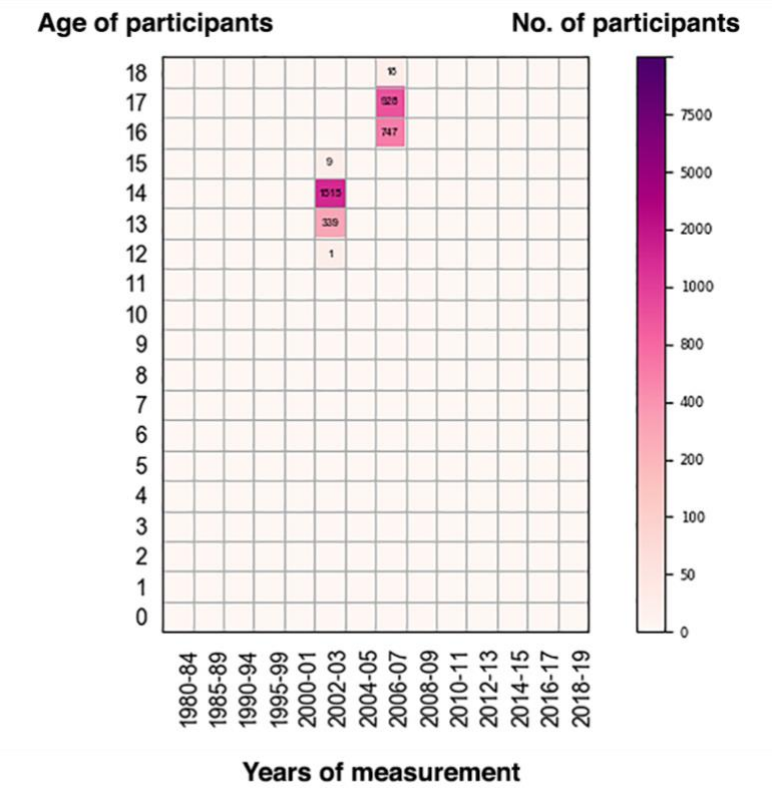


Figure 4.20 Matrix illustrating the number of participants who had their participation in physical education measured using the question recommended for children and adolescents by the Delphi experts.

This question was included in the Western Australian Pregnancy Cohort Study (RAINE), and measured PE participation of 13– to 14–year–olds and 16– to 17–year–olds in 2003 and 2006, respectively (Figure 4.20). A total of 3,558 participants from WA have previously completed this question (Figure 4.20). No psychometrics were located for this question.

Table 4.19 Thematic analysis of expert feedback on questions measuring participation in physical education.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	16	*The first part of the question will measure number of days but it would be useful to also know the length of the lesson and to have additional descriptors for the question about how active they are (in addition to exercise and sports).*
Time frame	4	*Suitable for the primary setting where there is a one-week schedule - would need to be altered for secondary schools in each state / territory in Australia where sport and PE and different subjects on alternate week schedules.*
Respondent burden	18	*If you want to know how many children attend PE or how frequent PE classes are, this could be gathered from the school. Asking a child how active they are during PE is going to be a difficult question to answer, and is likely to vary alot from week to week.*
Rigour	2	*Since there is no reliability/validity information, I actually think students can't recall this information.*
Clarity	15	*The terms "exercising or playing sports" may be confusing as much of a PE lesson may be in skill development or practice.*
Changes suggested	8	*...would substitute exercising with moving..*
Other	10	*Objective measures would be more reliable.*

Experts provided feedback on two questions, with two main themes identified from the comments (Table 4.19). Regarding the *respondent burden* of these questions, experts were concerned about how accurately either a child or parent would report participation in PE, particularly the duration and intensity. Some experts also identified other complexities of using self- or parent-report due to differences in how PE is scheduled across different schools and states/territories. Similar comments were provided focusing on the *dimensions of the assessment*, including the capability of the question to capture the frequency, duration and intensity of participation.

A suggestion offered to improve how physical activity participation during PE could be measured is to administer proxy-report questions to the PE teachers.

4.6.4.8 *Exercise*

The Delphi experts rated two questions as able to measure exercise participation of children and adolescents. There were no questions rated as able to measure exercise for pre-schoolers, toddlers and infants. The highest-ranked question has

a mean of 5.4 (Table 4.20).

Table 4.20 Highest-ranked questions measuring participation in exercise.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	No questions		
Pre-schoolers	No questions		
Children & adolescents	Outside school hours: How often do you usually exercise so much that you get out of breath or sweat? Outside school hours: How many hours a week do you usually exercise so much that you get out of breath or sweat?	5.8	5.4

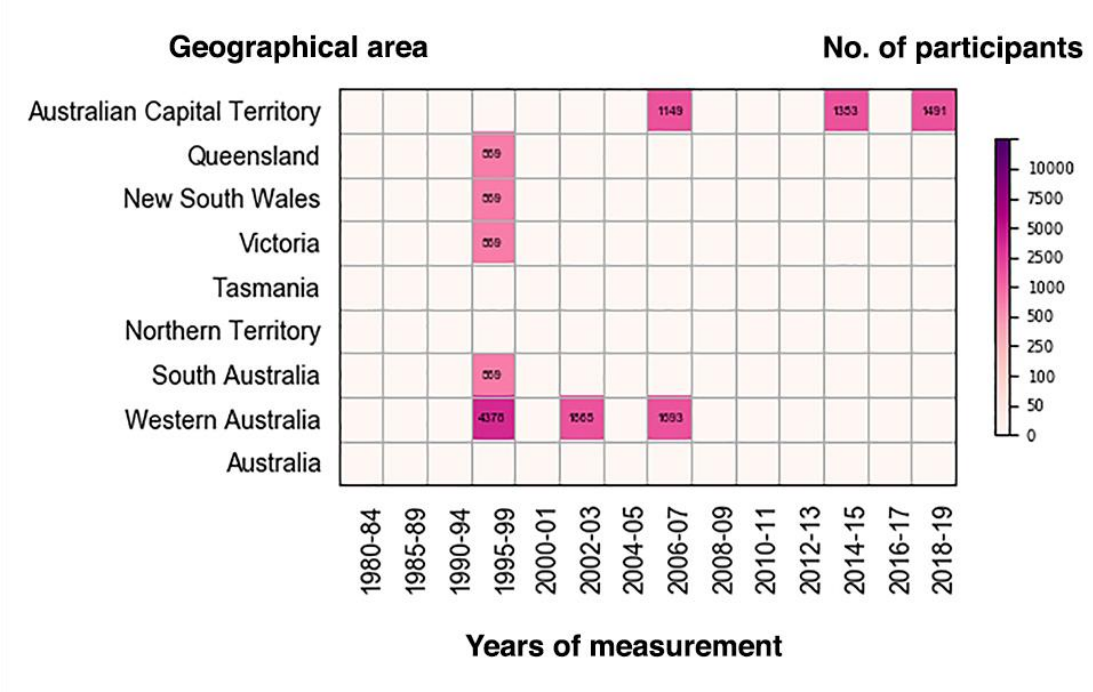


Figure 4.21 Matrix chart illustrating the geographical spread of the highest-ranked question measuring exercise participation for children and adolescents.

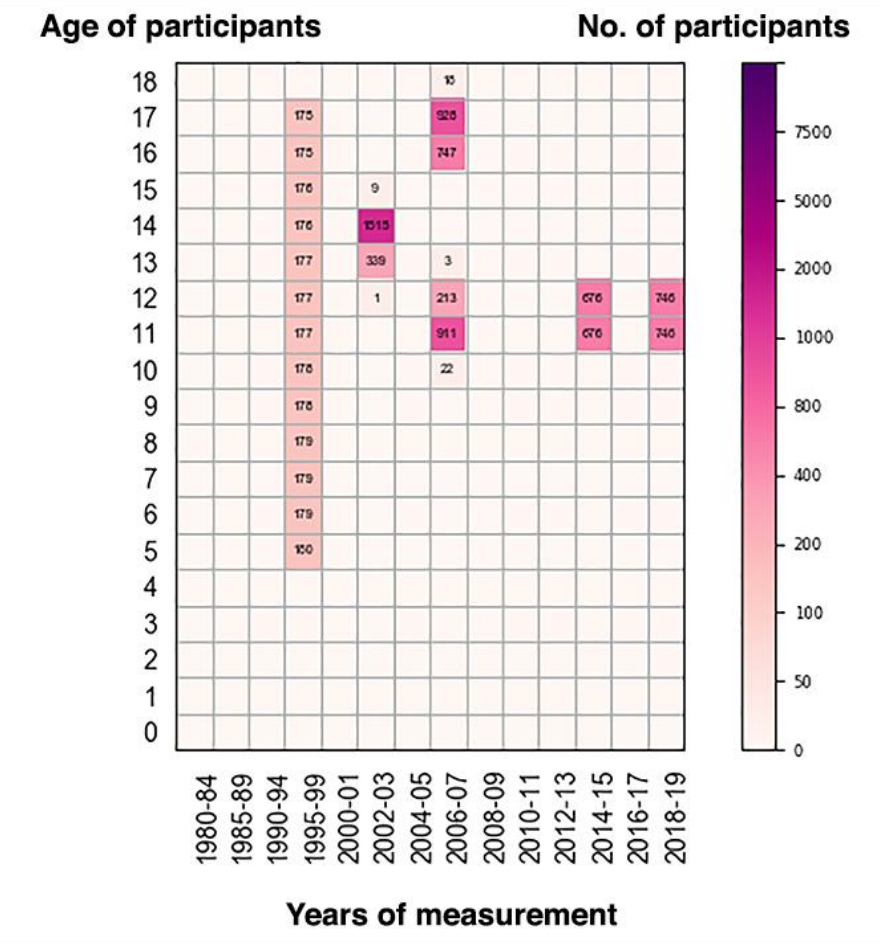


Figure 4.22 Matrix illustrating the number of participants who had their participation in exercise measured using the question recommended for children and adolescents by the Delphi experts.

This question has collected data from a total of 9,827 participants from six different states and territories (Figure 4.21). First used in 1997 in the Life Activity Project, which measured exercise participation across four states and included 2,276 participants aged 5– to 17 (Figure 4.22). It has been used a total of six times. Information on the reliability or validity of this question was not available.

Table 4.21 Thematic analysis of expert feedback on questions measuring participation in physical education.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	3	*I feel mixing the response with week and months could be affected by recall…*
Time frame	0	
Respondent burden	3	*…the question on time requires some Maths, which can be difficult for some children.*
Rigour	0	
Clarity	3	*Nice picture. Allows characterisation of MVPA.*
Changes suggested	0	
Other	6	*Don't recommend the use of term 'exercise' for PA monitoring - especially with children.*

The Delphi experts provided feedback on two questions that they selected to measure participation in exercise. As illustrated in Table 4.21, most feedback was on the *other* theme. The remainder of the feedback was evenly distributed between the following themes: *dimensions of assessment*, *respondent burden*, and *clarity*. Some experts commented about the inconsistent response options (*dimensions of assessment* theme), and some comments were concerning the difficulty respondents may have in understanding and conceptualising the recall of exercise-related activities. Few experts also expressed concern around the question instructions and lack of appropriate examples (*clarity* theme).

Despite the concerns about measuring exercise participation, the Delphi experts did not suggest any changes to these questions.

4.6.4.9 *Overall sedentary behaviour*

The questions measuring the amount of participation in overall sedentary behaviour consisted of three questions. There were no questions rated as able to measure overall sedentary behaviours for pre-schoolers. The highest-ranked question for children and adolescents had a mean of 5.9 and the question for infants and toddlers had a mean of 5.3, as seen in Table 4.22.

Table 4.22 Highest-ranked questions measuring participation in overall sedentary behaviour.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	Over the last week, about how much time did your baby spend doing the following activities. (Q4) e. In a stroller or pram f. In a car seat or capsule g. In a cot or bed during the day h. In a high chair or other chair n. Watching or in front of the television	6.1	5.3
Pre-schoolers	No questions		
Children & adolescents	Did you do any of the following sitting down activities over the past 7 days? Watch TV; Watch videos/dvds; Play or watch handheld electronic games/movies etc; Use a computer for fun; Study, homework or extra tutoring; Read for fun; Chat on the phone; Hang out at home, park or shopping centre; Do hobbies/crafts; Music lessons/practice; Travel in a car, train, bus or boat/ferry; Go to church or Saturday school.	6.4	5.9

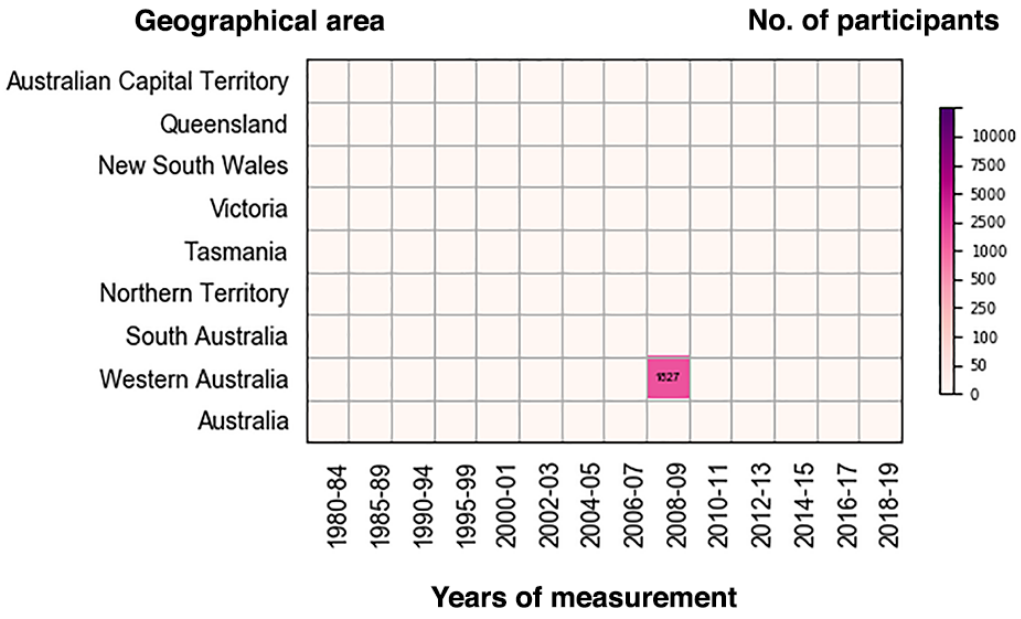


Figure 4.23 Matrix chart illustrating the geographical spread of the highest-ranked question measuring participation in overall sedentary behaviour.

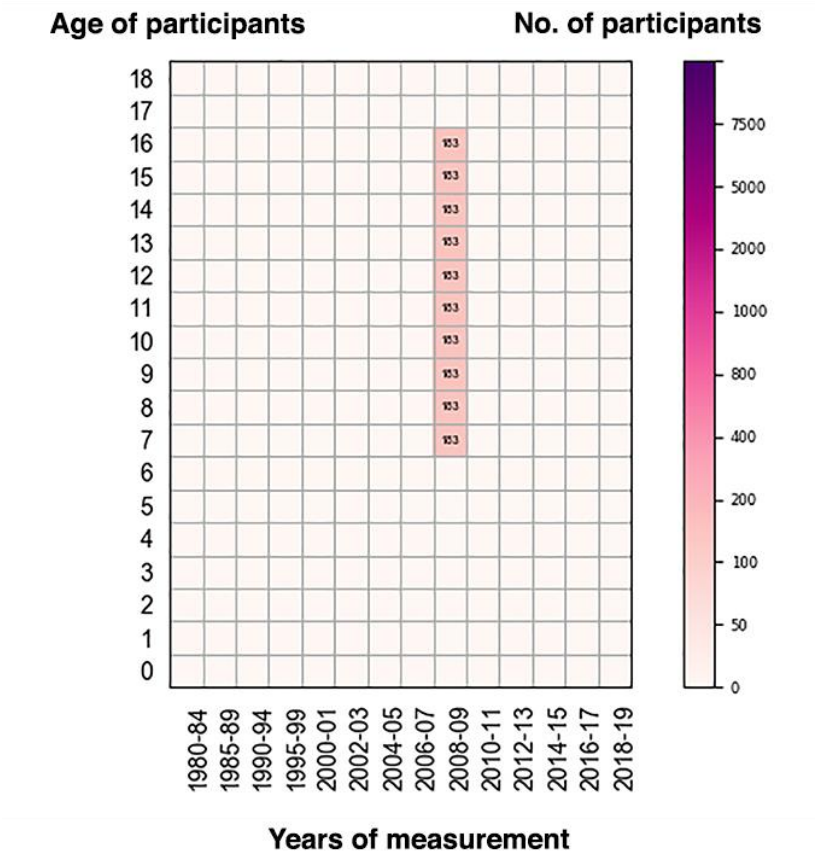


Figure 4.24 Matrix illustrating the number of participants who had their participation in overall sedentary behaviour measured using the question recommended for children and adolescents by the Delphi experts.

The highest-ranked question for infants and toddlers has previously been outlined in Section 4.6.4.1. The highest-ranked question recommended to measure participation in overall sedentary behaviour for children and adolescents has been slightly modified from the question from The Adolescent Sedentary Activity Questionnaire (ASAQ). Due to the slight modification, only the measurement instances which have used this exact question have been included in the matrix charts (Figure 4.23 and Figure 4.24). This question appears to have initially been altered for the second data collection wave of the Western Australian Child and Adolescent Physical Activity and Nutrition Survey (CAPANS) conducted in 2008.

Table 4.23 Thematic analysis of expert feedback on questions measuring participation in overall sedentary behaviour.

Theme	Frequency	Example of experts' comments
Dimensions of assessment	6	*...likely to get confusion / double reporting with hrs and mins - eg if get 1 hr 60 mins is that total 1 or2 hours?!*
Time frame	9	*Children's days are variable (sport etc occurring on different days, Saturdays can be different to Sundays etc) so asking an average for week and weekend days will be difficult to respond (which probably reflects the validity coefficient).*
Respondent burden	16	*Quite tricky question to add it all up and then find an average or "usual" response.*
Rigour	4	*Reliability is reasonable.*
Clarity	3	*...it might seem obvious, but providing broad examples of sitting time might help individuals recollect the response.*
Changes suggested	8	*This question needs to be updated to include modern technology use e.g. mobile phones.*
Other	5	*Doesn't include domains of sitting - I feel this is important to inform intervention strategies.*

Experts provided feedback on three questions that were selected to measure overall sedentary behaviour (Table 4.23). Most feedback concerned the *respondent burden*, with experts commenting on the high respondent burden of answering some of the overall sedentary behaviour questions. Regarding the highest-ranked question, some experts expressed concern over the amount of information and the potential complexity of completing it. The other central theme was *time frame*, in which nine comments were of this nature. The alternative two questions have a 7-day time frame for recall, for which some experts believe is too long to recall what activities are participated in accurately.

The *changes suggested* by the experts concerned the need to update the examples in the questions. Also, changing the time frame to an average day was also suggested.

4.6.4.10 *Screen time*

A total of eight questions were rated for use to measure participation in screen time activities. The highest-ranked questions ranged from 5.3 for the question most suitable for toddlers to 7.2 for the question most suitable for children and adolescents (Table 4.24). No questions were found to be suitable to measure participation of infants.

Table 4.24 Highest-ranked questions measuring participation in screen time.

Age range	Question	Rd 1	Rd 2
Infants	No questions		
Toddlers	How many hours per week does (child) spend watching TV or DVDs, or using the computer, iPad or tablet device (for the internet, to play games etc)?	6.7	5.3
Pre-schoolers	How many hours per week does (child) spend watching TV or DVDs, or using the computer, iPad or tablet device (for the internet, to play games etc)?	6.7	6.4
Children & adolescents	For each of the past 7 days, mark how many hours (outside of school) did you spent sitting or lying down looking at a screen. Think about the time you spent watching TV and movies, playing video games, video chatting, text messaging, or surfing internet sites like Twitter or YouTube, for example.	7.1	7.2

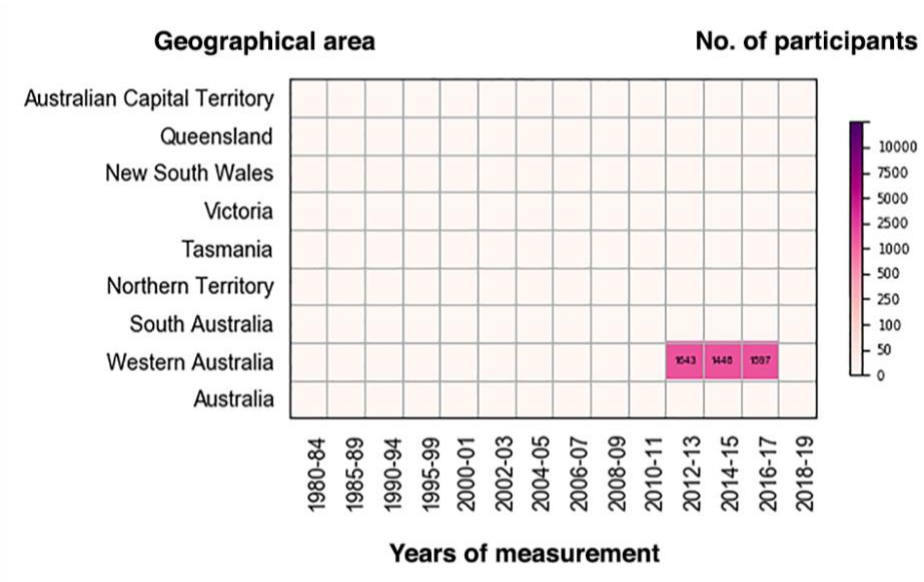


Figure 4.25 Matrix chart illustrating the geographical spread of the highest-ranked question measuring participation in screen time recommended for toddlers and pre-schoolers.

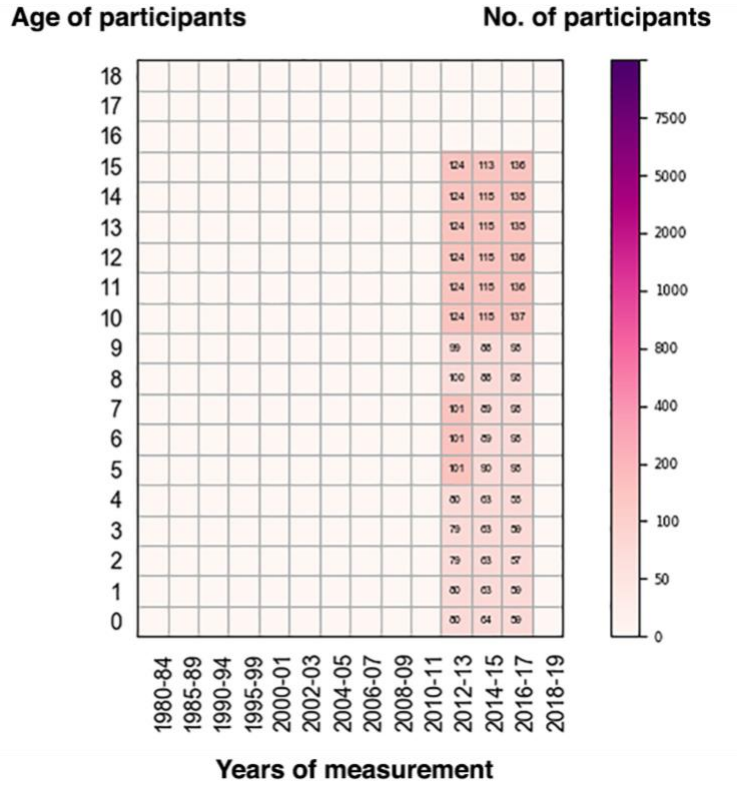


Figure 4.26 Matrix illustrating the number of participants who had their participation in screen time measured using the question recommended for toddlers and pre-schoolers by the Delphi experts.

The highest-ranked question for toddlers and pre-schoolers, has previously been used to collect data for the Western Australian Health and Wellbeing Surveillance System (WA HWSS) from a total of 4,688 participants aged 0–15 years (Figure 4.26). This question was first identified to be used in 2012 and included in each annual WA HWSS since (Figure 4.25). The survey in which this question appears has an ICC of 0.6 to 0.8.

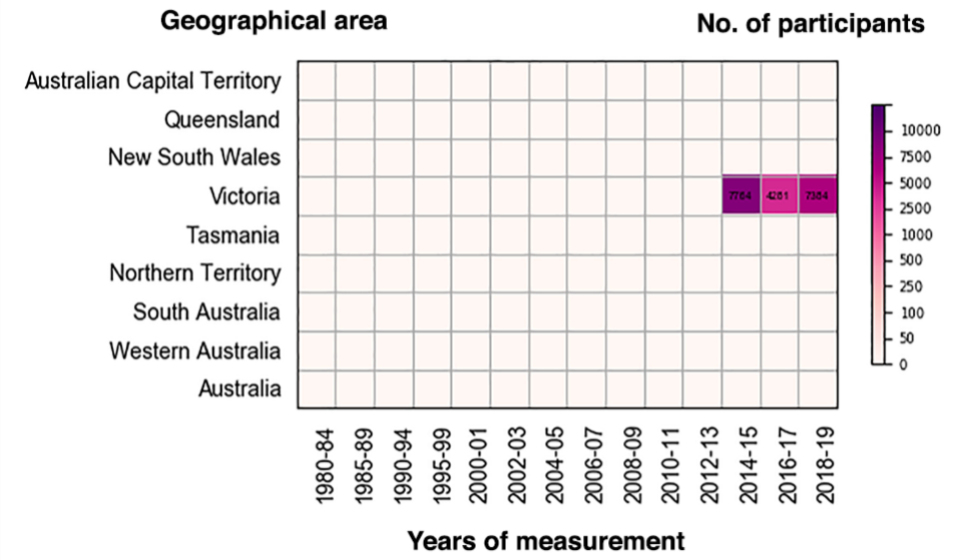


Figure 4.27 Matrix chart illustrating the geographical spread of the highest-ranked question measuring participation in screen time recommended for children and adolescents.

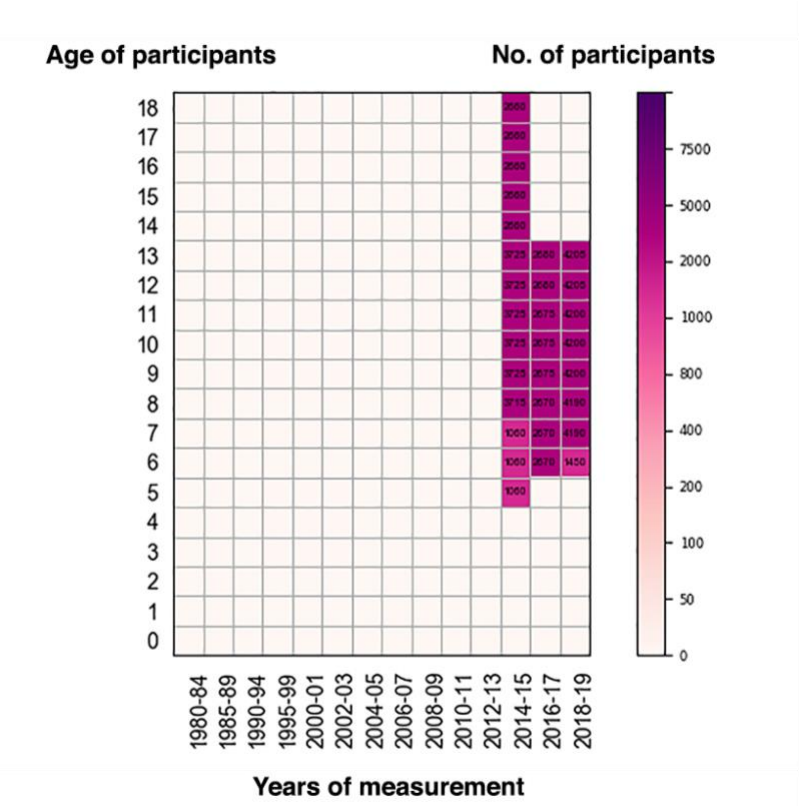


Figure 4.28 Matrix illustrating the number of participants who had their participation in screen time measured using the question recommended for children and adolescents by the Delphi experts.

The highest-ranked question recommended for children and adolescents has previously been used to collect data for the 2014 Healthy Together Children's Evaluation from a total of 5,851 participants aged 8–18 years (Figure 4.27 and Figure 4.28). The reliability of the survey in which this question appears is 75.4% to 94.3% percentage agreement.

Table 4.25 Thematic analysis of expert feedback on questions measuring participation in screen time.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	51	*Doesn't distinguish between recreational and educational screen time.*
Time frame	8	*…would prefer to see delineation between weekdays and weekend.*
Respondent burden	21	*Too challenging to recall entire week.*
Rigour	3	*Reasonable reliability.*
Clarity	20	*…phrasing is a touch confusing*
Changes suggested	43	*Would need updating with current technologies and trends beyond listed here.*
Other	26	*Could be used as an indicator across a broader range of age groups.*

Participants provided comments on eight questions which had been assigned to be able to measure participation in the behaviour of screen time. Due to the number of questions, this behaviour received the highest number of comments, most concerning the *dimensions of assessment* (51 comments) and *suggested changes* (43 comments), as seen in Table 4.25. The *dimensions of the assessment* theme included comments about the importance of the questions being able to capture the nature of the screen time and differentiate between educational and recreational screen time.

Regarding the suggested changes, most comments included the need to update these questions in line with current and on trend screen activities, for example, including social media use such as TikTok, Instagram, etc.

4.6.4.11 *Non-screen sedentary time*

Two questions were rated as suitable to measure participation in non-screen sedentary time activities. The highest-ranked questions ranged from 5.5 for the question rated most suitable for children and adolescents to 5.6 for the question most suitable for infants and toddlers (Table 4.26). No questions were found to be suitable to measure participation of pre-schoolers. Both questions have previously been described in Section 4.6.4.1 and 4.6.4.9.

Table 4.26 Highest-ranked questions measuring participation in non-screen sedentary time.

Age range	Question	Rd 1	Rd 2
Infants & toddlers	Over the last week, about how much time did your baby spend doing the following activities. e. In a stroller or pram f. In a car seat or capsule g. In a cot or bed during the day h. In a high chair or other chair	5.7	5.6
Pre-schoolers	No questions		
Children & adolescents	Did you do any of the following sitting down activities over the past 7 days? Watch TV; Watch videos/dvds; Play or watch handheld electronic games/movies etc; Use a computer for fun; Study, homework or extra tutoring; Read for fun; Chat on the phone; Hang out at home, park or shopping centre; Do hobbies/crafts; Music lessons/practice; Travel in a car, train, bus or boat/ferry; Go to church or Saturday school.	6.8	5.5

Table 4.27 Thematic analysis of expert feedback on questions measuring participation in non-screen sedentary time.

Theme	Frequency	Example of experts' comment
Dimensions of assessment	4	*…has no estimate of duration.*
Time frame	25	*Suspect not many add responses up to 10,080 minutes.*
Respondent burden	11	*It could be difficult for parents to answer for the whole week - will have to retrospectively add up times across the last 7 days or multiply what they think was an average day by 7.*
Rigour	11	*As an academic, I would question the reliability of recall from mothers*
Clarity	7	*Lack of clarity across the items. For example, infant could be on the floor sitting or lying (i.e. sedentary) or moving about.*
Changes suggested	32	*…breaking down SB types into separate questions would be more clear and easier to answer.*
Other	11	*…physiology doesn't change much with purpose - cognitive/emotional may well do good to be focussed on sitting and NOT one sitting behaviour (screens).*

Participants provided feedback on the two selected questions for their suitability for measuring non-screen sedentary time. As seen in Table 4.27, the most feedback was provided concerning the *changes suggested* and the *time frame*. The experts were concerned about the recall time frame of 7 days for both questions.

Suggested changes included restructuring the questions to measure non-screen sedentary time more directly and ensuring all non-screen options are included.

4.6.5 Presentation of recommended survey questions

The highest-ranked questions measuring children's and adolescents' participation in domains of physical activity and sedentary behaviours were presented within two figures. One figure was created for physical activities (Figure 4.29) and one for sedentary behaviours (Figure 4.30), with the key recommended question in the centre of the circle and the other domains in the outer section. If one question is to be used to measure compliance with the physical activity guidelines, then the central question in Figure 4.29 is recommended, with the outer questions selected depending on the measurement focus of the research. Likewise, with Figure 4.30, the central question is preferred to measure compliance to the screen guidelines.

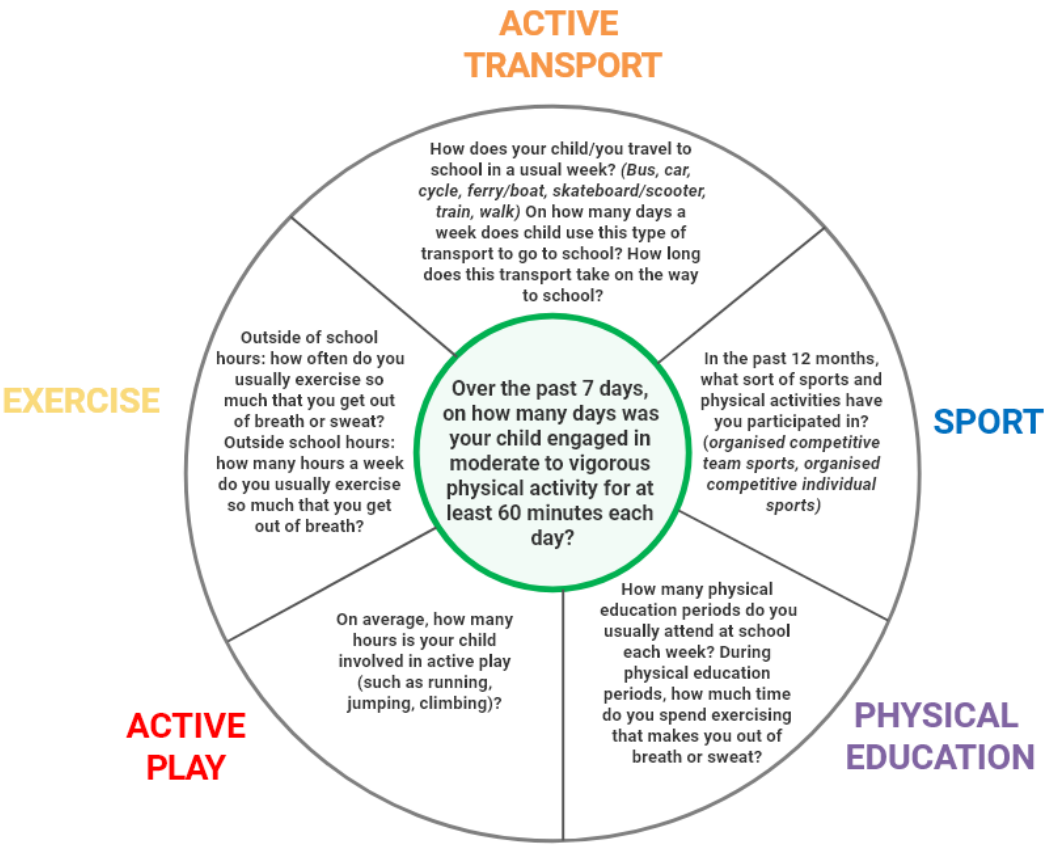


Figure 4.29 Presentation of recommended questions to measure compliance to guidelines (centre question) and other domains of physical activity for children and adolescents.

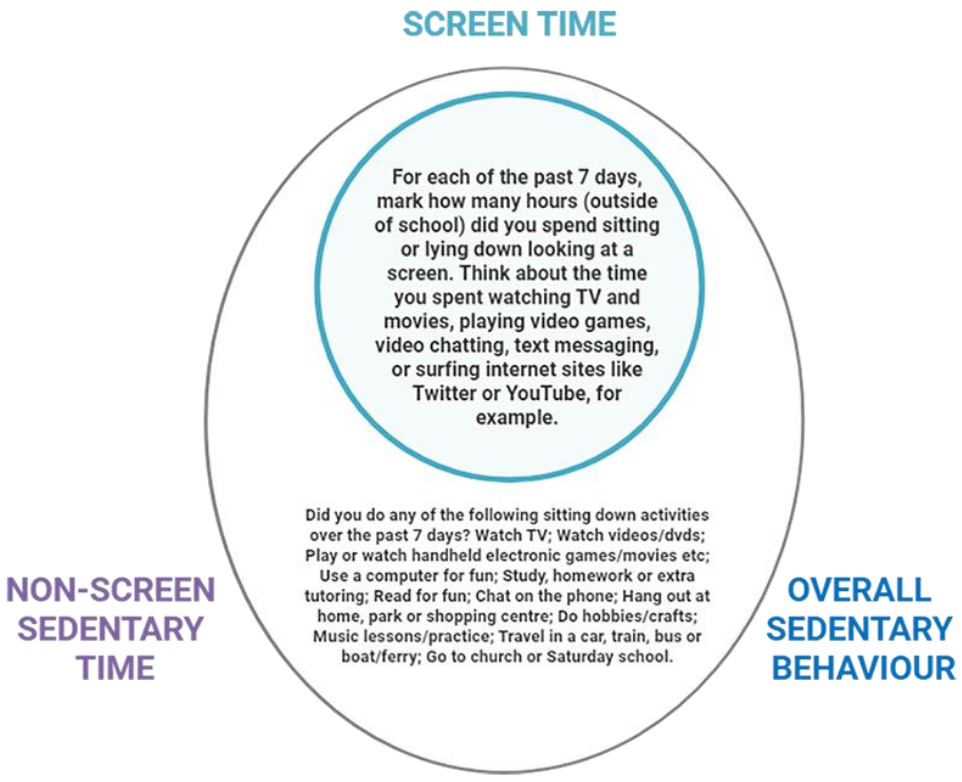


Figure 4.30 Presentation of recommended questions to measure compliance to screen guideline (centre question) and other sedentary behaviours for children and adolescents.

4.7 Main findings

This study aimed to create a set of recommended questions to measure children's and adolescents' participation in physical activity and sedentary behaviours. Twenty-nine experts provided feedback on a selection of 31 questions to identify a set of recommended questions measuring participation in physical activity and sedentary behaviours. A rating was provided for each question, along with written feedback, which indicated some disagreement in how experts believe the domains should be measured. The experts commented on different aspects of the survey questions, identifying areas of concern, including the dimensions measured (intensity, duration, frequency), the clarity of the question (instructions, explanations) and the recall timeframe.

Two central questions were identified to measure compliance with guidelines: one question measuring moderate-to-vigorous physical activity and one measuring recreational screen time. The central physical activity question recommended by the experts (mean rating 7.2) has already cumulated data from approximately 83,000 school-aged children over the last two decades. The recommended screen time question (mean rating 7.2) has accumulated fewer data, used only in Australia since 2014. Alternative questions were recommended to measure physical activity participation and screen time of younger children, however, neither question was rated highly (mean rating 5.3–6.4). The Australian guidelines also stipulate the importance of participation in muscle strengthening activities, for which one question has been recommended (mean rating 6.1), however this question has only previously collected data on 15– to 17– year-olds. Despite this, the Delphi experts suggested this question could be updated to reflect more realistic muscle strengthening activities of all ages.

Besides capturing compliance to guidelines, measuring participation in each domain is also valuable. One highest-ranked question measuring participation in each domain was also identified, including active play, active transport, sport, PE, exercise, overall sedentary behaviour and non-screen sedentary behaviour. Active play consisted of one recommended question measuring infants' participation (mean rating 5.3) and a different question to measure toddlers, pre-schoolers, children and adolescents (mean rating 5.7–7.7).

The highest-ranked question measuring participation in active transport for children and adolescents was assigned a mean rating of 7.7. The Delphi experts seemed reasonably satisfied with this question, suggesting minor detail could be measured regarding duration or distance travelled. In contrast, the questions included in the Delphi questionnaire measuring sport participation received a lower rating of 6.1. The Delphi experts provided varied comments concerning the long 12-month time frame, the high respondent burden, and the need for more child-friendly language.

Less confidence was evident for the questions assigned to measure the participation in two domains, PE and exercise, both receiving a mean rating of 5.4. Some disparity was evident on the ideal survey question for these domains, with particular concern on the suitability of using the term *exercise* with children.

The same question was recommended to measure children's and adolescents' overall sedentary behaviour and non-screen sedentary behaviour. A different question was recommended to measure infants' and toddlers' participation in both domains. Both questions were not rated highly (mean ratings 5.5–5.9), and the experts' comments reflected this, with one expert stating the question measuring infants' and toddlers' participation was *not suitable for population surveillance*.

4.7.1 Implications

A lack of consensus concerning which questions should be used to measure physical activity and sedentary behaviours was evident throughout the Delphi process. Experts provided diverse ratings and feedback on the existing questions and their suitability to measure participation in different physical activity and sedentary behaviour domains. This disparity has undoubtedly contributed to the vast number of previously used questions, limiting the amount of data available to analyse trends and estimate prevalence rates.

Recommending central questions that could be used to monitor compliance to guidelines and measure participation in other domains of physical activity and sedentary behaviours would lead to more consistent measurement and an

increase in comparable data. Some research may have different measurement needs for which the recommended questions are not suitable. However, if these were adopted as part of national surveillance and other state-based surveys, this would result in data encompassing more age groups, geographic locations, and other subpopulations, from which interventions can be designed and evaluated and policies created.

Issues and complexities were apparent for each domain, resulting in different implications and limitations to employing a consistent measurement approach. The following few sections outline the issues and measurement implications for each domain.

4.7.1.1 *Overall physical activity*

Measuring physical activity participation is crucial to estimate compliance with guidelines, however using inconsistent measurement approaches across Australia can lead to uncertainly regarding true population in prevalence estimates. As previously discussed, variance in prevalence estimates can stem from differences in how a domain is defined and measured. The expert ratings and feedback provided on the measurement of overall physical activity, illustrated that experts defined overall physical activity differently. Despite the guidelines recommending participation in physical activity across a spectrum of intensities (light, moderate-to-vigorous and vigorous), the question the experts recommended to measure overall physical activity captured only moderate-to-vigorous physical activity. One Delphi participant explained their interpretation of this domain, stating, *I find the term 'overall pa' challenging here …For example, for the report cards we define overall pa for 5-17 yr as 'Children and young people (5 to 17 years), accumulate 60 minutes or more of moderate to vigorous physical activity every day and engage in activities that strengthen muscle and bone on at least 3 days per week'*. When provided with the overall question ratings in round 2, two other experts commented on the different interpretations, stating they were *unsure how it can be considered as a measure of overall PA, given it only assesses MVPA and not light PA*, and another commented, *the Delphi asks about measurement of "overall physical activity" which is not captured by Q15 which refers to MVPA only. It looks like the experts preferred questions which measured*

MVPA as this lines up with guidelines. Is this what is important to the Delphi, or is it measurement of overall physical activity?" Inconsistencies in the definition used could result in physical activity participation measured at different intensities, hence limitations around the comparability of data.

The one central question most recommended by the experts to measure overall physical activity was initially created by Prochaska and colleagues in 2001.[173] This question has been used 35 times across 12 different datasets, therefore it has been used in 8% of datasets collected since 2001. The experts recommended this question for use with children and adolescents however, no questions were rated suitable for pre-schoolers. Coincidently, this question has not previously been used to measure participation of younger children (<5 years old). A lack of research on the physical activity participation of younger children is limited by a lack of relevant questions for this age range. Globally, physical activity and sedentary behaviour guidelines for 0– to 5–year–olds were first developed in 2010 in Australia.[18] In comparison, the first official guidelines for 5– to 17–year–olds were developed in 1994 in the US.[15, 16] This has provided more time and opportunity to create appropriate survey questions. When Delphi experts were asked to suggest a possible question for pre-schoolers, one Delphi expert commented *obviously it is up to parents to decide*, and another offered *could be same as for school aged children*. Since most of the existing research has been collected on school-aged participants, possibly most of the Delphi experts also only have expertise with this age group.

Pre-schoolers and younger children in childcare would be very difficult to accurately self-report weekday activity levels. These settings are less structed compared to school settings, and result in much variance to activity level of children within the same setting. It would be impossible for parents to report, and due to the teacher to student ratio, it would be challenging for a proxy-report by a teacher. The most accurate method would be through objective measurement using an accelerometer.

4.7.1.2 *Active play*

A systematic review investigating a possible definition of active play also discussed the nature of this domain to be complex and challenging to define.[29]

Since the primary purpose is for child development and fun, and unlike some domains in which physical activity is one of the predominant goals, children's play has other benefits, including psychological, emotional and social well-being.[180] Physical activity is a by-product of play, and, as Alexander[180] suggests, defining active play for more precise measurement may compromise the free, creative and pleasurable nature of children's play. Hence, the measurement of active play is ambiguous and unclear. The disparity was evident through the ratings and feedback provided by the experts, particularly regarding what activities and settings should be included when measuring active play. One participant stated *intensity and dose [are] more important than location of activity* while another stated, *I think it definitely does matter if play is indoor or outdoor*. The issue was outlined in the 2014 Report Card, surmising:

There needs to be a consensus reached on how to define and operationalise the concept of active play. The lack of a clear definition has resulted in a lack of research in this area and the collection of inconsistent data. Thus we are currently unable to accurately capture how much 'active play' children are engaging in.[70]

They imply that a consensus on an appropriate definition is required to improve measurement and prevalence estimates.

4.7.1.3 *Active transport*

Active transport is not only measured for health reasons but is also included in surveys conducted to investigate factors such as walkability, independent mobility and the community environment.[181] Van der Ploeg and collegues[76] compared research over three decades revealing declines have occurred in the percentage of children and adolescents who walk to school. This research, to date, has been cited more than 300 times, providing some indication of the value of accumulating data using consistent measurement. The question recommended by the Delphi experts was first used in 2004 and has accrued more than 43,000 school-age participants. Experts commented that it is important to capture more dimensions (duration, distance, intensity, frequency) within a survey question to understand the health implications of this type of activity to differentiate it from general transport-related research. The experts suggested that questions should be updated to reflect this.

4.7.1.4 *Sport*

Megatrends and social patterns suggest that future sports participation will move away from seasonal team sports, and participation in individual lifestyle physical activities will become more prevalent.[182] Most of the questions included in the Delphi questionnaire included a recall of sports participation over 12 months. As commented by some Delphi experts, *12 month time for recall is too long.* This perspective more closely aligns with a contemporary view of sports participation. Notably, the highest-ranked question includes measurement of organised but non-competitive physical activity (e.g., swimming and walking), which reflects the definition of sport recently published by the Australian Sports Commission as

a; *broad range of physical activities including informal, unstructured activity such as walking, riding, swimming and running as well as traditional, structured sport and new and evolving sport and physical activity offerings such as mixed martial arts, "ninja" style obstacle courses and stand-up-paddle boarding.*[183]

4.7.1.5 *Physical education*

Students attend school for many hours each week, providing an ideal opportunity to accrue the recommended amount of physical activity. Although PE is available to most students, the primary aim of this curriculum subject consists of a mix of physical activity participation, motor skill development, sports specific skills and to encourage lifelong health and wellbeing. The variety of activities integrated into a limited time results in difficulty for students to recall the frequency, duration and intensity of these sessions. Consequently, some Delphi experts stated their preferred method for measuring physical activity participation during PE was *better to ask schools about PE time.* Another preferred method is *to measure PE using objective methods*, as was stated in 4 comments. Overall, the comments supported measuring physical activity during PE lessons. One expert commented *that it is necessary to measure PE for policy* due to the inconsistent mandatory physical activity policies in schools across Australia (outlined in Table 1.3, Section 1.5.1.4).

4.7.1.6 *Exercise*

Some consider exercise to be an adult concept, not relevant for children and adolescents.[184] When the Delphi experts were provided with an opportunity to

comment on this domain, few experts agreed, with one stating that *exercise is activity for health reasons - and that's not really relevant for most children's activity*. Five of the 15 comments stated concerns about using the term *exercise* and blurriness around the definition. In addition, the highest-ranked question has an overall mean rating of 5.4, suggesting the experts did not strongly recommend it. Despite some concerns, the current social pattern across Australia illustrates an increased interest in health and fitness, with a consequent increase in the number of gyms and fitness facilities.[183] Likewise, the AusPlay annual national survey found an increase in 15– to 17–year–old adolescents' participation in fitness/gym activities from 21.6% (2016)[185] to 29.8% (2020).[186] With almost a third of older adolescents participating in activities traditionally classified as exercise, this suggests it is a worthwhile domain to measure and, therefore, an appropriate survey question is necessary.

4.7.1.7 *Screen time*

Screen time is a domain that has changed dramatically over the last few decades. Since the introduction of TV in the 1950s, survey questions measuring this domain have been pressed to adjust to this progressively changing technology. When recreational screen time was first included in the Australian guidelines in 2004, prior to the release of the first iPhone, screen time consisted of TV viewing and computer use and, hence, *less screen-related activities to recall*. In contrast, contemporary screen time can occur in many settings and at many times throughout the day (e.g., streaming TV shows at any time and on any mobile device). T*o assist with recall, t*he Delphi experts express that it is important to ensure the examples and explanations included in the questions remain relevant. Twenty-three comments across all the screen time questions conclusively supported the need to update the question content to align with current screen-related behaviours. In addition, the main question recommended by the Delphi experts is also structured for individual daily recall of screen viewing times.

4.7.1.8 *Overall sedentary behaviour and non-screen sedentary behaviour*

Overall sedentary behaviour encompasses screen time and non-screen sedentary behaviours. Unlike non-screen sedentary activities, screen time behaviours are widely measured. Few questions measuring overall sedentary behaviour and non-

screen sedentary activities were identified and included in the Delphi questionnaire. One Delphi expert stated their thoughts on the best approach to measure overall sedentary behaviour, *time spent using screens recreationally, screens for homework/education with a definition for screens - phones, on-line films, computer games, computers/laptops/i-pads, then other domains of sitting - reading, hobbies tutoring, Saturday school.* Likewise, another expert suggested *breaking down SB types into separate questions would be more clear and easier to answer.* The experts' ratings on these questions illustrated a lack of confidence in their ability to accurately capture participation in these domains. However, one expert stated *physiology doesn't change much with purpose - cognitive/emotional may well do good to be focussed on sitting and NOT one sitting behaviour (screens),* showing some inconsistencies in how to best measure this domain.

4.7.1.9 *Future implications*

Differences in how physical activity and sedentary behaviours are measured create difficulties for the estimation of prevalence rates and tracking activity levels over time. One main finding from the Delphi is the need to modify and improve some of the questions used to measure participation rates. Despite the importance of consistently using the same questions to accumulate data for feedback on temporal trends, it is perhaps more important to accurately estimate current participation levels to establish how active children and adolescents currently are. This is important for public health measures, with the overall intention of increasing participation rates.[145]

The recent WHO guidelines could drive further motivation for modifying or creating new survey questions.[61] The updated WHO physical activity, sedentary behaviour and sleep guidelines for children and adolescents have altered the time frame for the total amount of physical activity to be accumulated, from each day to an average per day accumulated across a week (ages 5-17 y). For sedentary behaviour, the recommendations are to limit the amount of total sedentary time and recreational screen time, with no specific time limit included.[187] If Australia adopts these guidelines, the measurement needs for overall physical activity and

the sedentary behaviours may also need to alter to be able to estimate compliance subjectively.

4.7.2 Strengths and limitations

Questions could have potentially been excluded from the Delphi questionnaire, due to the limitations of the inclusion criteria from Study 1 (e.g., sample size criteria). Not all questions were able to be located, which limited the questions available for the Delphi questionnaire, however, there were still 362 questions to select from. An error in the data entry resulted in 2 well-used questions measuring sports participation not being included in the Delphi questionnaire. Therefore, the questions recommended to be used for sports participation are not as comprehensive as the other behaviours. It may have been beneficial to ask the Delphi experts the age range they have expertise researching and if they had previously used any of the survey questions. While it may not have changed the outcome, it would have been beneficial to know if the Delphi expert had a more in-depth understanding and experience collecting data using an included survey question or participant age range.

Despite these limitations, this research is the first Australian study to engage experts to select a comprehensive set of recommended questions to measure physical activity and sedentary behaviours. The Delphi process consisted of more Delphi participants (29) than expected from a range of academic institutions and industry organisations with varying levels of experience and research expertise.

4.8 Conclusion

The exploration of experts' perspectives on existing questions revealed diversity in the way behaviours were defined and measured. This disparity has further implications, potentially resulting in inconsistent measurement of prevalence rates, and research gaps. As a way forward, a set of recommended questions to measure children and adolescents' participation in physical activity and sedentary behaviours was suggested. Adopting these questions at a national and state level would lead to an increase in comparable, widely distributed data encompassing more age groups, inform and evaluate interventions, and create

policies. Future research is encouraged to investigate the best subjective approach to further capture participation in selected behaviours.

CHAPTER 5.

Main discussion

If we accept the principle that health promotion must address problems perceived by the public as important in the context of their everyday lives, we must seek to understand health as children themselves see it and within that their own relevant social contexts.

Kalnins and collegues

Health Promotion International 1992[188]

5. Main discussion

5.1 Introduction

The purpose of this chapter is to combine the findings from this thesis, offer explanations for each main finding and discuss future implications. I will begin by summarising the main findings from each of the three studies. In the next section, I will discuss the implications of my findings, particularly in relation to how they can influence the estimation of participation rates and compliance with guidelines. I will then discuss future implications and suggestions for further research. Where possible, the findings and implications will be discussed through the lens of previous research. To complete this chapter, I will provide concluding remarks.

5.2 Summary of findings

Estimates of current participation rates for physical activity and sedentary behaviour are mostly acquired through sporadic national and state-based surveys, many of which using incomparable measurement methods/techniques. This results in limitations when attempting to compare activity levels and participation across time and jurisdictions with no standardised measurement and a lack of clear publicly available research. The inconsistency in physical activity assessment among Australian children and adolescents has been the motivation for this research.

The first study was an audit of existing data on Australian children's and adolescents' physical activity participation and sedentary behaviours. This was the first comprehensive audit of datasets, finding 597 relevant publications, 172 studies, 190 datasets, and covering 751,237 participants. Across the 68-year time span, identified datasets included diverse characteristics, collected with different methodologies, locations, years of measurement, and participant age ranges. Of note, there was a clear prevalence of using cross-sectional designs (81%), in survey format (75%), to assess participation rates of school-aged participants (90%) at the state/territory level (89%). This study also identified significant gaps, that need to be addressed in future research.

The second study (Chapter 3) identified survey questions used to measure Australian children's and adolescents' participation in physical activity and sedentary behaviour. Three hundred and sixty-two index questions were identified. Two-thirds measured physical activity, as classified using the CS-PAS, with the remaining one-third measuring sedentary behaviours, mostly as screen time. Few questions across the 190 datasets allowed for comparisons across time and discrete time points.

Research gaps were identified by descriptively analysing the historical and geographical contexts of the existing research, including:

1. There are no national datasets that have consistently measured physical activity and sedentary behaviour in children and adolescents (0-18 years) *in the same collection wave*.

2. Few studies have measured physical activity and/or sedentary behaviour in younger children (0-4 years).

3. There is disparity in the amount of data collected from each state and territory, even when adjusted for population size.

4. There are disparities in the measurement of the various domains of physical activity and sedentary behaviours, with more data collected on screen time and sport, and few data collected on PE and non-screen sedentary time.

5. Only a small number of questions capable of measuring compliance with Australian physical activity guidelines were identified across several datasets.

The third study (Chapter 4) engaged experts to create a set of recommended questions. Specifically selected questions measuring the domains of physical activity and sedentary behaviours were presented to 29 experts using a Delphi questionnaire. Despite differences in opinion around the best questions to use, two central questions were identified to best measure compliance with national guidelines, and a series of alternative questions were ranked for measurement of other domains. Thematic analysis identified many areas of dissatisfaction,

particularly concerning how the domains were defined, the dimensions of assessment, clarity and recall timeframes. The experts provided suggestions on how the questions could be improved, for example, by ensuring the activities provided as examples in the questions are relevant to today's children and adolescents. Additional findings included:

6. There is much diversity among experts regarding the best questions for measuring physical activity and sedentary behaviours.

7. Experts recommended two central questions for measuring participation in overall physical activity and screen time for children and adolescents.

8. There is a need for questions measuring participation levels for infants, toddlers and pre-schoolers.

In addition, the impact that the development and introduction of guidelines on physical activity and sedentary behaviours had on this research area was noted. This time in history aligns with significant growth in the use of survey questions and the amount of research collected. A change in measurement was also evident, particularly by the questions designed and used.

5.3 Discussion of findings

These findings have arisen from inconsistencies in research. An incohesive approach to measuring physical activity and sedentary behaviours has resulted in research gaps and difficulties estimating prevalence rates. This can result from inadequate questions and disparity in perspectives between experts and researchers. This section further discusses the main findings stated above within three sections: inconsistent measurement, disparity in perspectives, and guideline development.

5.3.1 Inconsistent measurement

Available data on children's and adolescents' physical activity and sedentary behaviour in Australia forms an incomplete mosaic. Inconsistencies were identified in the existing datasets, with noticeable research gaps for young children, across geographical spread and years of measurement. Additional

inconsistencies were identified concerning the questions used, with few questions repeated over time, disproportionate measurement focus of the existing questions and lack of questions suitable for younger children.

Significant research gaps were evident regarding the research collected on younger children (0–4 y). Only 10% of datasets collected data on younger children, and a lack of relevant questions for this age range provides further limits in collecting comparable data. The early years are a crucial time for growth, development and the formation of healthy habits, therefore a lack of information on the participation levels of this age group could have long term health implications.[8, 153]

There was also an imbalance in data from state-based research, with only one dataset identified from NT and one question previously used in this territory. With high obesity rates and a large Indigenous population in the NT, the available data does not provide confident insight regarding how best to promote an active lifestyle with these children and adolescents.

An imbalance was also noted in the distribution of questions between measurement of physical activity participation and sedentary time. When comparing the questions used to measure each behaviour to the proportion of time spent participating in different types of activities throughout a 24-hr period, disproportionate measurement of the different domains is evident. For example, there was a lack of questions measuring non-screen sedentary time, despite this domain consuming 59% of a child's total time spent in sedentary behaviour.

Few questions measured compliance with national guidelines. Three questions measuring overall physical activity participation were repeatedly asked across a 20-year period, with one asked a total of 35 times. The use of consistent measurement allows a pool of data to be collected over a series of occasions, enabling the tracking of compliance with guidelines over time. In addition, it is vital to collect data from children across different life stages and from different geographical locations and to measure their participation in a range of physical activities and sedentary behaviours. Widespread uptake of a consistent set of questions able to measure compliance would reduce the inconsistencies

identified in the existing research and the variability identified in prevalence estimates.

5.3.2 Disparity in perspectives

Despite many existing questions, they embody varying characteristics and measurement foci, resulting in only a small number that have been used repeatedly across time. Feedback from Delphi experts suggested there were differences in opinion around how the behaviours were defined, and this was reflected in their measurement requirements. Experts did not agree, even for the highest-ranked question for measurement of overall physical activity, on how best to define this domain. With some confusion around whether measurement of this domain assessed compliance with guidelines. Modifications to many of the questions were suggested, with some consistent suggestions found between experts. Despite the lack of questions considered suitable to measure participation levels of pre-schoolers, toddlers and infants, no additional questions were suggested by the Delphi experts. Due to the lack of questions for younger children and the discontent with many questions, it is recommended that some new questions be created to fill such research gaps.

5.3.3 Guideline development

The development and introduction of Australia's physical activity and sedentary behaviour guidelines for children and adolescents appears to have had a significant impact on this research area. Initially, a combination of international research, international advice stating the need for guidelines, and political interest in increasing the activity levels of Australians, assisted the process of establishing Australia's guidelines for children and adolescents.[171] A notable change regarding the amount of research conducted around this time, the year 2000, with significant growth in the number of datasets collected and survey questions used. The measurement of physical activity became more focussed on estimating compliance with guidelines, as evident by the highest number of questions classified as measuring overall physical activity and screen time. Overall physical activity had the most significant overlap of questions (CCA 43%),

with the most repeated question considered suitable for measurement of compliance with the guidelines.

Guidelines for young children (0–5y) were developed more recently. In comparison to the guidelines for school-aged children, less time has elapsed to develop relevant survey questions measuring compliance for this age group. This has resulted in less research, however, this is just one limitations for the measurement of participation levels at this age.

5.4 Implications

A closer look at the Australian physical activity and sedentary behaviour research exposes how the research gaps and inconsistencies in data collection could influence participation estimates and the cumulation of data, limiting the amount of data available for the detection of trends. For these research findings to have a meaningful impact, communication to appropriate users is also an important process to consider. Identification of potential users and possible barriers for knowledge translation can assist in successful dissemination. One possibility is the school sector, a setting with valuable potential where further measurement and more opportunities to be active could be ingrained. The implications of these findings are discussed in the following sections, specifically the policy, research, and practice implications.

5.4.1 Policy

The health and wellbeing benefits of physical activity participation are well established, along with the physical, mental and emotional consequences including the increased risk of disease that can result from a lack of physical activity. This understanding resulted in the development of Australia's 24-hour movement guidelines and the creation of policies and interventions to assist children and adolescents achieve these recommendations. Despite this, estimated prevalence rates still show that only one in five children and adolescents are sufficiently active.[11]

As previously discussed, relevant data that accurately illustrate current participation levels are needed. Ideally, the two central questions recommended

by this research could be included in a national survey conducted regularly, resulting in more available data on compliance with guidelines. When/if the results provide clear evidence that most young people are falling considerably short of meeting the guidelines there will be undeniable evidence to justify those advocating for policy action to support increased activity levels of children and adolescents.

Most of the consistent annual and biennial research is conducted and funded by state-based health or education departments. Policymakers use evidence-based research to support their policy development, but there is also an element of political self-interest and opportunism which contributes to these policies.[189] It is not always clear what evidence is used to inform these policies, especially when significant variance can occur in participation rates. As discussed by Ries and Kypri[189], government departments often outsource their data collection, which can result in less transparency around the evidence collected and used by the government to inform policy. Many experts have their personal perspectives, as seen in this research, which could further influence measurement of participation rates. A large proportion of the research conducted in this area was funded by the government sector (46%) with most research completed by a university (70%). Therefore, the disparity in perspectives, variance in prevalence rates and lack of transparency around available data could lead to less effective policy development. A national approach to physical activity measurement would help to decrease the variability that would result from surveillance funded and conducted at a state/territory level.

Standardisation of measurement can also help reduce this potential bias. If the same measurement is used nationally and across different sectors, it allows policymakers, the private sector, city and community leaders, and the wider community to combine consistently collected data and develop a joint approach to improve activity levels. The WHO has ingrained a collaborative approach into their action plan, developed to increase activity levels globally by 2030.[190] A consistent measurement approach using the same survey questions allows for easier collaboration, global comparison of data or even shared collection of data. Within the action plan, WHO recommends the use of a question from the Global School-based Student Health Survey (GSHS), specifically:

During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?

This question follows a prior instruction at the start of the physical activity section explaining that physical activity is *any activity that increases your heart rate and makes you breathe hard.*

This is very similar to the question recommended to measure overall physical activity in our Delphi study. It is convenient that the findings of this study were consistent with recommendations from the WHO,[190] as it allows Australian representative data to be compared with other globally collected data. If various sectors across Australia use a single, central physical activity question, it will allow comparisons of national findings with those from other children and adolescents worldwide.

5.4.2 Research

Further research is needed to make better use of the existing available data and to improve the measurement of physical activity across all ages. This audit forms the basis to further explore whether physical activity levels have truly declined over time. Overall physical activity had the highest overlap of questions, and therefore the data collected using these questions could be investigated to assess comparability, hence detecting trends. Looking back at past physical activity levels would give a better indication of the amount of physical activity children and adolescents used to participate in, consequently providing more evidence on how much is needed for the current generation to stay healthy and fit.[162]

Further discussions are needed to reach a collaborative agreement around the measurement needs of each domain. The existing disparity in experts' perspectives remains a barrier, particularly concerning what constitutes each different domain. Experts also strongly recommended that many questions need to be updated and modernised. Some suggested the same physical activity question could be used across all ages, however, the validity and reliability of using this question with younger children completed by parent-report needs to be investigated further.

Most questionnaire designs in this research area involve adult experts designing the questions followed by a pilot trial with a target sample of children. This adult centred model treats children as *objects of research*, rather than *experts of their own lives*.[191] Exploring and listening to children's understanding of each domain is essential, considering that children and parents/caregivers are the respondents who complete these questions. A participatory agenda with children as co-researchers could be vital, especially due to the unlikelihood of reaching agreement between adult experts.[173] Agreement between all adult experts may involve overcoming barriers including personal interest, alliance with organisations, funding and sponsors, and industry input that can create bias. Future collaboration could involve experts from a broader scope of backgrounds, including representatives from ACHPER, experienced PE teachers, marketing personnel, sport coaches, and child development experts. Involvement from all stakeholders will assist in buy in from respondents and experts alike, hopefully leading to more uptake of questions and government backing.

To get a more comprehensive understanding of participation levels, it would be beneficial to further investigate correlates and environmental influences. Whilst collaborating with all stakeholders, other questions could be designed or selected to collect data on barriers and facilitators alongside measurement of physical activity participation. Comparisons could then be made, for example, between the children and adolescents who are most active with less screen time and the least active or have the highest screen time, and more targeted interventions created to address this participation gap. For example, collecting data on the walkability or rideability of a neighbourhood, could provide vital feedback for infrastructure change that may need to occur to facilitate more active transport, leading to a multifaceted public health approach. Also, measuring participation rates in conjunction with family and peer participation rates can provide information to design interventions and policies focussed on social support for increasing activity levels. If all this data was entered into a data repository, it could provide opportunities for stakeholders to also complete secondary data analysis, for example, further analysis of existing sport participation data could be used to inform financial investment and policy.[192]

Considering an alternative perspective, the necessity of having consistent measurement across all domains of physical activity and sedentary behaviour could be debated. With central age-dependent survey questions that can measure compliance with physical activity guidelines and recreational screen time, recommended questions for other domains may not be needed. If experts prefer to measure the various domains depending on their specific research objectives, then it is likely recommended questions may not be taken up. However, having some survey questions endorsed by domain experts could be helpful to provide guidance and an option for those interested in measuring without a specific investigation focus like some research studies have.

5.4.3 Practice

Physical activity is an integral part of a child's life, tied to their social, emotional, intellectual, spiritual, physical and mental well-being. Some scholars have expressed concern that physical activity is coming to be seen exclusively through a public health lens, and that both measurement and interventions to encourage physical activity have the effect of reducing the social and contextual richness of the physical activity experience for children.[180] An emphasis on measurability encourages children to behave in ways which are measurable (sports, PE, steps taken) at the expense of less quantifiable participation in fun-based free play. With an emphasis on measurement and collecting data especially for the purpose of informing public health initiatives, it is important that children and adolescents are not nudged towards opportunities that are easier to monitor and intervene in. As an example, as previously discussed, there are some concerns that active play could be adjusted towards a public health agenda,[180] with an increased focus on physical activity while playing rather than encouraging imaginative play and exploration. Likewise, the proper role of PE has generated a great deal of debate, regarding the balance between physical activity and skill learning.[34] It is important that children and adolescents' participation still be fun, with measurement an important but non-invasive tool that respectfully determines compliance but does not determine how people should be compliant.

Ideally, the integrity of children's physical activity will not be lost in knowledge translation; the process of communicating research to the appropriate users.[193]

Communicating scientific knowledge to the users of research evidence can be challenging, sometimes leading to research becoming essentially *lost*.[146] The important findings of this research to communicate to users includes the data repository of existing research and the recommended questions. Considerations for the uptake of this knowledge into practice includes methods of dissemination and feasibility of implementation.

The data repository consists of valuable data that could be highly beneficial for users. Policy makers, health professionals, researchers and other stakeholders could use this resource to inform policy, future research and intervention design. Accessibility would be key to the successful translation of this research to practice. Developing an online searchable data repository for intended users to access would allow this valuable data to be easily available. This approach is discussed further in the upcoming section 5.5.3.

Dissemination of the recommended questions could be through the data repository, along with publications and presentations targeting academics, public health officers, and PE teachers. Visually presenting the recommended questions so that they are clear and engaging would assist with user uptake and engagement. Other potential users (i.e., non-government organisations) may require a different knowledge translation approach tailored to their measurement needs. An example of a potential user is Play Australia who may be interested in the questions recommended for measurement of active play, along with the existing data for these questions, which could be provided in a user-friendly format. Furthermore, compiling all the questions into a survey available online, including appropriate graphics and common introductory questions collecting participant information, would make it easier to implement. Of note is the need for further research on the validity and reliability of a newly created survey such as this.

Schools have the potential to provide meaningful change in active behaviours, despite the current difficulties of conducting research in this setting. The progressive integration of technology into the school curriculum[37] has increased students' educational screen time, leading to a critical need for more physical activity opportunities in schools. Despite this, as discussed in Section 1.5.1.4, the

amount of physical activity provided varies considerably between schools across Australia.[127] A lack of policy stating that schools provide 60 minutes per day for students to be active during breaktimes,[127] suggests that most students would not have an opportunity to accumulate physical activity recommendations during school time, shifting this requirement to parents and caregivers to provide the necessary opportunities. However, students attending outside of school hours care (OSHC) should be provided with the opportunity to participate in 45 minutes before school and 90 minutes after school of physical activity, as per newly designed recommendations for this setting.[194]

To monitor OSHC and school physical activity, measurement should be made easier and more accessible. A national survey could be conducted with school-age children including these recommended questions, providing important data on the amount of activity that occurs in these settings. Previously, the school sector has supported comprehensive national research, evident by the Australian Health and Fitness Survey conducted in 1985. In addition to measuring physical activity and fitness data, the researchers collected blood samples from the students to measure cardiovascular risk factors. Comparatively, current research in schools is restricted by regulations and time constraints.[195] One such limitation results from the mandatory literacy and numeracy testing, NAPLAN, which has a significant influence on the focus of classroom time. However, possibly the central recommended questions could be included in this national assessment tool, to ensure physical activity opportunities remain a priority for schools.

Employing an *opt-out* consent process can lead to higher participation rates in school-based measurement,[196] and using a short online survey administered in classrooms with the data collected and made available on the online repository. Alongside this, teachers could complete a survey once per year to report on the settings and opportunities provided in each school. Creation of a national policy outlining mandatory physical activity opportunities and measurement, with compliance to these requirements being made publicly available would ensure the health of students is given high priority. Measurement in schools would also encourage monitoring of OHSC national quality standards and guidelines within this setting.

5.5 Future implications

Future implications will likely include advancements in survey measurement and progressions with wearable technology. Ideally, positive change will lead to the introduction of a national surveillance system and an online data repository, both assisting with accessibility of consistent, commensurable data. These future implications will be discussed in the next sections, with the underpinning concept that measurement needs to respect children's and adolescents' right to be active.

5.5.1 Recommendations for updating questions

As suggested by the Delphi experts, many changes are needed to improve the existing questions used to measure domains of physical activity and sedentary behaviours. Question content, response options, graphics, clarity, dimensions assessed and recall timeframes are all components of the questions that could be changed to improve how each domain is measured. Suggestions specific to each domain were discussed within Section 4.6, however, it is also important to relay general recommendations that can be applied to any survey questions measuring activity levels. It would also be of benefit to explore the respondents' perspectives, in addition to these recommendations.

Children are developmentally different across the lifespan, therefore measurement needs may also vary.[172] Self-report requires children to recall conceptual information from their long-term memory. It is important to consider the language used in the questions, which ideally should vary according to the respondent's age, along with their understanding of the concepts being asked about. Terminology such as *physical activity* has previously been considered as more of an adult concept,[172] even though is it commonly used in questions assessing compliance with guidelines. If a question includes concepts or terminology such as this, it is suggested to also include child-orientated definitions and explanations, along with appropriate yet simple pictures or videos to assist with understanding. Examples of the types of activities which the respondents may engage in need to be realistic, current, and age appropriate. If response options are used, child experts could assist with designing appropriate

options that will not confuse or mislead respondents or elicit some social desirability effects.

Respondent burden is important to understand, as this will impact on respondent buy in. There is a balance between the measurement needs, such as measuring numerous dimensions of participation (e.g., intensity, duration), and the respondent burden. The recall time frame can also add to the respondent burden, with general comments suggesting 7-day recalls are too long for some domains, especially for parent-report of infant or toddler activity. Other important considerations are to ensure the questions are inclusive of respondents from various cultural backgrounds, especially since Australia consists of many people who have been born in other countries.

The use of survey questions into the future will provide valuable and consistent data to assess changes in activity levels or temporal trends. Considering future trends and social patterns when updating/designing questions, allows the questions to remain more accurate and applicable to possible changes into the future, whilst still able to measure current participation rates.

5.5.2 National surveillance system

Many countries globally employ a national surveillance system to track physical activity participation, including Australia. Surveys such as the annual AusPlay survey and the ABS National Nutrition and Physical Activity Survey administer physical activity-related questions. The AusPlay survey measures children's and adolescents' participation in organised physical activity recalled over 12 months. These survey questions are unable to measure compliance with national guidelines as they lack the assessment dimensions and scope needed to acquire the necessary data. Therefore, a more comprehensive surveillance system is required in Australia to measure compliance with guidelines.

Ideally, a consistent set of questions, such as those identified in Study 3, could be used to measure participation rates within a national surveillance survey conducted at regular intervals. These questions could be included in the AusPlay survey, or another regular survey conducted by the ABS. Alternatively, a survey such as the Australian Secondary Schools Drug and Alcohol Survey, conducted

within each state and territory triennially, could include core physical activity and sedentary behaviour questions, as some states/territories optionally include. Another option is designing a new national health and wellbeing survey funded by the government and conducted in schools annually, also capturing data on other aspects of health including mental health and nutrition. It is important to also administer questions to younger children (0–5y), which could be completed by parents or caregivers.

Observations of successful systems in different countries can provide valuable insight into possible collaborative systems to establish in Australia. Finland is an example of a country conducting national surveillance on all its citizens, with surveys regularly conducted throughout various collaborative government sectors, including health, education, sports, and transport.[197] The data collected through these systems informs policy and of subpopulations needing further assistance. As a result, they have initiated four national policies targeting children and adolescents to promote more active lifestyles. This translation of results into effective and timely policy creation reinforces the effectiveness of this system. When respondents and stakeholders can see that progress is made as a direct result from the data they provide, it has more buy in from respondents,[173] and stakeholders to provide future funding.

Even though a national physical activity surveillance system is seen as a high priority by most experts in this research area,[64, 198] some areas of consideration could be complex. In particular, consideration for the implementation, practicality and integration of the system would need to occur.[199] The implementation at regular intervals along with the practicality could be challenging, especially to achieve consistent funding for longer than a government is elected for. It is unclear what the financial burden would be to conduct a regular national survey, however one report by an Australian research institute revealed it costs approximately $56,000 to conduct a random digit-dialling phone survey including 1000 participants.[200] Therefore, to administer a randomly sampled national survey either by phone interview or paper-based to a sufficient sample size (approximately 800,000 participants), it could cost approximately $40 million.

5.5.3 Online data collection and storage

The internet is a valuable tool that can widely disseminate data, improving accessibility of data for the broader community. A lack of awareness of which survey questions have previously been used has contributed to the vast number of existing questions. Therefore, an online data repository would be an essential step in disseminating these research findings, dispersing the recommended questions and information on existing datasets. Furthermore, the set of recommended questions could be collated in an online survey, widely available to be used by universities, organisations, schools and sports clubs to measure the activity-related behaviours of children and adolescents.

An online data repository could consist of metadata describing previously collected datasets, particularly the year of measurement, location, de-identified participant characteristics, methodological approach, data custodians, and findings. This repository could be stored on a government server or by a research institute with the capacity to oversee the process. Storing national data in an accessible repository supports broader reach of data, for smaller community studies through to larger national designs. In addition, increasing the availability of the data provides a more precise base from which future research can develop. The repository could also be used to download available data, searchable by date, sample age and sex, geographical area, and question type. Moreover, researchers could upload their data, submitting it with automated cleaning and range checks.

5.5.4 Alternative measurement approaches

Big data refers to large-scale data that cannot be stored, managed, or analysed using traditional database software.[201] This type of data can be collected by the smartphones owned by most adolescents, or by *fitness-tracking* wearables. The potential for capitalising on big data is immense, with great potential to capture physical activity such as steps taken using a smartphone app. Tracking of activity behaviours using smartphones can also integrate GPS, providing further information about where the activity occurs. Physical environment imaging programs can be combined with GPS data, alongside the physical activity

measurement to provide detailed feedback on environments which enable physical activity and for different subpopulations.[202]

A recent study capturing people's steps by their smartphone in 111 countries illustrated the potential for global data comparisons.[203] However, limitations exist, with significant error found in the big data collected, by way of over or under-reporting of steps taken.[203] Some error sources are due to the difference in movement between people (speed and stride length) and between the different makes of phone.[203] However, positively, smartphones are also starting to be used for health promotion, with the capability of supporting the individual to be active through messaging and real-time feedback.[56]

Other benefits of using smartphones to collect data is the potential to collect additional information using photos. This measurement approach, namely photovoice, involves using photos to obtain the respondents perspective, or it could be used to assist with physical activity measurement as the respondent can capture the activities they participate in. MyDailyMoves is a smartphone app which combines photovoice and self-report to assess children's and adolescents' physical activity participation alongside photos of the type of activity participating in to allow the researchers to classify the domain of activity.[204] Baby Moves is another app which can observe activity levels of infants by way of parents/caregivers capturing videos at timed intervals of the activity their infant is participating in.[205] Future progress could lead to measurement of activity levels with a smartphone accelerometer in combination with photos to assess the specific domain.

Challenges to be considered in relation to collecting data from a child's or adolescent's smartphone is data privacy and anonymity.[202] Particularly when collecting data from an app, clearly defining a data collection timeframe is important with the researchers only gaining access to their data during this timeframe. Also the *digital divide* between socioeconomic populations, with some children and adolescents unable to access a smartphone, excluding them from the data collection.[202]

With global popularity of child wearables and smartwatches increasing, there are some strengths and limitations to the use of this technology. One strength

includes the ability to gain important data from children by using the child-friendly features to increase wear time. For example, if a child wears the device for a set number of days, it could be programmed to reward them with engaging games and features. However, Burton and colleagues highlighted possible limitations of this technology, including the effectiveness of cyber security to protect the data.[206] This technology often contains the capability to track where a child travels, leading to the possibility of data hacking to locate a particular child's whereabouts, if the data are not effectively secured. Also, parents/caregivers reportedly also use this technology to track their child's location, which some consider could be invading their right to free movement and independence.[206]

Other wearable devices such as accelerometers are currently used for some population surveillance studies, such as in Canada and the US.[1] Considering the recently updated WHO guidelines, which require an average daily duration of activity across the week, it is complex to capture this using self-report and therefore is more suited to measurement using accelerometers.[1]

Alternative measurement techniques could also be used to capture screen time. Due to the nature of screen time, there are some complexities around how it is measured using survey questions. Media multitasking and switching between devices provides challenges to accurately capturing and classifying (recreational or educational) screen time.[207] Furthermore, the nature of sporadic smartphone checking sometimes whilst participating in other activities such as homework on a computer or walking for exercise, can mean it is difficult to accurately capture. The use of software programs integrated into smartphones could be used to track time spent in various apps, however this does not include other screen devices (e.g., computer use). There is potential for a program which could run across multiple devices to track the use of each, including any multitasking behaviours, to improve how compliance with screen guidelines are measured.

Ideally, future data collection methods could include both questions and devices, with devices quantifying participation and questions capturing the context. Even when further advancements in technology occur, the use of questions will still be

vital for the collection of comparable data to enable the tracking of participation trends.

5.6 Conclusion

Children's exploration through movement is of paramount importance, creating the foundation for lifelong active behaviours. The available data suggest that few Australian children and adolescents are active enough to achieve minimal health and well-being benefits. Despite the numerous attempts at increasing physical activity levels, it appears that there has been little change in children's and adolescents' participation levels.

Data collection is now a common occurrence in our daily lives, made effective through organisation and accessibility. A lack of organisation of the existing data on Australian children's and adolescents' physical activity and sedentary behaviours has resulted in the uncertainty of what research has previously been conducted. Identifying and exploring these existing datasets has highlighted the data needed to assist in meaningful change. Consistent and commensurable data provides valuable information concerning which subpopulations need the most assistance, in addition to informing interventions, policies, future research, and making temporal and global comparisons. However, research gaps from inconsistent measurement approaches created largely incommensurable data due to geographical disparity, lack of younger children's measurement (0–4 y), and uneven measurement focus. Promisingly, few datasets were identified with consistent characteristics, suggesting the potential to commensurate these data, leading to a more comprehensive measurement of compliance to guidelines and detection of trends.

As a way forward, funnelling data collection by adopting a set of recommended questions to measure participation in physical activity and sedentary behaviours within a national surveillance system would streamline this process. This would lead to an increase in comparable, widely distributed data encompassing more age groups. Quality data will reinforce advocacy for policy change on aspects such as school-based physical activity, community opportunities, and environmental/infrastructure change. It is recommended that data collection

should be unobtrusive and allow for the combination of developmental benefits with the enjoyment of participation to ensure it enhances children's opportunities to lead active lives.

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Contributions and presentations

Presentations

- Physical activity data on Australian children: What's out there? What's not? Oral presentation, 2018 International Society for Physical Activity and Health, London.
- Physical activity data on Australian children: What's out there? What's not? 2021 3 minute thesis competition, University of South Australia
- Physical activity data on Australian children, poster presentation and oral presentation, 2019 University of South Australia Research Week

Other contributions

Findings from this research contributed to:

- Measuring Physical (In)activity: Research into how Australia measures physical (in)activity at a national level, prepared by the Centre for Sport and Social Impact, La Trobe University. Specific data analysis provided to inform report.
- Presentation by Dr Natasha Schranz, 2018 Exercise and Sports Science Australia Conference, Brisbane. Initial results from study 1 presented.
- The 2022 Active Healthy Kids Australia Report Card on Physical Activity for Children and Young People. Select findings from study 1 and study 2 contributed to report card data.
- Member of the working group for the design of the Pre-Exercise Screening for Young People. Initial findings from study 2 contributed to how compliance to physical activity guidelines is assessed within the screening tool.

Findings also shared with individual researchers and industry professionals from:

- Active Healthy Kids Australia
- Australian Sports Commission

- Curtin University
- Flinders University
- NSW Health
- Play Australia
- Sydney University
- University of Wollongong

Appendix 1 Access database structure

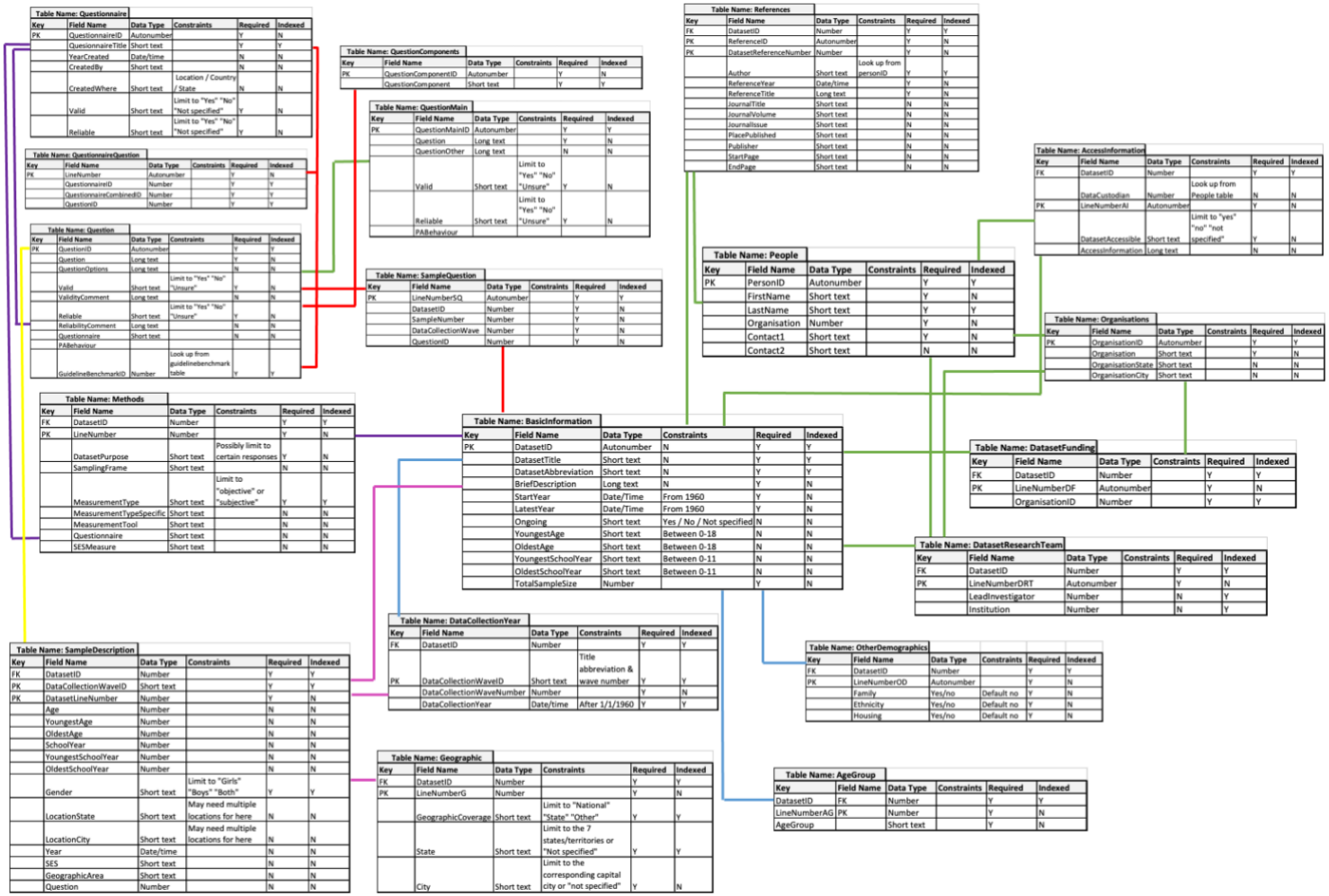


Table Name: Questionnaire

Key	Field Name	Data Type	Constraints	Required	Indexed
PK	QuestionnaireID	Autonumber		Y	N
	QuesionnaireTitle	Short text		Y	Y
	YearCreated	Date/time		N	N
	CreatedBy	Short text		N	N
	CreatedWhere	Short text	Location / Country / State	N	N
	Valid	Short text	Limit to "Yes" "No" "Not specified"	Y	N
	Reliable	Short text	Limit to "Yes" "No" "Not specified"	Y	N

Table Name: QuestionnaireQuestion

Key	Field Name	Data Type	Constraints	Required	Indexed
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	QuestionnaireID	Number		Y	Y
	QuestionnaireCombinedID	Number		Y	Y
	QuestionID	Number		Y	Y

Table Name: Question

Key	Field Name	Data Type	Constraints	Required	Indexed
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	Question	Long text		Y	N
	QuestionOptions	Long text		N	N
	Valid	Short text	Limit to "Yes" "No" "Unsure"	Y	N
	ValidityComment	Long text		N	N
	Reliable	Short text	Limit to "Yes" "No" "Unsure"	Y	N
	ReliabilityComment	Long text		N	N
	Questionnaire	Short text		N	N
	PABehaviour				
	GuidelineBenchmarkID	Number	Look up from guidelinebenchmark table	Y	Y

Table Name: QuestionComponents

Key	Field Name	Data Type	Constraints	Required	Indexed
PK	QuestionComponentID	Autonumber		Y	N
	QuestionComponent	Short text		Y	Y

Table Name: QuestionMain

Key	Field Name	Data Type	Constraints	Required	Indexed
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	Question	Long text		Y	N
	QuestionOther	Long text		N	N
	Valid	Short text	Limit to "Yes" "No" "Unsure"	Y	N
	Reliable	Short text	Limit to "Yes" "No" "Unsure"	Y	N
	PABehaviour				

Table Name: SampleQuestion

Key	Field Name	Data Type	Constraints	Required	Indexed
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	SampleNumber	Number		Y	N
	DataCollectionWave	Number		Y	N
	QuestionID	Number		Y	N

Table Name: References

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	ReferenceID	Autonumber		Y	N
PK	DatasetReferenceNumber	Number		Y	N
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	ReferenceYear	Date/time		Y	N
	ReferenceTitle	Long text		Y	N
	JournalTitle	Short text		N	N
	JournalVolume	Short text		N	N
	JournalIssue	Short text		N	N
	PlacePublished	Short text		N	N
	Publisher	Short text		N	N
	StartPage	Short text		N	N
	EndPage	Short text		N	N

Table Name: People

Key	Field Name	Data Type	Constraints	Required	Indexed
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	FirstName	Short text		Y	N
	LastName	Short text		Y	Y
	Organisation	Number		Y	N
	Contact1	Short text		Y	N
	Contact2	Short text		N	N

Table Name: AccessInformation

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
	DataCustodian	Number	Look up from People table	N	N
PK	LineNumberAI	Autonumber		Y	N
	DatasetAccessible	Short text	Limit to "yes" "no" "not specified"	Y	N
	AccessInformation	Long text		N	N

Table Name: Organisations

Key	Field Name	Data Type	Constraints	Required	Indexed
PK	OrganisationID	Autonumber		Y	Y
	Organisation	Short text		Y	N
	OrganisationState	Short text		N	N
	OrganisationCity	Short text		N	N

Table Name: Methods

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	LineNumber	Number		Y	N
	DatasetPurpose	Short text	Possibly limit to certain responses	Y	N
	SamplingFrame	Short text		N	N
	MeasurementType	Short text	Limit to "objective" or "subjective"	Y	Y
	MeasurementTypeSpecific	Short text		N	N
	MeasurementTool	Short text		N	N
	Questionnaire	Short text		N	N
	SESMeasure	Short text		N	N

Table Name: BasicInformation

Key	Field Name	Data Type	Constraints	Required	Indexed
PK	DatasetID	Autonumber	N	Y	Y
	DatasetTitle	Short text	N	Y	Y
	DatasetAbbreviation	Short text	N	Y	Y
	BriefDescription	Long text	N	Y	N
	StartYear	Date/Time	From 1960	Y	N
	LatestYear	Date/Time	From 1960	Y	N
	Ongoing	Short text	Yes / No / Not specified	N	N
	YoungestAge	Short text	Between 0-18	N	N
	OldestAge	Short text	Between 0-18	N	N
	YoungestSchoolYear	Short text	Between 0-11	N	N
	OldestSchoolYear	Short text	Between 0-11	N	N
	TotalSampleSize	Number		Y	N

Table Name: DatasetFunding

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	LineNumberDF	Autonumber		Y	N
	OrganisationID	Number		Y	Y

Table Name: DatasetResearchTeam

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	LineNumberDRT	Autonumber		Y	N
	LeadInvestigator	Number		N	Y
	Institution	Number		N	Y

Table Name: SampleDescription

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	DataCollectionWaveID	Short text		Y	Y
PK	DatasetLineNumber	Number		Y	N
	Age	Number		N	N
	YoungestAge	Number		N	N
	OldestAge	Number		N	N
	SchoolYear	Number		N	N
	YoungestSchoolYear	Number		N	N
	OldestSchoolYear	Number		N	N
	Gender	Short text	Limit to "Girls" "Boys" "Both"	Y	Y
	LocationState	Short text	May need multiple locations for here	N	N
	LocationCity	Short text	May need multiple locations for here	N	N
	Year	Date/time		N	N
	SES	Short text		N	N
	GeographicArea	Short text		N	N
	Question	Number		N	N

Table Name: DataCollectionYear

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	DataCollectionWaveID	Short text	Title abbreviation & wave number	Y	Y
	DataCollectionWaveNumber	Number		Y	N
	DataCollectionYear	Date/time	After 1/1/1960	Y	Y

Table Name: OtherDemographics

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	LineNumberOD	Autonumber		Y	N
	Family	Yes/no	Default no	Y	N
	Ethnicity	Yes/no	Default no	Y	N
	Housing	Yes/no	Default no	Y	N

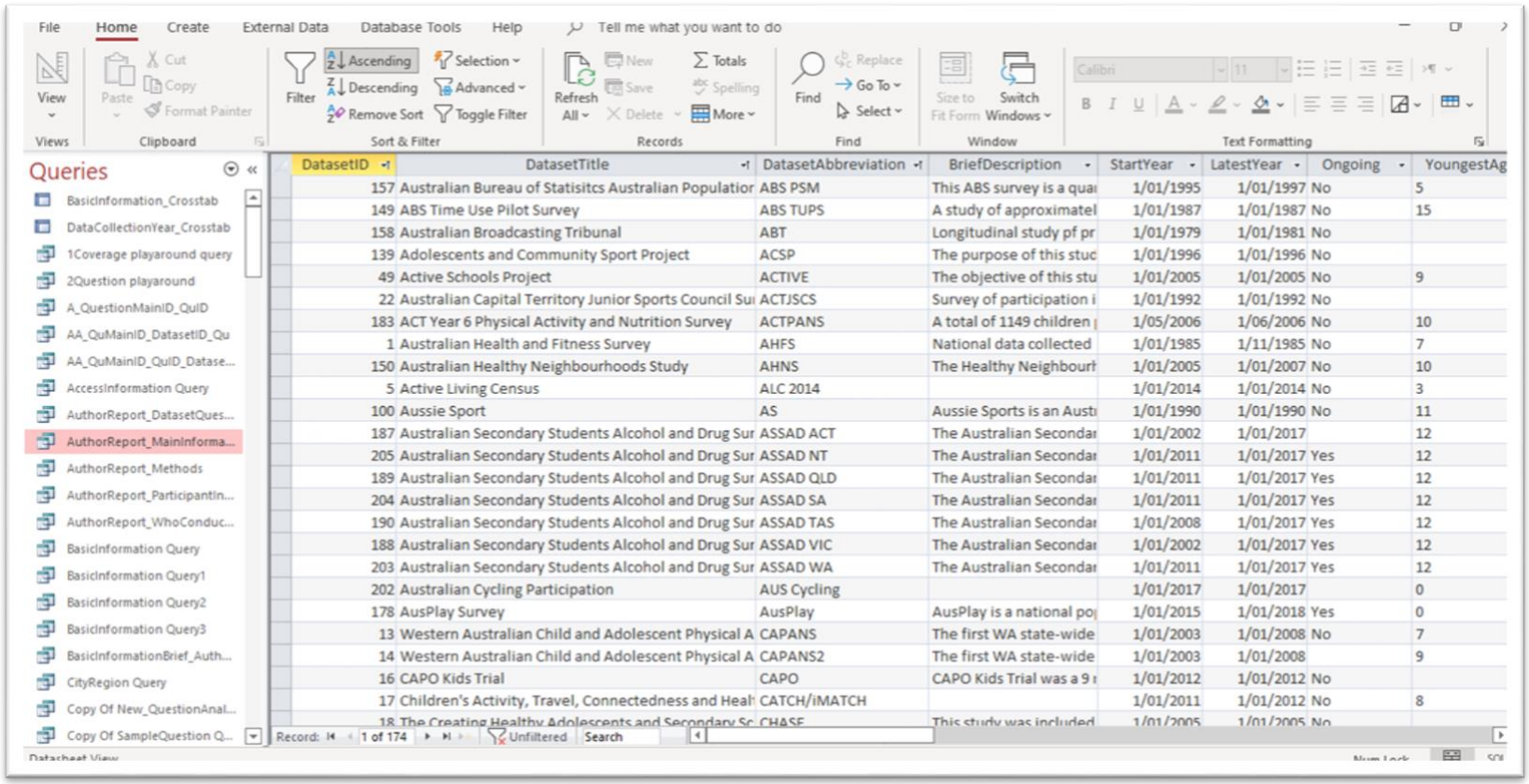
Table Name: Geographic

Key	Field Name	Data Type	Constraints	Required	Indexed
FK	DatasetID	Number		Y	Y
PK	LineNumberG	Number		Y	N
	GeographicCoverage	Short text	Limit to "National" "State" "Other"	Y	Y
	State	Short text	Limit to the 7 states/territories or "Not specified"	Y	Y
	City	Short text	Limit to the corresponding capital city or "not specified"	Y	N

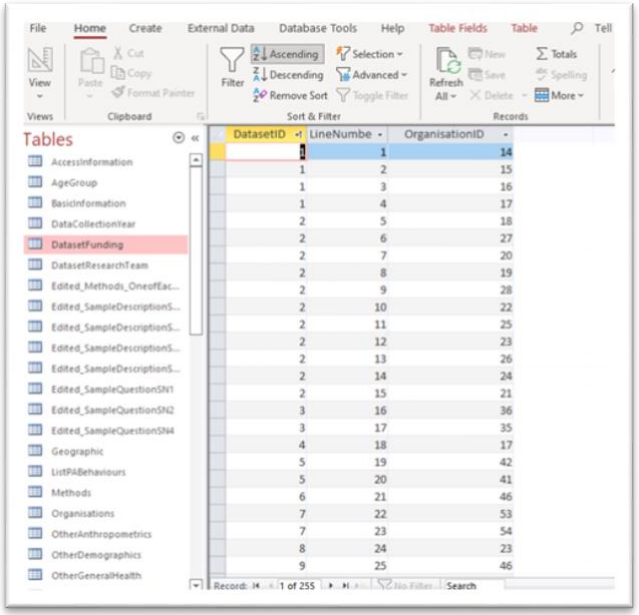
Table Name: AgeGroup

Key	Field Name	Data Type	Constraints	Required	Indexed
DatasetID	FK	Number		Y	Y
LineNumberAG	PK	Number		Y	N
AgeGroup		Short text		Y	N

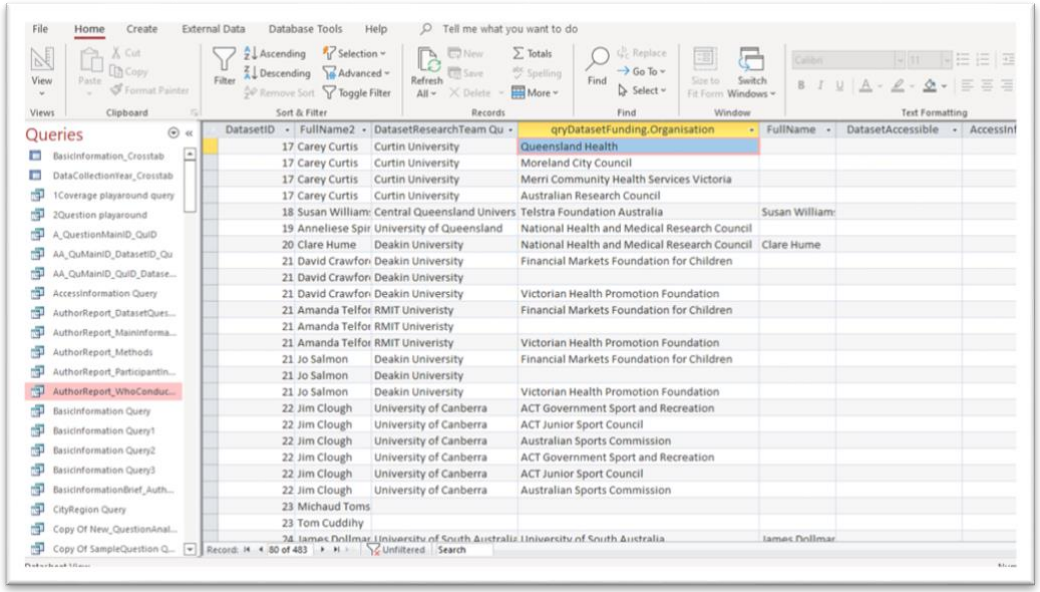
Appendix 2 Microsoft Access database screenshots



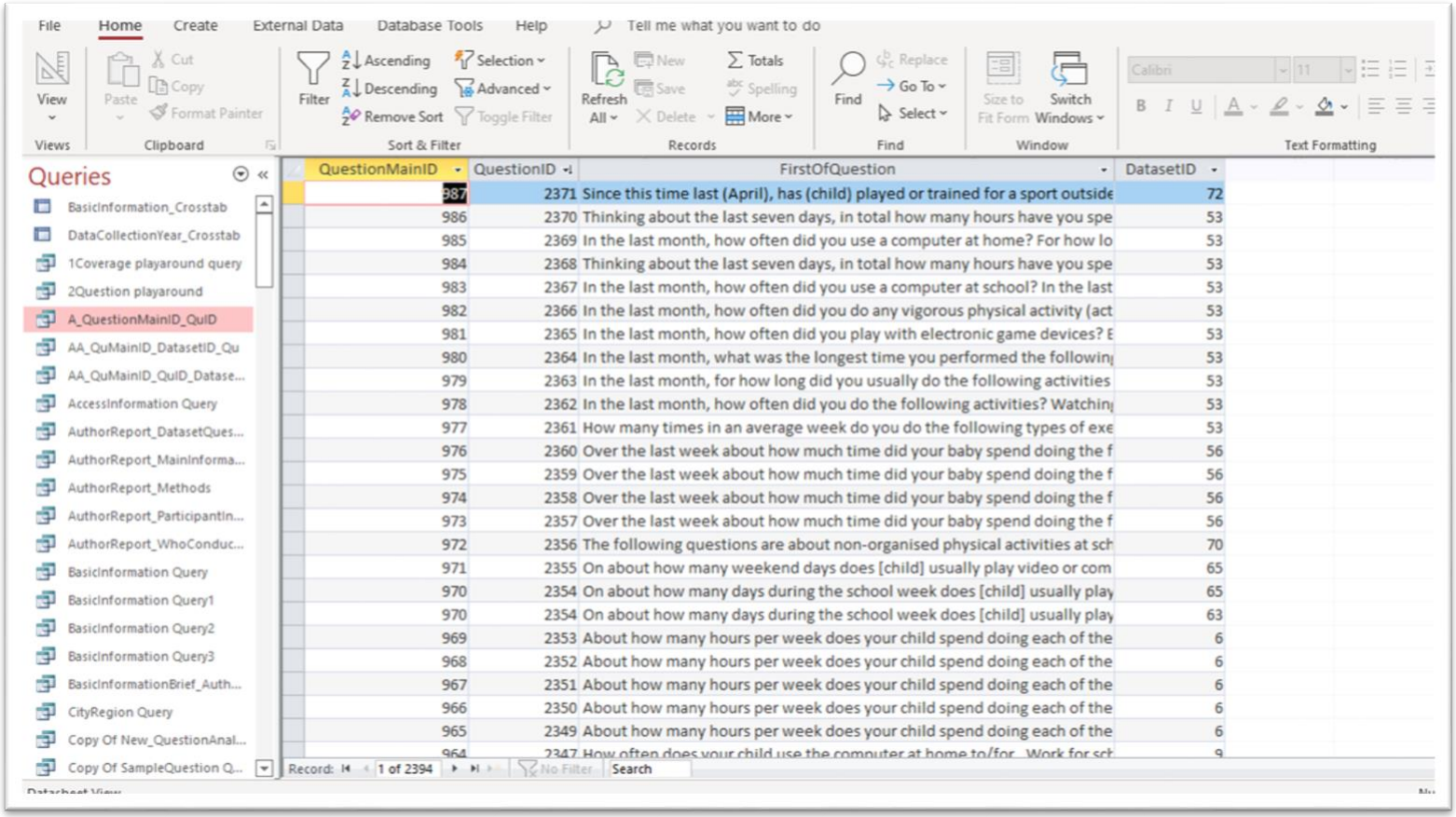
Screenshot of a query combining information describing the datasets.



Screenshot of a table consisting of identification numbers relating datasets and the research organisation who conducted it.



Screenshot of a query combining datasets and the research organisations who conducted it.



Screenshot of a query combining questions used to measure physical activity and sedentary behaviours with the different datasets they were used in.

Appendix 3 List of included studies

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
Australian Health and Fitness Survey	AHFS	1	National	1985	All	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Health and Fitness Survey	OPA; SP; AT; AP; SB; VPA; PE	9-15	6586	Janet Pyke	Australian Council for Health, Physical Education and Recreation	National Heart Foundation of Australia, Commonwealth Schools Commission, Dept of Health, Dept of Sport, Recreation and Tourism	NA
The Travel to Work, School and Shops Survey	TWSSS	1	State	1974, 1984, 1994	VIC	Cross-sectional	NA	Proxy-report	Questionnaire	The Travel to Work, School and Shops Survey	AT	5-18	NA	Stuart Jackson	Australian Bureau of Statistics	Australian Bureau of Statistics, Dept of Economic Development, Jobs, Transport and Resources,Dept of Health	Nick Skondreas
Life Activity Project	LAP	1	Other	1997	NSW, QLD, VIC, SA	Cross-sectional	NA	Self-report	Questionnaire	Physical activity and physical culture in the lives of young people	EX	5-17	2276	Jan Wright	University of Wollongong	Department of Health	NA
Active Living Census	ALC 2014	1	State	2014, 2019	VIC	Cross-sectional	Stratified	Self-report	Questionnaire	Active Living Census	EX, SP, PA	3-17	2509 (2014)	Graham Challice	The Social Research Centre	State Government of Victoria, Australian Government	Amy Brown
The Longitudinal Study of Australian Children B Cohort	LSAC-B, LSAC-K	2	National	2004, 2006, 2007, 2008, 2010, 2012, 2014, 2016, 2018	ALL	Longitudinal	Stratified	Self-report, parent-report, proxy-report	Questionnaire	Growing up in Australia (varies for each wave)	SB, ST, AP, SP, EX, AT, NST	0-1 (Wave 1), 14-15 (Wave 8)	10,090 (2004 W1) 6,164 (2018 W8)	Galina Daraganova	Department of Social Services, the Australian Institute of Family Studies and the Australian Bureau of Statistics	Department of Family and Community Services	Unknown
Fit-4-Fun	F4F	1	State	2011	NSW	Cross-sectional	NA	Pedometer (Yamax SW700)	Yamax SW700	NA	PA	10-13	212	Narelle Eather	University of Newcastle	University of Newcastle, Sports Medicine Australia	Narelle Eather
Central Sydney Walk to School Program	CSWTSP	1	State	2005	NSW	Cross-sectional	NA	Self-report	Questionnaire	NA	NA	9-11	1966	Helen Dirkis, Dafna Merom, Chris Rissel, Li Ming Wen, Angela Balafas	Sydney South West Area Health Service, Western Sydney University, Sydney South West Area Health Service, Sydney South West Area Health Service	NSW Health	NA

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
Australian National Children's Nutrition and Physical Activity Survey	NCNPAS	2	National	2007	ALL	Cross-sectional	Stratified	Self-report, Pedometer (New Lifestyles 1000)	Time-use diary	MARCA	PA, SB, AT, AP, SP, EX, ST, PE, MSA, NST	5-16	4487	Tim Olds, Lynne Cobiac	University of South Australia, CSIRO	Department of Agriculture, Fisheries and Forestry, Dept of Health, Australian Food and Grocery Council	NA
Good for Kids, Good for Life	GFK2	2	State	2010	NSW	Cross-sectional	Stratified	Parent-report, Pedometer (Yamax SW200 & SW7000)	Yamax SW200 and SW7000, questionnaire	NA	PA	3-6	328	Luke Wolfenden, Meghan Finch, Philip Morgan	Hunter New England Population Health, University of Newcastle	Hunter Medical Research Institute, Hunter New England Population Health, Royal Australian College of General Practicioners, NSW Health	Luke Wolfenden
Western Australian Child and Adolescent Physical Activity and Nutrition Survey- Y3	CAPANS	2	State	2003, 2008	WA	Cross-sectional	Stratified	Parent-report, self-report	Questionnaire	Western Australian Child and Adolescent Physical Activity and Nutrition Survey 2003 (Year 3), Western Australian Child and Adolescent Physical Activity and Nutrition Survey 2008 (Year 3)	PA, SB, ST, SP, EX, AP, PE, NST, AT	7-16	2275 (2003) 1827 (2008)	Beth Hands, Karen Martin	University of Notre Dame, Edith Cowan University,	Healthway, Dept of Health	Beth Hands
CAPO Kids Trial	CAPO	1	State	2012	QLD	Cross-sectional	NA	Proxy-report	Questionnaire	Bone-Specific Physical Activity Questionnaire (BPAQ)	PA, SP	10-11	151 girls	Belinda Beck	Griffith University	NA	Belinda Beck
Children's Activity, Travel, Connectedness and Health / Independent Mobility, Active Travel and Children's Health	CATCH/iMATCH	2	Other	2011	QLD, VIC, WA	Cross-sectional	Cluster	Self-report, Accelerometer (Actiheart)	Questionnaire, Actiheart	NA	PA, AT, AP, SB, VPA	8-13	340	Christine Armit, Paul Tranter, Mitch Duncan, Matthew Burke, Carey Curtis, Carolyn Whitzman	Merri Community Health Services Victoria, University of New South Wales, Central Queensland University, Griffith University, Curtin University, University of Melbourne,	Department of Transport and Main Roads, Queensland Health, Australian Research Council, Merri Community Health Services Victoria, Moreland City Council, Moreland City Council	NA
The Creating Healthy Adolescents and Secondary School Environments project	CHASE	1	State	2005	QLD	Cross-sectional	Stratified	Self-report, Parent-report	Questionnaire	Adolescent Physical Activity Recall Questionnaire (APARQ), Parent questionnaire unknown	PA, SB, SP, ST, NST, VPA, EX, AT, AP	14-17	295	Susan Williams	Central Queensland University	Telstra Foundation Australia	Susan Williams

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
The Childhood Injury Prevention Study	CHIPS	1	State	2001	QLD	Cross-sectional	Stratified	Parent-report	Questionnaire, 7 day Physical Activity Diary	NA	PA, SP	5-12	518	Anneliese Spinks	University of Queensland	National Health and Medical Research Council	NA
Children Living in Active Neighbourhoods	CLAN	1	State	2004, 2006	VIC	Longitudinal	NA	Parent-report, Self-report, Accelerometer (Manufacturing Technology Inc Model 7164)	Questionnaire, Manufacturing Technology Inc Model 7164	NA	PA, SB, VPA	8-15 (2004) 10-17 (2006)	591 (2004) 503 (2006)	Clare Hume	Deakin University	National Health and Medical Research Council	Clare Hume
The Children's Leisure Activities Study	CLASS	1	State	2001	Victoria	Cross-sectional	Stratified	Parent-report, Self-report, Accelerometer (unknown)	Questionnaire	Children's Leisure Activities Study Survey (CLASS)	PA, AP, AT, SP, EX, PE, SB, ST, NST	5-12	1210	Amanda Telford, David Crawford, Jo Salmon	RMIT Univeristy, Deakin University	Financial Markets Foundation for Children, Victorian Health Promotion Foundation	NA
Australian Capital Territory Junior Sports Council Survey of Sports Participation	ACTJSCS	1	State	1992	ACT	Cross-sectional	NA	Self-report	Questionnaire	NA	SP	5-17	1048	Jim Clough	University of Canberra	ACT Government Sport and Recreation, Australian Sports Commission, ACT Junior Sport Council, ACT Government Sport and Recreation, Australian Sports Commission, ACT Junior Sport Council	NA
NoName_Vincent	NN_VINCENT	1	State	2000	QLD	Cross-sectional	Convenience	Pedometer (Yamax MLS-2000)	Yamax MLS-2000	NA	PA	6-12	563	NA	NA	NA	NA
NoName_Dollman97	NN_Dollman97	1	State	1997	SA	Cross-sectional	Cluster	Self-report	Questionnaire	Australian Health and Fitness Survey	PA, SP, AP, AT, PE, SB	10-11	1371	James Dollman	University of South Australia	University of South Australia	James Dollman
The Youth Eating Patterns	YEP	1	State	2004	VIC	Cross-sectional	Stratified	Self-report	Questionnaire	The Children's Leisure Activities Study Survey (CLASS)	PA, AP, AT, SP, EX, PE, SB, ST, NST	12-15	3264	Kylie Ball, David Crawford	Deakin University	Australian Research Council, William Buckland Foundation,	NA
Youth Activity Participation Study of Western Australia	YAPS-WA	1	State	2007, 2008, 2009	WA	Longitudinal	Stratified	Self-report	Questionnaire	NA	SP, PA	12-16 (2007), 13-17 (2008), 14-18 (2009)	1364	NA	Murdoch University	Australian Research Council	NA

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
NSW Walk Safely to School Day	WSTSD	1	State	2002	NSW	Cross-sectional	NA	Proxy-report	Questionnaire	NA	AT	5-12	812	Dafna Merom	University of New South Wales	NSW Health	NA
NoName_Wright	NN_WRIGHT	1	Other	1984	NSW, VIC	Cross-sectional	NA	Self-report	Questionnaire	NA	PA	15	1288	Maureen Wright, Barry Watkin	Deakin University, University of Wollongong	NA	NA
Womensport West	WSW	1	State	1995	WA	Cross-sectional	NA	Self-report	Questionnaire	Student Questionnaire (Womensport West)	PE, SP, AP	12-18	1140 girls	Addy Carroll, Wendy Ey	Healthway, Women's Sport Foundation (WA)	Healthway	NA
Watch Me Grow	WMG	1	State	2013	NSW	Cross-sectional	Convenience	Parent-report	Questionnaire	Watch Me Grow 18mth Questionnaire	SB	1-2	451	David Hawes, Jenny Richmond, Caroline Moul, Eva Kimonis, Paul Frick, Valsamma Eapen, Mark Dadds, Divya Mehta	University of Sydney, Queensland University of Technology, University of New South Wales,	NSW Health, National Health and Medical Research Council	NA
NoName_AUCOTE	NN_AUCOTE	1	State	2004	VIC	Cross-sectional	Stratified	Parent-report	Questionnaire	NA	ST, PA, SP	9-13	393	Helen Aucote	University of Ballarat	No funding	NA
NoName_Burke	NN_Burke	1	State	2005	WA	Cross-sectional	Stratified	Self-report	Questionnaire	Adolescent Physical Activity Recall Questionnaire (APARQ)	PA, SB, SP, EX, AT, AP	11-14	602	Valerie Burke	University of Western Australia	Healthway	NA
NoName_Haye	NN_HAYE	1	State	2008	SA	Cross-sectional	Convenience	Self-report	Questionnaire	NA	PA, SP, AP, EX, SB, ST	12-15	378	Kayla de la Haye	University of Adelaide	NA	NA
NoName_EVANS	NN_EVANS	1	State	2002	SA	Cross-sectional	Stratified	Parent-report	Questionnaire	NA	NA	4-6	1445	Angela Evans	University of South Australia	Brooks Australia, Australasian Podiatry Education and Research Foundation	NA
NoName_Fisher	NN_FISHER	1	State	2002	NSW	Cross-sectional	Stratified	Parent-report	Questionnaire	NA	SP, AP, ST	3-8	676	John Fraser	Hunter New England Health	Royal Australian College of General Practicioners	
NoName_Foon	NN_FOON	1	State	1988	VIC	Cross-sectional	NA	Self-report	Questionnaire	NA	SP	15	811 girls	Anne Foon	University of Canberra	NA	NA
NoName_Granich	NN_GRANICH	1	State	2004	WA	Cross-sectional	Stratified	Self-report	Questionnaire	NA	ST, PA	11-12	298	Joanna Granich	University of Western Australia	Healthway, Victorian Health Promotion Foundation	NA
NoName_Gray	NN_GRAY	1	State	1992	NSW	Cross-sectional	Stratified	Self-report	Questionnaire	Sport and Me	SP	14-15	2000 girls	Anne Gray	University of Sydney	NA	NA
NoName_Grimmer	NN_GRIMMER	1	State	1997	SA	Cross-sectional	Stratified	Self-report	Questionnaire	NA	SP	11-16	3538	Karen Grimmer	University of South Australia	Australian Sports Commission, Channel Seven Children's Research Foundation, Sports Medicine Australia (SA), James N Kirby Foundation, Office for Sport and Recreation (SA)	NA

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
Girls Healthy Development Study	NN_HARDY	1	State	2000, 2001, 2002	NSW	Longitudinal	NA	Self-report	Questionnaire	Adolescent Sedentary Activity Questionnaire	SB, ST, NST	12-15	196	Louise Hardy	University of Sydney	National Health and Medical Research Council	Louise Hardy
NoName_Tomson	NN_TOMSON	1	State	2002	QLD	Cross-sectional	Cluster	Self-report, Pedometer (Yamax Digiwalker (SW-200))	Questionnaire, Yamax Digiwalker (SW-200)	Active Australia	EX, AT, PA, VPA	9-12	491	Mich Tomson	Griffith University	NA	NA
NoName_Carver	NN_CARVER	1	State	2010	VIC	Cross-sectional	Stratified	Self-report	Questionnaire	Modified One False Move Study Questionnaire	AT, SP, AP	8-16	688	Alison Carver	Deakin University	VicHealth	Alison Carver
NoName_Cox	NN_Cox	1	State	2010	VIC	Cross-sectional	Convenience	Parent-report	Questionnaire	Preschool-aged Children's Physical Activity Questionnaire (Pre-PAQ)	PA, SP, AP, AT, ST, SB, EX, NST	2-6	135	Helen Skouteris	Deakin University	NA	Helen Skouteris
NoName_Carlin	NN_CARLIN	1	Other	1994	VIC, WA	Cross-sectional	Cluster	Self-report	Questionnaire	NA	AT	5-10	5979	John Carlin	The Royal Children's Hospital Melbourne	Healthway, Department of Infrastructure, Regional Development and Cities, Department of Transport and Main Roads	NA
Travel, Environment and Kids Project	TREK	1	State	2007	WA	Cross-sectional	Stratified	Self-report, Parent-report, Pedometer (unknown)	Questionnaire	TREK surveys	AT, PA	10-12	1480	Billie Giles-Corti	University of Western Australia	National Health and Medical Research Council	Billie Giles-Corti
NoName_Harris	NN_HARRIS	1	State	2006	WA	Cross-sectional	Stratified	Self-report	Questionnaire	Young People's Activity Questionnaire (modified) (YAQ-II)	VPA, PA, ST	6-16	1351	Courtenay Harris	Curtin University	None	NA
Active Schools Project	ACTIVE	1	State	2005	WA	Cross-sectional	Stratified	Accelerometer (unknown)	NA	NA	PA, SB, VPA	9-13	408	Karen Martin	University of Western Australia	Department of Education, Healthway	Karen Martin
NoName_Hardyb	NN_HARDYb	1	State	2004	NSW	Serial cross-sectional	Stratified	Self-report	Questionnaire	Adolescent Sedentary Activity Questionnaire	SB, ST, NST	11-15	250	Louise Hardy	University of Sydney	NSW Health	NA
Motivating Active Learning in Physical Education trial	MALP	1	State	2011	NSW	Cross-sectional	Cluster	Accelerometer (Actigraph GT3X)	Actigraph GT3X	NA	PA, SB, VPA	13	288	Chris Lonsdale	Australian Catholic University	Western Sydney University	Chris Lonsdale

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
The Australian Lifestyle of our Kids Intervention	LOOK	1	State	2005, 2006, 2007, 2008, 2009	ACT	Longitudinal	Cluster	Pedometer (Walk4Life, New Lifestyles), Accelerometer (2008, 2009) (Actigraph GT1M)	Walk4Life, New Lifestyles, Actigraph GT1M	NA	PA, SB, VPA	8 (2005), 12 (2009)	853	Marita McCabe	University of Canberra	Department of Health, Commonwealth Education Trust	Boyd Swinburn
NoName_Harris_b	NN_HARRIS_b	1	State	2006	WA	Cross-sectional	Stratified	Parent-report, self-report	Questionnaire	Year One Activity Questionnaire (YQAQ), Young People's Activity Questionnaire (modified) (YAQ-II)	SB, ST, PA	7-17	1350	Courtenay Harris	Curtin University	NA	NA
It's Your Move	IYM	1	State	2005	VIC	Cross-sectional	Stratified	Self-report	Questionnaire	Adolescent Behaviours, Attitudes and Knowledge Questionnaire (ABAKQ)	AT, SP, AP, ST	12-16	3026	NA	Deakin University	Deakin University, Health Research Council, Wellcome Trust, National Health and Medical Research Council, Department of Health and Human Services, Australian Research Council, VicHealth	NA
Romp & Chomp	RC	1	State	2005	VIC	Cross-sectional	Stratified	Parent-report	Questionnaire	Eating and Physical Activity Questionnaire (EPAQ)	ST, AP	1-4	932	NA	Deakin University	Department of Health and Human Services, Deakin University, Australian Research Council, Department of Health, National Health and Medical Research Council, VicHealth	NA
Melbourne Infant, Feeding, Activity and Nutrition Trial	InFANT	1	State	2008	VIC	Longitudinal	Cluster	Parent-report, Accelerometer (Acti-Graph GT1M)	Questionnaire, Acti-Graph GT1M	InFANT Questionnaire	PA, SB, ST, NST, AP, VPA	0	542	Karen Campbell, Kylie Hesketh	Deakin University	National Health and Medical Research Council	Potentially
Mind Exercise Nutrition Do It!	MEND	1	State	2010	VIC	Cross-sectional	Convenience	Parent-report	Questionnaire	Preschool-aged Children's Physical Activity Questionnaire (Pre-PAQ)	SB, NST, ST, SP, AP	2	201	Marita McCabe, Boyd Swinburn, Helen Skouteris	Deakin University	Australian Research Council	NA
NoName_Meylink	NN_MEYLINK	1	State	1971	NSW	Cross-sectional	Stratified	Self-report	Questionnaire	NA	SP	15	2241 girls	Willa Meylink	NSW Department of Education	NA	NA

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
Mater-University of Queensland Study of Pregnancy Cohort	MUSP	1	State	1996	QLD	Cross-sectional	Cluster	Parent-report	Questionnaire	NA	ST, PA	14	2494	Jake Najman	University of Queensland	National Health and Medical Research Council, National Heart Foundation	Shelby Marrington
Nutrition and Enjoyable Activity for Teen Girls	NEAT Girls	1	State	2010	NSW	Cross-sectional	Cluster	Self-report, Accelerometer (Actigraph MTI model 7164, GT1M, GT3X)	Questionnaire, Actigraph accelerometer MTI model 7164, GT1M, GT3X	Adolescent Sedentary Activity Questionnaire	PA, SB, ST, VPA	12-14	357 girls	David Lubans	University of Newcastle	Australian Research Council	NA
Nepean Kids Growing Up Study	NKGUS	1	State	1996, 2002, 2004	NSW	Longitudinal	Cluster	Self-report, Parent-report	Questionnaire	The Children's Leisure Activities Study Survey (CLASS)	PA, AP, AT, SP, EX, PE, SB, ST, NST	7-8 (1996), 12-13 (2002), 14-15 (2004)	436 (1996), 350 (2002), 290 (2004)	Sarah Garnett	The Children's Hospital at Westmead	Novo Nordisk, The AMP Foundation, Meat & Livestock Australia, The Children's Hospital at Westmead, The Raymond E. Purves Foundation, National Health and Medical Research Council	Sarah Garnett
National Secondary Students' Diet and Activity Survey	NaSSDA	1	National	2009, 2013, 2018	ALL	Serial cross-sectional	Stratified	Self-report	Questionnaire	Adolescent Physical Activity Recall Questionnaire (APARQ), Adolescent Sedentary Activity Questionnaire, The 60-minute Moderate-to-Vigorous Physical Activity (MVPA)	PA, SB, SP, ST, NST, VPA, EX, AT, AP	12-17	12188 (2009), 8888 (2013), 9102 (2018)	Melanie Wakefield, Philippa Niven, Maree Scully	Cancer Council Victoria	Cancer Council Victoria, Cancer Council Australia, Cancer Council ACT, Cancer Council Western Australia, Cancer Council Northern Territory, Cancer Council Tasmania, Cancer Council SA, Cancer Council Queensland, Cancer Council NSW	Unknown
New South Wales Child Health Survey	NSWCHS	1	State	2001, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018	NSW	Serial cross-sectional	Cluster	Proxy-report	Questionnaire	Population Health Survey	SP, AP, PA, ST,	5-12	5887 (2001), 3710 (2004), 2215 (2006), 2437 (2008), 1992 (2010), 2420 (2012), 2749 (2014), 3161 (2016), 2802 (2018)		NSW Health	NSW Health	Soufiane Boufous
National Health Survey	NHS	1	National	2001, 2004, 2007, 2011, 2014, 2017	ALL	Serial cross-sectional	Stratified	Proxy-report, self-report	Questionnaire	National Health Survey	EX, AT, VPA, OT, MSA	15-17	1221 (2001), 1057 (2004), 834 (2007), 945 (2011), 854 (2014), 899 (2017)	NA	Australian Bureau of Statistics	Australian Government	

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
New South Wales Population Health Survey	NSWPHS	1	State	1997, 1998, 1999, 2002-18	NSW	Serial cross-sectional	Stratified	Self-report	Questionnaire	NSW Population Health Survey	EX, AT, SP, ST	16-18	282 (04), 308 (05), 135 (07), 207 (08), 411 (09), 383 (10), 225 (11), 319 (12), 327 (13), 297 (14), 328 (15), 243 (16), 271 (17), 241	Margo Barr	NSW Health	NSW Health	NSW Health
NSW Schools Physical Activity and Nutrition Survey	SPANS, SPANS-PASS	2	State	2004, 2010, 2015	NSW	Serial cross-sectional	Stratified	Parent-report, Self-report	Questionnaire	Adolescent Physical Activity Recall Questionnaire (APARQ), Adolescent Sedentary Activity Questionnaire	PA, AP, AT, SP, EX, PE, SB, ST, NST	5-16	5400 (2004), 8058 (2010), 7556 (2015)	Louise Hardy, Anthony Okely, Michael Booth	University of Sydney, University of Wollongong	NSW Health	NSW Health
Australian Bureau of Statistics Children's Participation in Sport and Leisure Time Activities	ABS CPSLTA	1	National	2000, 2003, 2009, 2012	ALL	Serial cross-sectional	Random	Proxy-report	Questionnaire	The Children's Leisure Activities Study Survey (CLASS) - Children's Questionnaire	PA, AP, AT, SP, EX, PE, SB, ST, NST	5-14	1849 (2000), 1849 (2003), 2722 (2009), 1849 (2012)	NA	Australian Bureau of Statistics	Australian Government	NA
Australian Bureau of Statisitcs Multipurpose Household Survey	ABS MPHS	1	National	2005, 2009	ALL	Cross-sectional	Random	Self-report	Questionnaire	NA	SP, PA	15-18	NA	NA	Australian Bureau of Statistics	Australian Government	NA
Australian Bureau of Statistics How Australian's Use Their Time	ABS HAUTT	1	National	1992, 1997, 2006	ALL	Serial cross-sectional	Random	Self-report	Time-use diary	NA	ST, PA	15-18	NA	NA	Australian Bureau of Statistics	Australian Government	NA
Western Australian Pregnancy Cohort "Raine" Study	RAINE	2	State	1995, 1998, 2000, 2003, 2006	WA	Longitudial	Cluster	Self-report, Parent-report, Pedometer (Yamax Digiwalker SW200)	Questionnaire, MARCA, Yamax Digiwalker SW200	Western Australian Pregnancy Cohort (RAINE) Study Follow Up Questionnaires	PA, SB, ST, SP, PE, AT, OT, EX	5-18	2236 (1995), 2142 (1998), 2048 (2000), 1865 (2003), 1693 (2006)	Leon Straker, Peter Eastwood	University of Western Australia, Curtin University	University of Western Australia, Edith Cowan University, Telethon Kids Institute, Curtin University, University of Notre Dame, Murdoch University	Alex D'Vauz

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South Australian Obesity Prevention and Lifestyle Programme	OPAL	1	State	2011	SA	Serial cross-sectional	Stratified	Self-report	Questionnaire	OPAL Student Survey	PA, AP, SP, ST, SB	7-13	4604	Lucy Bell	Flinders University	Australian Government, SA Health	NA
Exercise, Recreation and Sport Survey	ERASS	1	National	2001-10 (yearly)	ALL	Serial cross-sectional	Stratified	Self-report	Questionnarie	Exercise, Recreation and Sport Survey Questionnaire	PA, EX, SP, AP	15-18	1393 (approx each year)	Australian Sports Commission	Australian Sports Commission	Australian Sports Commission, State/Territory Department of Sport and Recreation	NA
Exercise, Recreation and Sport Survey (5-14 yr old)	ERASS (5-14)	1	National	2010	ALL	Cross-sectional	Stratified	Proxy-report	Questionnarie	Exercise, Recreation and Sport Survey Questionnaire (children's questionnaire)	PA, EX, SP, AP. AT	5-14	3306	Australian Sports Commission	Australian Sports Commission	Australian Sports Commission, State/Territory Department of Sport and Recreation	NA
International Study of Childhood Obesity, Lifestyle and Environment	ISCOLE	1	State	2011	SA	Cross-sectional	Stratified	Self-report, Accelerometer (Actigraph GT3X)	Questionnaire, Actigraph GT3X	ISCOLE Diet and Lifestyle Questionnaire	ST, AP, PE, AT, SP, VPA	9-11	528	Tim Olds, Carol Maher	University of South Australia	The Coca-Cola Company	NA
Factors Influencing Transitions in Girls' Active Leisure and Sport Study	FITGALS	1	State	2008, 2009, 2010	VIC	Longitudinal	Stratified	Self-report	Questionnaire, Previous Day Physical Activity Recall	Factors Influencing Transitions in Girls' Active Leisure and Sport Survey 2008	SP, PA, ST, AP, EX, MSA	11-18	732 girls (2008), 605 girls (2009), 448 girls (2010)	Rochelle Eime	Victoria University	Sport and Recreation Victoria, Victorian Health Promotion Foundation, Victoria University, University of Ballarat	Rochelle Eime
Healthy Active Preschool and Primary Years Study	HAPPY	1	State	2008, 2009	VIC	Longitudinal	Stratified	Parent-report, Accelerometer (ActiGraph model GT1M)	Questionnaire, ActiGraph model GT1M	NA	PA, AT, AP, SP, SB, ST	3-6	516 (2008), 177 (2009)	Kylie Hesketh	Deakin University	Australian Research Council, Deakin University	Kylie Hesketh
Health, Eating and Play	HEAPS	1	State	2002	VIC	Cross-sectional	Stratified	Parent-report, Accelerometer (Manufacturing Technology Inc Model 7164)	Questionnaire, Manufacturing Technology Inc Model 7164	NA	PA, ST, SB, VPA	5-12	1484	Anna Timperio	Deakin University	VicHealth	NA

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Physical Activity 4 Everyone	PA4E1	1	State	2011	NSW	Cross-sectional	Stratified	Accelerometer (Actigraph GT3X and GT3X+)	Actigraph GT3X and GT3X+	NA	PA, SB, VPA	11-13	1150	NA	University of Newcastle	Hunter New England Health, Hunter Medical Research Institute, NSW Health	NA
The Sydney Childhood Eye Study	SCES	1	State	2004	NSW	Cross-sectional	Stratified	Parent-report	Questionnaire	NA	SB, ST, NST, PA	6-12	4088	Paul Mitchell	University of Sydney	National Health and Medical Research Council	Paul Mitchell
Switch-Play	SP	1	State	2002	VIC	Cross-sectional	Cluster	Parent-report, Self-report, Accelerometer (Manufacturing Technology Inc Model AM7164-2.2C)	Questionnaire, Manufacturing Technology Inc Model AM7164-2.2C	NA	PA, SB, ST, VPA	10-11	397	Jo Salmon	Deakin University	Victorian Health Promotion Foundation	NA
Sydney Playground Project	SPP	1	State	2009	NSW	Cross-sectional	Cluster	Accelerometer (Actigraph GT3X)	Actigraph GT3X	NA	PA, SB, VPA	5-7	214	Lina Engelen	University of Sydney	National Health and Medical Research Council	NA
Victorian Adolescent Health Cohort Study	VAHCS	1	State	1992, 1993, 1993, 1994, 1994, 1995	VIC	Longitudinal	Stratified	Self-report	Questionnaire	NA	EX, SP	14-15	1947	George Patton	Murdoch Children's Research Institute	National Health and Medical Research Council	NA
Up4it Physical Activity Survey	U4I	1	State	2006	WA	Cross-sectional	Cluster	Self-report	Questionnaire	Adolescent Physical Activity Recall Questionnaire (APARQ)	PA, SB, SP, EX, AT, AP	12-15	1304	Nicole Edwards	University of Western Australia	Healthway	Nicole Edwards
Transform-Us	TU	1	State	2010	VIC	Cross-sectional	Stratified	Accelerometer (Actigraph GT3X)	Actigraph GT3X	NA	PA, SB, VPA	8	406	Jo Salmon	Deakin University	National Health and Medical Research Council, Diabetes Australia	NA
Triple G (Girls Get Going)	GGG	1	State	2011	VIC	Cross-sectional	Cluster	Self-report	Questionnaire	Triple G Student Survey 2011	PA, SP, SB, ST, EX, AP, MSA	11-17	900	Warren Payne	University of Ballarat	Victorian Health Promotion Foundation, Australian Research Council, Helen McPerson Smith Trust	Meghan Casey
Sydney Greater Metropolitan Area Household Travel Survey	HTS	1	State	1971, 1981, 1991, 2003	NSW	Serial cross-sectional	Random	Self-report, Proxy-report	Questionnaire	The New South Wales Government Household Travel Survey	AT	5-14	4284 (1971), 4936 (1981), 662 (1991), 816 (2003)	Transport and Population Data Centre, NSW Department of Planning	Transport and Population Data Centre, NSW Department of Planning	NSW government	Transport and Population Data Centre, NSW Department of Planning

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NoName_Penney	NN_Penney	1	State	1997	QLD	Cross-sectional	Convenience	Self-report, Parent-report	Questionnaire, Time-use diary	NA	SP	13-14	792	Dawn Penney	University of Queensland	University of Queensland	NA
Supporting Children's Outcomes using Rewards, Exercise and Skills	SCORES	1	State	2012	NSW	Cross-sectional	Stratified	Accelerometer (Actigraph GT3X+)	Actigraph GT3X+	NA	PA, SB, VPA	7-10	250	Dave Lubans	University of Newcastle	Hunter Medical Research Institute	Dave Lubans
Good for Kids Child Obesity Prevention Program	G4K	2	State	2007	NSW	Cross-sectional	Stratified	Parent-report, Pedometer (Yamax Digiwalker SW-200)	Questionnaire	Population Health Survey	PA, SP, Sb, ST, AP, EX	3-15	4006	Ben Smith	NSW Health	NSW Health	NA
Randomly Ascertained Sample of Children born in Australia's Largest State	RASCALS	1	State	2000, 2003	WA	Longitudinal	Random	Parent-report	Questionnaire	Womensport West Student Questionnaire	PA, SP, EX, AP, AT, PE	5	1615	Wendy Ey, Addy Carroll, Leon Straker	Women's Sport Foundation (WA), Curtin University	National Health and Medical Research Council, Australian Sports Commission	Stephen Zubrick
Resillience for Eating and Activity Despite Inequality	READI	1	State	2007	VIC	Cross-sectional	Stratified	Self-report, Parent-report, Accelerometer (Actigraph AM 7164-2.2C)	Questionnaire, Actigraph AM 7164-2.2C	The Children's Leisure Activities Study Survey (CLASS), Adolescent Physical Activity Recall Questionnaire (APARQ)	PA, AP, AT, SP, EX, PE, SB, ST, NST	4-13	636	Kylie Ball	Deakin University	National Health and Medical Research Council	NA
Aussie Sport	AS	1	State	1990	SA	Cross-sectional	Random	Self-report	Questionnaire	NA	SP	11-12	1121	Ian Robertson	University of South Australia	Australian Sports Commission	NA
Physical Activity Children and the Environment	PACE	1	State	2011	NSW	Cross-sectional	Cluster	Field observations	SOPLAY	NA	PA	4-13	1582	Anne-Maree Parrish	University of Wollongong	University of Wollongong	NA
12 to 20: Studies of City Youth	12 to 20	1	State	1969	NSW	Cross-sectional	Stratified	Self-report	Questionnaire	12 to 20: Studies of City Youth Survey	SP	11-18	8801	Raewyn (William) Connell	University of Sydney	NA	NA
NoName_YewMeng	NN_YEWMENG	1	State	2012	WA	Cross-sectional	NA	Accelerometer (Acti-Graph GT1M)	Acti-Graph GT1M	NA	PA, SB, VPA	12-13	257	Ben Jackson	University of Western Australia	NA	NA
NoName_Woodward	NN_Woodward	1	State	1990	TAS	Cross-sectional	Random	Self-report	Questionnaire	NA	ST	12-15	2082	D Woodward	University of Tasmania	NA	NA

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NoName_Weinberg	NN_WEINBERG	1	Other	1999	NSW, QLD, WA	Cross-sectional	NA	Self-report	Questionnaire	NA	PA, SP	13-18	577	NA	University of Wollongong, University of Western Australia, University of Queensland, University of Southern Queensland	NA	NA
NoName_Vaughan	NN_Vaughan	1	State	2004	VIC	Cross-sectional	Random	Self-report	Questionnaire	NA	PA, ST	11-18	443	Clare Vaughan	Flinders University, Deakin University	NA	NA
NoName_Tandy	NN_Tandy	1	State	1995	NSW	Cross-sectional		Self-report, Parent-report	Questionnaire	NA	ST, AP	5-12	421	C Tandy	University of Newcastle	NA	NA
NoName_Spurrier	NN_Spurrier	1	State	2005	SA	Cross-sectional	Convenience	Parent-report	Questionnaire	Physical and Nutritional Home Environment Inventory	AP, AT, SP	4-5	280	Nicola Spurrier	Flinders University	Channel Seven Children's Research Foundation	Nicola Spurrier
NoName_Sparks	NN_SPARKS	1	State	1991	NSW	Cross-sectional	NA	Self-report	Questionnaire	NA	SP, EX, PE	17	358	John Sparks	University of Wollongong	NA	NA
NoName_Slater	NN_SLATER	1	State	2010	SA	Cross-sectional	NA	Self-report	Questionnaire	NA	SP, EX	12-16	714	Marika Tiggerman	Flinders University	Australian Research Council	NA
NoName_Taylor	NN_Taylor	1	State	2009	SA	Cross-sectional	NA	Parent-report	Time-use diary	NA	PA, SB	7-11	175	Amanda Taylor	University of Adelaide	Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australian Government	Amanda Taylor
NN_SKOUTERIS	NN_SKOUTERIS	1	State	2014	VIC	Cross-sectional	NA	Parent-report	Questionnaire	Eating and Physical Activity Questionnaire (EPAQ)	PA	4-5	128	Helen Skouteris	Deakin University	Australian Research Council	NA
NoName_Schofield	NN_Schofield	1	State	2002	QLD	Cross-sectional	Convenience	Pedometer (Yamax SW700)	Yamax SW700	NA	PA	16-17	318 girls	Grant Schofield	New Zealand	Central Queensland University	NA
NoName_Savage	NN_Savage	1	NA	1995		Cross-sectional	Convenience	Self-report	Questionnarie	PWP 400	PA, MSA	12-14	220	Michael Savage	USA	NA	NA
NoName_Sanders	NN_Sanders	1	State	2012	NSW	Cross-sectional	Convenience	Accelerometer (Actigraph GT3X)	Actigraph GT3X	NA	PA, SB, VPA	14	133	Taren Sanders	Western Sydney University	NA	Taren Sanders
NoName_Rehor	NN_REHOR	1	State	1999	TAS	Cross-sectional	NA	Parent-report	7 day Physical Activity Recall	NA	PA, SB	12-16	262	Peter Rehor	University of Tasmania	NA	NA
NoName_Parrish	NN_Parrish	1	State	2005	NSW	Cross-sectional	Random	Field observations	The Children's Activity Scanning Tool 2 (CAST2)	NA	PA	5-11	2946	Anne-Maree Parrish	University of Wollongong	NA	NA
NoName_Parker	NN_Parker	1	State	2006	NSW	Cross-sectional	Stratified	Self-report	Questionnaire	Active Australia	PA, VPA, EX, AT	4-17	705	Andrew Martin	University of Sydney	Australian Research Council	Andrew Martin
WA Health and Wellbeing Surveillance System	HWSS	1	State	2002-18	WA	Serial cross-sectional	Random	Parent-report, Self-report	Questionnaire	Health and Wellbeing Surveillance System Questionnaire	PA, VPA, ST	5-18	755 (2012), 688 (2013), 609 (2014), 709 (2015), 728 (2016), 727 (2017)	NA	Health Department of WA	Health Department of WA	NA

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Youth in Australia	YIA	1	State	1990	WA	Cross-sectional	NA	Self-report	Questionnaire	Youth in Australia	SP, EX, AP	13-17	1248	Alison Garton	Graylands Hospital	NA	NA
Western Australian Schools Physical Activity and Nutrition Project	WASPAN	1	State	1990, 1993	WA	Cross-sectional	Stratified	Self-report	7 day Physical Activity Diary	NA	PA	11	1147 (1990), 800 (1993)	Valerie Burke	University of Western Australia, Edith Cowan University	National Health and Medical Research Council	NA
Central Queensland Adolescent Physical Activity and Nutrition Study	CQAPANS	1	State	2001	QLD	Cross-sectional	Stratified	Self-report	previous Day Physical Activity Recall	NA	PA, SP	13-16	1005	Louise Schofield	Central Queensland University	NA	NA
Play5	PLAY5	1	State	2005	WA	Cross-sectional	Stratified	Parent-report, Pedometer	Questionnarire	Physical Activity Questionnaire (Elementary School) (PAQ-C), Amherst Health and Activity Study (AHA) Student Survey	PE, AP, SP, EX, PA	7	303	Beth Hands, Helen Parker	University of Notre Dame	Telstra Foundation Australia	NA
Physical activity and diet among pre-school children study	PANDA	1	State	2004	NSW	Cross-sectional	NA	Parent-report	Questionnaire	Physical Activity and Exercise Questionnaire for Children (PAEC-Q)	PA, SB, VPA, ST, AP	2-5	139	Tony Okely	University of Wollongong	University of Wollongong	NA
South-East Queensland Preschool Physical Activity Study	SEQPPA	1	State	2003	QLD	Cross-sectional	Stratified	Parent-report	Questionnaire	Physical Activity and Exercise Questionnaire for Children (PAEC-Q)	ST, AP	3-5	407	Stuart Trost	University of Queensland	University of Queensland	NA
Patterns of Habitual Activity across Seasons Study	PHASE	2	State	2012, 2013	VIC	Longitudinal	Stratified	Accelerometer (Actigraph GT3X+, ActivPAL)	Questionnaire, Actigraph GT3X+, ActivPAL	NA	PA, SB, VPA	8-11	249 (2012), 221 (2012), 174 (2013)	Nicky Ridgers	Deakin University	Australian Research Council	Nicky Ridgers
Professional Learning for Understanding Games Education	PLUNGE	1	State	2013	NSW	Cross-sectional	Random	Pedometer (Yamax Digi-walker CW700)	Yamax Digi-walker CW700	NA	PE	10-12	168	David Lubans, Andrew Miller, Narelle Eather, Erin Christensen	University of Newcastle	University of Newcastle	Andrew Miller
Queensland Child Health Status Survey	CHS	2	State	2011, 2013-2018	QLD	Cross-sectional	Random	Parent-report, self-report	Online questionnaire	Child Health Status Survey	PA	5-17	2484 (2011), 2467 (2013), 2986 (2014), 2521 (2015), 2504 (2016), 2393 (2017), 2633 (2018)	NA	Queensland Health	Queensland Health	

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Switch-2-Activity	S2A	1	State	2006	VIC	Cross-sectional	Convenience	Self-report	Questionnaire	The Children's Leisure Activities Study Survey (CLASS)	PA, AP, AT, SP, EX, PE, SB, ST, NST	9-12	957	Jo Salmon	Deakin University	Deakin University	NA
Victorian Ride2School Program (parent)	R2S	2	State	2006	VIC	Cross-sectional	NA	Self-report, Parent-report	Questionnaire, CATI	NA	AT	10-11	409	Jan Garrard, Sharyn Crawford	Deakin University	NA	NA
Students As Lifestyle Activists	SALSA	1	State	2014	NSW	Cross-sectional	Stratified	Self-report	Questionnaire	SALSA Questionnaire	PA, ST	13-15	2448	Smita Shah	Western Sydney Local Health District, University of Sydney	Department of Health	Smita Shah
South Australian Monitoring and Surveillance System	SAMSS	1	State	2010-2016	SA	Serial cross-sectional	Random	Self-report	Questionnaire	NA	PA, SP, ST	5-17	1147 (2010), 937 (2011), 934 (2012), 1254 (2013), 1257 (2014), 1255 (2015), 1034 (2016)	NA	University of Adelaide	NA	NA
Rural Activity Project	RAP	1	State	2003	WA	Cross-sectional	Stratified	Self-report	Questionnaire	Minnesota Leisure-time Physical Activity Questionnaire	SP	17	440	Dorien Simons	Belgium, Deakin University	Healthway, Marie Curie Actions	NA
NoName_Stanley	NN_Stanley	1	State	2011	SA	Cross-sectional	Stratified	Accelerometer (Actigraph GT3X and GT3X+)	Actigraph GT3X and GT3X+	NA	PA, SB, VPA	10-14	423	Rebecca Stanley	University of South Australia	None	Rebecca Stanley
Adolescents and Community Sport Project	ACSP	1	State	1996	WA	Cross-sectional	Stratified	Self-report	Questionnaire	NA	SP	12-17	2230	NA	Edith Cowan University	NA	NA
NoName_Marks	NN_Marks	1	State	2013	VIC	Longitudinal	Stratified	Self-report	Questionnaire	NA	SP, PA, AT, SB	10-13	310	Jennifer Marks	Deakin University	Windermere Foundation	NA
NoName_Milligan	NN_Milligan	1	State	1988, 1991, 1994	WA	Longitudinal	Stratified	Self-report	Questionnaire	NA	PA	12, 15, 18	1311 (1988), 555 (1991), 583 (1994)	Valerie Burke	University of Western Australia	Australian Rotary Health Research Fund, Healthway, National Health and Medical Research Council, National Heart Foundation	NA
The Encouraging Activity to Stimulate Young Minds study	EASY	1	State	2013	NSW	Cross-sectional	Stratified	Accelerometer (Actigraph GT3X)	Actigraph GT3X	NA	PA, SB, VPA	9-13	240	Nick Riley	University of Newcastle	NSW Department of Education	Nick Riley
Fun 'n Healthy in Moreland!	FHM	1	State	2004	VIC	Cross-sectional	Convenience	Self-report	Questionnaire	Fun 'n healthy in Moreland Child Questionnaire	AP, AT, SP, ST, EX	4-13	3168	Lisa Gibbs	University of Melbourne, Merri Community Health Services Victoria	Moreland City Council, VicHealth	Lisa Gibbs
Model of Children's Travel	M-CAT	1	State	2012	QLD	Cross-sectional	Cluster	Parent-report	Questionnaire	NA	AT	9-12	206	David Wadley	University of Queensland	Queensland Health	NA

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Health Behaviour in School-Aged Children: a WHO Cross-National Survey	WHO HBSC	1	State	1996	NSW	Cross-sectional	Cluster	Self-report	Questionnaire	Health Behaviours in School-Aged Children (HBSC)	PA	11-15	3918	Chris Rissel	Central Sydney Area Health Service	NA	NA
NoName_Robertson	NN_Robertson	1	State	1979, 1980	SA	Cross-sectional	Stratified	Self-report	Questionnaire	NA		12	1282	Ian Robertson	University of South Australia	Department of Health	NA
ABS Time Use Pilot Survey	ABS TUPS	1	State	1987	NSW	Cross-sectional	NA	Self-report	Time-use diary	NA	AT, SP, EX, AT, AP, NST	15-18	NA	Bernard Hanslow	Australian Bureau of Statistics	Australian Government	NA
Australian Healthy Neighbourhoods Study	AHNS	1	State	2006	VIC	Cross-sectional	Stratified	Self-report	Questionnaire	NA	SP, ST, PE	10-14	7114	Joanne Williams	Murdoch Children's Research Institute, Deakin University, University of Melbourne	National Health and Medical Research Council	NA
NSW Summer Sports Survey	NSW SSS	1	State	1995	NSW	Cross-sectional	NA	Self-report	Quesionnaire	NA	SP	12-18	7153	Alan Knox	NA	NA	NA
Girls in Sport	GIS	1	State	2009	NSW	Cross-sectional	Convenience	Accelerometer (Actigraph 7164 and GT1M)	Actigraph 7164 and GT1M	NA	PA, SB, VPA	13	1518 girls	Anthony Okely	University of Wollongong	NSW Department of Education	Anthony Okely
NoName_Ey	NN_Ey	1	State	1981	SA	Cross-sectional	Random	Self-report	Questionnaire	Questionnaire on School Sport	SP	12-18	723	Wendy Ey	Flinders University	NA	Wendy Ey
Australian Bureau of Statisitcs Australian Population Survey Monitor	ABS PSM	1	National	1996, 1997	ALL	Cross-sectional	Random	Proxy-report	Questionnaire	NA	SP, EX	5-14	NA	NA	Australian Bureau of Statistics	Department of Sport, Recreation and Tourism, Australian Sports Commission	NA
Australian Broadcasting Tribunal	ABT	1	State	1979, 1980, 1981	QLD	Longitudinal	Convenience	Self-report	Questionnaire	NA	ST	5-17 (1979)	NA	NA	NA	NA	
Dads And Daughters Exercising and Empowered	DADEE	1	State	2015	NSW	Cross-sectional	Random	Pedometer (Yamax Digiwalker SW-200)	Yamax Digiwalker (SW-200)	NA	PA	4-12	153	Philip Morgan	University of Newcastle	Hunter Children's Research Foundation, Hunter Medical Research Institute, Port Waratah Coal Services	NA
Healthy Kids Queensland	HKQ	1	State	2006	QLD	Cross-sectional	Random	Self-report, Pedometer (Yamax SW700)	Questionnaire, Yamax SW700	Western Australia Child and Adolescent Physical Activity and Nutrition Survey 2003	PA	6-15	5467	Rebecca Abbott	University of Queensland	Queensland Health	NA

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Motivation for Active Travel to School	MATSS	1	State	2014	NSW	Cross-sectional	NA	Self-report, Accelerometer (Actigraph GT1M)	Questionnaire, Actigraph GT1M	NA	AT, PA	13	1632	Rhiannon White	University of Newcastle, Unive	Australian Research Council Discovery Grant	NA
Melbourne University Child Growth Study	MUCGS	1	State	1962	VIC	Cross-sectional	NA	Self-report	Questionnaire	NA	PA	9-11	129	A Roche, Sydney Sunderland	University of Melbourne	H. J. Heinz Co, Nuffield Foundation, University of Melbourne	NA
Preventing Osteoporosis with Exercise Regimes in Physical Education	POWER PE	1	State	2006	QLD	Cross-sectional	Convenience	Self-report	Questionnaire	Bone-Specific Physical Activity Questionnaire (BPAQ)	SP, PA	13	99	Benjamin Weeks	Griffith University	None	NA
Program X	PX	1	State	2007	NSW	Cross-sectional	Stratified	Pedometer (Yamax SW700)	Yamax SW700	NA	PA	14	124	Dave Lubans	University of Newcastle	University of Newcastle	NA
The Standing Preschools Study	TSPS	1	State	2013	NSW	Cross-sectional	NA	Accelerometer (ActivPAL)	ActivPAL		PA, SB, VPA	4-5	115	Anthony Okely	University of Wollongong	University of Wollongong	Penny Cross
Move it Groove it	MIGI	1	State	1999	NSW	Cross-sectional	Stratified	Field observations	SOFIT	NA	PE	6-13	3912	John Beard	Southern Cross University	NSW Health	NA
Youth Say Project	YSP	1	State	1973	SA	Cross-sectional		Self-report		NA	SP	12-17	781	Michael Norman	Department of Sport, Recreation and Tourism, National Youth Council of Australia	Department of Sport, Recreation and Tourism	NA
NoName_Harten	NN_HARTEN	1	State	2002	SA	Cross-sectional	Random	Self-report	Questionnaire, MARCA	NA	AT	11-12	136	Nathan Harten	University of South Australia	None	Nathan Harten
Growing Up in an Australian City	GUAC	1	State	1951	NSW	Cross-sectional	Convenience	Self-report	Questionnaire	Twenty Questions		13-18	8705	William Connell	University of Sydney	Commonwealth Office of Education, Berlei, Australian Consolidated Industries, Consolidated Press	NA
Healthy Together Children's Evaluation	HTCE	1	State	2014	VIC	Cross-sectional	Cluster	Self-report	Questionnaire	Healthy Together Children's Evaluation Student Questionnaire	PA, SB, ST, AT	8-18	5851	Steven Allender, Claudia Strugnell	Deakin University	National Heart Foundation of Australia, National Health and Medical Research Council	Claudia Strugnell
Great South Coast Health Study	GSC	1	State	2015, 2017, 2019	VIC	Serial cross-sectional	Cluster	Self-report, Accelerometer	Questionnaire	Healthy Together Children's Evaluation Student Questionnaire	PA, SB, ST, AT, VPA	5-13	1913 (2015), 2675 (2017), 2325 (2019)	Steven Allender, Claudia Strugnell	Deakin University	National Health and Medical Research Council, Ian Potter Foundation, Western Alliance	Claudia Strugnell
Goulburn Valley Health Behaviours Monitoring Study	GVH	1	State	2016, 2019	VIC	Serial cross-sectional	Cluster	Self-report, Accelerometer	Questionnaire	Healthy Together Children's Evaluation Student Questionnaire	PA, SB, ST, AT, VPA	6-13	1606 (2016), 1164 (2019)	Claudia Strugnell	Deakin University	Goulburn Valley Primary Care Partnership	Claudia Strugnell

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
Reflexive Evidence & Systems Intervention to Prevent Obesity & Non-communicable Disease	RESPOND	1	State	2019	VIC	Serial Cross-sectional	Cluster	Self-report	Questionnaire	Healthy Together Children's Evaluation Student Questionnaire	PA, SB, ST, AT, VPA	6-13	3895	Claudia Strugnell	Deakin University	National Health and Medical Research Council, VicHealth	Claudia Strugnell
No Name_Haye2	NN_HAYE2	1	State	2008	SA	Cross-sectional	NA	Self-report	Questionnaire	NA	SP, EX, AP, ST	12-14	385	Kayla de la Haye	University of Adelaide	NA	Kayla de la Haye
AusPlay Survey	AusPlay	1	National	2015-2019	ALL	Serial cross-sectional	Stratified	Parent-report	Questionnaire	AusPLAY Survey	SP	0-18	3849 (2015), 3412 (2016), 3318 (2017)	NA	Australian Sports Commission	Australian Sports Commission	NA
National Nutrition and Physical Activity Survey (2-4YRS)	NNPAS	2	National	2011	ALL	Cross-sectional	Random	Parent-report, Pedometer	Questionnaire	National Nutrition and Physical Activity Survey	AP, SP, EX, PA, ST, SB, AT	2-18	2915	NA	Australian Bureau of Statistics	Australian Government	Australian Bureau of Statistics
SA Wellbeing and Engagement Survey	WEC	1	State	2013-18	SA	Serial cross-sectional	Random	Self-report	Questionnaire	Wellbeing and Engagement Collection	SP, ST, NST, OT	9-15	31960 (2015), 43206 (2016), 63926 (2017), 75158 (2018)	NA	Department of Education and Child Development	Department of Education and Child Development	NA
ACT Year 6 Physical Activity and Nutrition Survey	ACTPANS	1	State	2006, 2009, 2012, 2015, 2018	ACT	Cross-sectional	Stratified	Self-report	Questionnaire	ACT Year 6 Physical Activity and Nutrition Survey 2006	SP, EX, PE, ST	10-13	1149 (2006) 1353 (2015) 1491 (2018)	NA	ACT Health	ACT Health	NA
Victorian Child Health and Wellbeing Survey	VCHWS	1	State	2006, 2009, 2013	VIC	Cross-sectional	Cluster	Self-report	Questionnaire	Victorian Health and Wellbeing Survey	ST, NST, AT, PA	5-12	3028 (2009), 4635 (2013)	Michael Ackland	Department for Human Services	Department for Human Services	NA
Victorian Student Health and Wellbeing Survey	VSHAWS	1	State	2009, 2014, 2016	VIC	Cross-sectional	Cluster	Self-report	Questionnaire	Victorian Student Health and Wellbeing Survey	ST, AT, PE, SP	10-17	5094 (2014), 11421 (2016)	George Patton	University of Melbourne	Victorian Health Promotion Foundation, National Health and Medical Research Council	NA
NSW School Students Health Behaviours Survey	SSHB	1	State	2002, 2005, 2008, 2011, 2014, 2017	NSW	Cross-sectional	Stratified	Self-report	Questionnaire	The New South Wales Secondary Schools Students Health Survey	SP, AP, EX, ST, PA, VPA, AT	12-17	6180 (2002), 5522 (2005), 7553 (2008), 7966 (2011),	NSW Health	NSW Health	NSW Health	NSW Health

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
Australian Secondary Students Alcohol and Drug Survey ACT	ASSAD ACT	1	State	2002, 2005, 2008	ACT	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey ACT 2002-17	VPA, PA, ST	12-17	2927 (2002), 2641 (2005), 1489 (2008), 1542 (2011), 2876 (2014), 2389 (2017)	ACT Health	ACT Health	ACT Health	NA
Australian Secondary Students Alcohol and Drug Survey VIC	ASSAD VIC	1	State	2002, 2005, 2008	VIC	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey VIC 2002-17	VPA, PA, ST, SP, AP	12-17	2927 (2002), 2641 (2005), 3051 (2008), 3106 (2011), 2876 (2014), 2389 (3930)	Cancer Council Vicoria	Cancer Council Vicoria	Cancer Council Victoria, Department for Health and Human Services	NA
Australian Secondary Students Alcohol and Drug Survey QLD	ASSAD QLD	1	State	2011, 2014, 2017	QLD	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey QLD 2011-17	VPA, PA, ST	12-17	3106 (2011), 3930 (2014), 2389 (3930)	Cancer Council Queensland	Cancer Council Queensland	Cancer Council Quenensland, Queensland Health	NA
Australian Secondary Students Alcohol and Drug Survey TAS	ASSAD TAS	1	State	2008, 2011, 2014	TAS	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey TAS 2008-17	VPA, PA, ST, EX	12-17	3051 (2008), 3106 (2011), 1888 (2014), 2389 (2017)	Cancer Council Tasmania	Cancer Council Tasmania	Cancer Council Tasmania, Communities, Sport and Recreation, Department of Premier and Cabinet, Department of Education	NA
Australian Secondary Students Alcohol and Drug Survey WA	ASSAD WA	1	State	2011, 2014, 2017	WA	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey WA 2011-17		12-17	3771 (2011), 3305 (2014), 2389 (2017)		Cancer Council Western Australia	Cancer Council Western Australia	Cancer Council Western Australia
Australian Secondary Students Alcohol and Drug Survey SA	ASSAD SA	1	State	2014, 2017	SA	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey SA 2014-17		12-17	1519 (2014), 2389 (2017)		Cancer Council South Australia	Cancer Council South Australia	Cancer Council South Australia
Australian Secondary Students Alcohol and Drug Survey NT	ASSAD NT	1	State	2014, 2017	NT	Cross-sectional	Stratified	Self-report	Questionnaire	Australian Secondary Students Alcohol and Drug Survey NT 2014-17		12-17	1518 (2014), 2389 (2017)				
NN_Newcombe	NN_Newcombe	1	State	1990	QLD	Cross-sectional	NA	Self-report	Questionnaire	NA	SP	16-17	312	Peter Newcombe	University of Queensland	NA	NA
NoName_Ziviani	NN_ZIVIANI	1	State	2005	QLD	Cross-sectional	Stratified	Parent-report	Questionnaire	NA	PA, SP, AP, EX	6-7	318	Jenny Ziviani	University of Queensland	University of Queensland, Australian Research Council	NA
NoName_Smith	NN_SMITH	1	State	2004	SA	Cross-sectional	NA	NA	Questionnaire	NA	PA	11-13	512	D Smith	University of South Australia	NA	NA

Study name	Abbreviation	Number of datasets	Coverage	Years of data collection	Geographical area	Design	Sampling frame	Methods	Measurement Tool	Questionnaire	Domains measured	Age of participants	Sample	Lead Researcher	Group who conducted the research	Dataset funding	Data Custodian
NN_Scott	NN_Scott	1	State	2011	NSW	Cross-sectional		Accelerometer, Pedometer (Yamax Digi-Walker CW700)	Pedometer Yamax Digi-Walker CW700 Accelerometer Actigraph GT3X+		PA	14-15	123	Joseph Scott	University of Newcastle	NA	NA
NN_McNaughton	NN_McNaughton	1	State	1961	VIC	Cross-sectional	Convenience	Self-report	Questionnaire	NA	PA	16-19	278	Jean McNaughton	University of Melbourne	University of Melbourne	NA
NoName_Livesey	NN_LIVESEY	1	State	2010	NSW	Cross-sectional	NA	Self-report	Questionnaire	Participation Questionnaire	SP, AP, SB, ST	9-12	192	David Livesey	University of Sydney	NA	NA
NoName_Hill	NN_HILL	1	State	2007	QLD	Cross-sectional	NA	Self-report	MARCA	MARCA	AT	4-12	318	Andrew Hills	University of South Australia	NA	NA
NoName_Delaney	NN_DELANEY95	1	State	1994	NSW	Cross-sectional	NA	Self-report	Questionnaire	NA	SP, EX, AP	14-17	163	Wendy Delaney	University of Newcastle	NA	NA
Tasmanian Child Health and Wellbeing Survey	TasCHWS	1	State	2009	TAS	Cross-sectional		Parent-report	Questionnaire	Tasmanian Child Health and Wellbeing Survey	PA, ST, AT	0-12	1228	NA	Social Research Centre	Department of Health and Human Services	NA
The PLAY Spaces & Environments for Children's	PLAYCE	1	State	2015	WA	Cross-sectional	Stratified	Parent-report, Accelerometer (ActiGraph GT3X+), Radio Frequency Identification	Questionnaire, ActiGraph GT3X+	Physical and Nutritional Home Environment Inventory	OPA, SB, VPA,	2-5	1596	Hayley Christian	University of Western Australia	Healthway	NA
South Australian Health and Fitness Survey	SAHFS	1	State	2007, 2013	SA	Serial cross-sectional	Stratified	Self-report	Questionnaire	Australian Health and Fitness Survey	OPA; SP; AT; AP; SB; VPA; PE	10-15	446 (2007) 394 (2013)	Nicole Lewis, Verity Booth	University of South Australia		Verity Booth
National Child Health Poll	NCHP	1	National	2017, 2018	ALL	Cross-sectional	Stratified	Parent-report	Questionnaire	NA	AT, ST	0-18	1977 (2017) 1745 (2018)	Anthea Rhodes	Royal Children's Hospital	RCH Foundation	NA
ACT Kindergarten Health Check	ACTKHC	1	State	NA	ACT	Cross-sectional	NA	Parent-report	Questionnaire	ACT Kindergarten Health Check	PA	4-5	NA	ACT Health	ACT Health	ACT Health	NA
ACT General Health Survey	ACTGHS	1	State	2007-2018	ACT	Cross-sectional	Random	Parent-report, Self-report	Questionnaire	ACT General Health Survey	PA	5-18	Approx 1000 each year	ACT Health	ACT Health	ACT Health	NA
Latrobe 14 to 18 year olds		1	State	1975	VIC	Cross-sectional	Stratified	Self-report	Questionnaire		SP	14-18	797	Millicent Poole	La Trobe University	Australian Advisory Council for Research and Development in Education	NA
Life style: Health Risk Factors		1	State	1985	NSW	Cross-sectional	Random	Self-report	Questionnaire	Labout Force Survey		15-18	NA	John Wilson	Australian Bureau of Statisitics	NA	Australian Bureau of Statistics

Appendix 4 Delphi participant information

PARTICIPANT INFORMATION SHEET

Project Title: Databases of physical activity in Australian children: an audit, an online repository, and recommendations on survey instruments

Researchers: Verity Booth, Professor Tim Olds, Dr Natasha Schranz, Professor Grant Tomkinson & Professor Dave Lubans

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Why is this research being conducted?
It is important to monitor physical activity levels for compliance to guidelines, as well as providing information on trends and possible future research. However, this is currently difficult to do due to the lack of comprehensive nationwide surveys. It is unclear what data currently exists on levels of children's physical activity and sedentary behaviour, and what exists consists of a vast number of different survey instruments. Currently, Australia does not have a set of standardised questions to asses these behaviours, making it difficult to combine or compare data collected. Therefore, the aim will be to compile a set of recommended questions which Australia could use to monitor physical activity and sedentary behaviour. The specific behaviours involved include; overall physical activity, sport, physical education, active transport, active play and sedentary behaviour.

What do I need to do?
This is an invitation for you to be a participant in a Delphi survey to gather expert opinions on which questions could be used to monitor physical activity and sedentary behaviours. This involves three-rounds of an online survey asking you to score previously used questions according to the information which will be provided.

Round one
The first round may take approximately an hour to complete, and can be completed over more than one occasion. It will involve rating each question based on a set of criteria. Participants will be provided with factual information on each question to assist with their appraisal.

Round two
In the second round you will be provided with a draft order of the questions and given an opportunity to comment on this. You will also be given an opportunity to alter your rating of each question. This round may take approximately 40 minutes.

Participants will be given four weeks to submit their answers for each round. The survey will be conducted from approximately November to February 2020. Your participation is entirely voluntary.

How will the participants be selected?

Participants will initially be invited from the Active Healthy Kids Australia Research Working Group. These participants will then be asked to suggest 2 other possible participants, one from academia and another from an industry setting. Participants are required to be experts in this research field, determined by having published in a peer-review journal in the last 12 months and been involved in in this research field for at least five years.

How will this research be used?

The outcome of this research will be to create a set of recommended questions that could be used to monitor the physical activity and sedentary behaviour participation of Australian children. This would make way for more consistent methodological approaches and result in easier comparison of data. Participants will be provided with a summary of the research findings including the recommended set of questions shortly following the completion of the survey. A de-identified copy of the data may be used for other research purposes.

What are the risks?

It is not anticipated that there are any risks to participation in this study beyond those encountered during everyday life.

Am I free to withdraw?

Participation in this study is voluntary and participants may withdraw from the research at any time without affecting their position now or in the future. Any information that has been provided within the survey may still be used anonymously.

Does this project have ethical approval?

This project has been approved by the University of South Australia's Human Research Ethics Committee. If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: 08 8302 3118; Email: vicki.allen@unisa.edu.au.

How will my confidentiality be protected?

All information containing personal information will remain confidential and no information which could lead to identification of any individual will be released, unless required by law. However, the researcher cannot guarantee the confidentiality or anonymity of material transferred by email or the internet. Any personal details that are provided are for the purpose of determining eligibility to be a participant in this survey. All information collected as part of the study will be retained for five years and stored on a password-protected computer at UniSA's City East Campus. Participants will be given the option to be included in any relevant publication which results from this Delphi survey.

Will participating cost me anything?

No, there is no cost associated with participation in this survey.

If I want to make a complaint?

Participants or third parties who wish to lodge a complaint about either the study or the way it is being conducted should contact the Executive Officer of UniSA Human Research Ethics Committee via email: humanethics@unisa.edu.au or phone: 08 8302 3118.

PARTICIPANT INFORMATION SHEET

What happens now?

If you are interested in participating in this survey, please confirm using the link provided at the end of the email.

Want more information about the study?

If you would like more information about this survey, please contact Verity either by email verity.booth@mymail.unisa.edu.au [redacted]

Appendix 5 Delphi questionnaire example

University of South Australia ACTIVE HEALTHY KIDS AUSTRALIA

Recommendations on physical activity and sedentary behaviour questions measuring participation of Australian children and adolescents

Question 1

Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?

Variation/s:
Over the last 7 days...

Example of how this question has appeared in a previous survey

(a) Over **the past 7 days**, on how many days were you physically active for a total of at least 60 minutes per day?

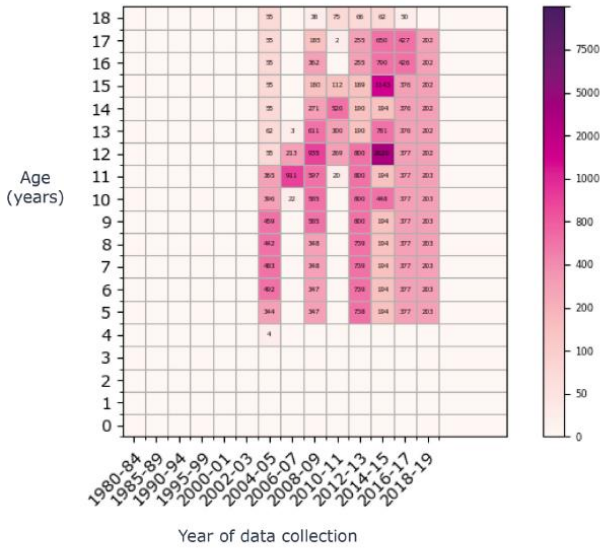
0 days	1 day	2 days	3 days	4 days	5 days	6 days	7 days
0 ☐	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	6 ☐	7 ☐

Question from the Australian Secondary Student's Drug and Alcohol Survey Victorian Questionnaire

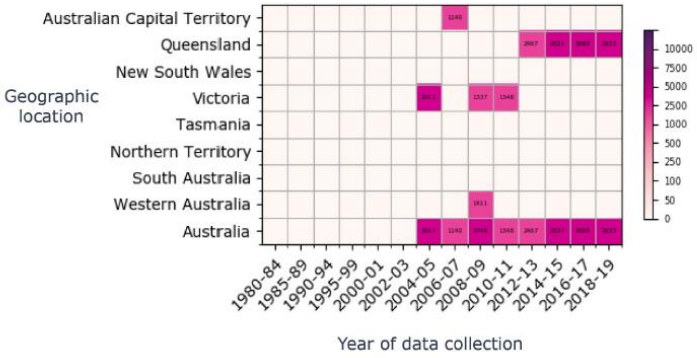
Summary of previous responses to this question

Total number of participants: *75,893 children and adolescents*
Age of participants: *4 - 18 years*
National representation? *Yes*

The number of participants per age who completed this question and the year of data collection



The number of participants per geographic location who completed this question and the year of data collection



Reliability and validity of this question

	Type	Comparison	Statistical analysis	Outcome
Reliability	*Test-retest*	*Not applicable*	*Intraclass correlation coefficient*	*ICC 0.88 (same day)* *ICC 0.53 (1 month)*
Validity		*Accelerometer*	*Pearson's coefficient*	*0.37*

Appendix 6 List of questions included in the Delphi questionnaire

No.	Question	Validity	Reliability
1	Over the past 7 days/last 7 days/past week, on how many days were you physically active for a total of at least 60 minutes per day?	• Accelerometer • r=0.37	• Test-retest • ICC=0.88 (same day) • ICC=0.53 (1 month)
2	How does your child travel TO/FROM school in a usual week? (bus, car, cycle, ferry/boat, skateboard/scooter, train, walk/walk public transport, cycle, car) On how many days a week does child use this type of transport to go to school/home from school? How long does this transport take on the way to school/home from school?	• Not found	• Not found
3	In an average week, when you are in school, on how many days do you go to physical education classes? During an average physical education (PE) class, how many minutes do you spend actually exercising or playing sports?	• Not found	• Test-retest • ICC=0.55-1.00
4	Over the last week, about how much time did your baby spend doing the following activities. a. Playing baby games with an adult (e.g. peek-a-boo, pat-a-cake etc); b. Being physically active with you (e.g. helping them roll, kicking their legs, move on a mat, etc); c. Having tummy time (on their stomach while awake); d. In a bouncer or swing; e. In a stroller or pram; f. In a car seat or capsule; g. In a cot or bed during the day; h. In a high chair or other chair; i. In a playpen; j. On the floor; k. Playing alone (supervised but no interaction); l. With other babies of a similar age; m. With older toddlers or children; n. Watching or infront of the television; o. Outside; p. In a baby carrier or sling	• Not found	• Test-retest • ICC=0.20 to 0.92 (2 week time frame) for entire survey
5	During the last 7 days, how much time did you usually spend sitting.... On a weekday? On a weekend day?	• Criterion validity • Accelerometer • Pearson's correlation • r=0.16 (age 20-69yrs)	• Test-retest • Spearman's correlation • ρ=0.59 to 0.72 (3-7 day timeframe) • Mean age 35.9yrs
6	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	• Not found	• Not found

7	In the past 12 months, what sort of sports and physical activities have you participated in? Organised competitive team sports, organised competitive individual sports, organised but non-competitive physical activity e.g. aerobics, weight class, circuit training, non-organised physical activity (e.g. playing chasey, going for a swim or brisk walk)	• Not found	• Not found
8	About how many hours on a typical weekday would you say that the child uses a computer at home? About how many hours on a typical weekend day, does the child use a computer at home?	• Not found	• Not found
9	How many physical education periods do you usually attend at school each week? During physical education periods, how much time do you spend exercising that makes you out of breath or sweat?	• Not found	• Not found
10	How many hours per week does (child) spend watching TV or DVDs, or using the computer, iPad or tablet device (for the internet, to play games etc)?	• Not found	• Test-retest • ICC=0.6 to 0.8 (no timeframe) for entire survey
11	Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day?	• Accelerometer • r=0.37	• Test-retest • ICC=0.88 (same day) • ICC=0.53 (1 month)
12	Thinking about the last seven days, in total how many hours have you spent using a computer at school? Thinking about the last seven days, in total how many hours have you spent using a computer at home?	• Not found	• Not found
13	Over the last 7 days, on how many days did you get at least 120 minutes (or 2 hours) of screen time (TV, videogames or computer use) per day outside of school hours?	• Not found	• Not found
14	Outside school hours: How often do you usually exercise so much that you get out of breath or sweat? Outside school hours: How many hours a week do you usually exercise so much that you get out of breath or sweat?	• Not found	• Not found
15	Over the past 7 days, on how many days was your child engaged in moderate to vigorous *sport or physical activity/physical activity* for *at least 60 minutes/1 hour or more* each day?	• Concurrent validity • Accelerometer • ICC=0.77	• Test-retest • ICC=0.88 (same day) • ICC=0.53 (up to one month)

16	During the current school term, in a typical week, where there are 10 trips to and from school, how many trips would (child) usually make...	• Convergent validity • 85.7% to 95.6% agreement • Spearman's correlation • ρ=0.61 to 0.76 • Criterion validity • Accelerometer • ρ=-0.04 (self-report) • ρ=-0.04 to 0.09	• Test-retest • Proxy-report ICC=-0.03 to 0.94 (14 days) • Self-report ICC=0.14 to 0.86 (7 days)
17	How much time did your child spend outdoors in active play yesterday? How much time did your child spend outdoors in active play last weekend?	• Accelerometer • Spearmans correlation • ρ=0.2	• Not found
18	On how many of the past 7 days did you do exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weight lifting?	• Not found	• Test-retest • ICC=0.55 to 1.0
19	Do you regularly participate in any type of informal, unstructured physical activity?	• Not found	• Not found
20	Did you do any of the following sitting down activities over the past 7 days? Watch TV; Watch videos/dvds; Play or watch handheld electronic games/movies etc; Use a computer for fun; Study, homework or extra tutoring; Read for fun; Chat on the phone; Hang out at home, park or shopping centre; Do hobbies/crafts; Music lessons/practice; Travel in a car, train, bus or boat/ferry; Go to church or Saturday school.	• Not found	• Test-retest • KAPPA • 0.098 to 0.827 for entire survey
21	How many times in the last week did you do any vigorous physical activity for at least 30 minutes that made you sweat and breathe hard?	• Not found	• Not found
22	We want to find out all the sports you have played regularly in the last year. Please include all sports you played with an organised team, group or club, or for your school, in the last year. Don't put in sports you have done as part of your P.E. classes but don't forget the sports you played during the last summer.	• Not found	• Not found

23	During the past 7 days, how did you usually get to and from school?	• Face validity • Focus group	• Test-retest • κ=0.87 (KAPPA) • 97.1 to 97.5%
24	For each of the past 7 days, mark how many hours (outside of school) did you spent sitting or lying down looking at a screen. Think about the time you spent watching TV and movies, playing video games, video chatting, text messaging, or surfing internet sites like Twitter or YouTube, for example.	• Face validity • Focus group	• Test-retest • κ=0.57 (KAPPA) • 75.4 to 94.3%
25	Some activities are designed to increase muscle strength or tone, such as lifting weights, resistance training, pull-ups, push-ups, or sit-ups. Including any activities already mentioned, in the last week did you do any strength or toning activities?	• Not found	• Not found
26	Mark how many minutes of physical activity you did on each of the past 7 days. Include physical activity during physical education class, lunch, after school, evenings, and spare time.	• Criterion validity • Accelerometer • ρ=-0.4 to 0.9	• Test-retest • ICC=0.00 to 0.97
27	On how many of the past 7 days did you watch television, play electronic games, or use a computer (other than for homework) for a combined total of 120 minutes (2 hours) or more per day?	• Not found	• Not found
28	Over the past 7 days, on how many days did you watch television, play electronic games, or use the computer (other than for homework) for a combined total of less than 2 hours per day?	• Not found	• Not found
29	How often do you usually play outdoors in your neighbourhood, for example, on the street, in a nearby park, bush area, or on a playground?	• Log book (1 week) • KAPPA • κ=0.41 to 0.6 (2 week timeframe)	• Test-retest • ICC=0.51 to 0.82 (2 week timeframe) • 63% to 100% agreement
30	About how many hours on a typical weekday would you say that the child plays with an electronic game system? About how many hours on a typical weekend day does the child play with an electronic game system?	• Not found	• Not found

31	On average, how many hours a day do you usually play video games or computer games, use the internet or chat online (including school days and weekends)? On average, how many hours a week do you usually play video games or computer games, use the internet or chat online (including school days and weekends)?	• Not found	• Test-retest • KAPPA • κ=46.7 (2 week timeframe)

Appendix 7 Delphi questionnaire results

Rankings of overall physical activity questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	15	Over the past 7 days, on how many days was your child engaged in moderate to vigorous physical activity for at least 60 minutes each day?	7.2	7.2
#2	11	Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day?	6.6	6.7
#3	26	Mark how many minutes of physical activity you did on each of the past 7 days. Include physical activity during physical education class, lunch, after school, evenings, and spare time.	6.5	6.3
#4	1	Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?	6.3	6.3
#5	7	In the past 12 months, what sort of sports and physical activities have you participated in? Organised competitive team sports, organised competitive individual sports, organised but non-competitive physical activity e.g. aerobics, weight class, circuit training, non-organised physical activity (e.g. playing chasey, going for a swim or brisk walk)	6.2	5.8

Rankings of overall physical activity questions for infants and toddlers (0-2 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	4	Over the last week, about how much time did your baby spend doing the following activities.? b. Being physically active with you (e.g. helping them roll, kicking their legs, move on a mat, etc) c. Having tummy time (on their stomach while awake)	6.2	5.8

Rankings of overall moderate vigorous physical activity questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	15	Over the past 7 days, on how many days was your child engaged in moderate to vigorous physical activity for at least 60 minutes each day?	7.4	7.5
#2	21	How many times in the last week did you do any vigorous physical activity for at least 30 minutes that made you sweat and breathe hard?	6.4	5.9
#3	14	Outside school hours: How often do you usually exercise so much that you get out of breath or sweat? Outside school hours: How many hours a week do you usually exercise so much that you get out of breath or sweat?	4.8	4.75

Rankings of muscle strengthening questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	25	Some activities are designed to increase muscle strength or tone, such as lifting weights, resistance training, pull-ups, push-ups, or sit-ups. Including any activities already mentioned, in the last week did you do any strength or toning activities?	6.7	6.1
#2	18	On how many of the past 7 days did you do exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weight lifting?	6.4	5.8

Rankings of active transport questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	2	How does your child travel TO/FROM school in a usual week? (Bus, Car, Cycle, Ferry/boat, Skateboard/scooter, Train, walk) On how many days a week does child use this type of transport to go to school/home from school? How long does this transport take on the way to school/home from school?	7.8	7.7
#2	23	During the past 7 days, how did you usually get to and from school?	6.6	5.9
#3	16	During the current school term, in a typical week, where there are 10 trips to and from school, how many trips would (child) usually make...?	6	5.6

Rankings of sport questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	7	In the past 12 months, what sort of sports and physical activities have you participated in? Organised competitive team sports, organised competitive individual sports, organised but non-competitive physical activity e.g. aerobics, weight class, circuit training, non-organised physical activity (e.g. playing chasey, going for a swim or brisk walk)	5.9	6.1
#2	22	We want to find out all the sports you have played regularly in the last year. Please include all sports you played with an organised team, group or club, or for your school, in the last year. Don't put in sports you have done as part of your P.E. classes but don't forget the sports you played during the last summer.	5.2	4.9

Rankings of active play questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	6	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	6	7.7
#2	17	How much time did your child spend outdoors in active play yesterday? How much time did your child spend outdoors in active play last weekend?	5.8	5.9
#3	29	How often do you usually play outdoors in your neighbourhood, for example, on the street, in a nearby park, bush area, or on a playground?	5.5	5.6
#4	19	Do you regularly participate in any type of informal, unstructured physical activity?	4.8	4.5

Rankings of physical education questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	9	How many physical education periods do you usually attend at school each week? During physical education periods, how much time do you spend exercising that makes you out of breath or sweat?	5.9	5.4
#2	3	In an average week, when you are in school, on how many days do you go to physical education classes? During an average physical education (PE) class, how many minutes do you spend actually exercising or playing sports?	5.6	5.3

Rankings of active play questions for toddlers (1-2 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	6	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	6	7.7
#2	17	How much time did your child spend outdoors in active play yesterday? How much time did your child spend outdoors in active play last weekend?	5.8	5.8
#3	4	Over the last week, about how much time did your baby spend doing the following activities. a.Playing baby games with an adult (e.g. peek-a-boo, pat-a-cake etc) b.Being physically active with you (e.g. helping them roll, kicking their legs, move on a mat, etc) c.Having tummy time (on their stomach while awake)	5.6	5.2

Rankings of active play questions for preschoolers (3-5 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	6	On average, how many hours is your child involved in active play (such as running, jumping, climbing)?	6	5.7
#2	17	How much time did your child spend outdoors in active play yesterday? How much time did your child spend outdoors in active play last weekend?	5.8	5.6

Rankings of active play questions for infants (0-1 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	4	Over the last week, about how much time did your baby spend doing the following activities. (Q4) a. Playing baby games with an adult (e.g. peek-a-boo, pat-a-cake etc) b. Being physically active with you (e.g. helping them roll, kicking their legs, move on a mat, etc) c. Having tummy time (on their stomach while awake)	5.6	5.3

Rankings of exercise questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	14	Outside school hours: How often do you usually exercise so much that you get out of breath or sweat? Outside school hours: How many hours a week do you usually exercise so much that you get out of breath or sweat?	5.8	5.4
#2	7	In the past 12 months, what sort of sports and physical activities have you participated in? Organised competitive team sports, organised competitive individual sports, organised but non-competitive physical activity e.g. aerobics, weight class, circuit training, non-organised physical activity (e.g. playing chasey, going for a swim or brisk walk)	5.1	5.1

Rankings of overall sedentary time questions for infants and toddlers (0-2 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	4	Over the last week, about how much time did your baby spend doing the following activities. (Q4) e. In a stroller or pram f. In a car seat or capsule g. In a cot or bed during the day h. In a high chair or other chair n. Watching or infront of the television	6.1	5.3

Rankings of overall sedentary behaviour questions for children and adolescents (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	20	Did you do any of the following sitting down activities over the past 7 days? Watch TV; Watch videos/dvds; Play or watch handheld electronic games/movies etc; Use a computer for fun; Study, homework or extra tutoring; Read for fun; Chat on the phone; Hang out at home, park or shopping centre; Do hobbies/crafts; Music lessons/practice; Travel in a car, train, bus or boat/ferry; Go to church or Saturday school.	6.4	5.9
#2	5	During the last 7 days, how much time did you usually spend sitting.... On a weekday? On a weekend day?	6.3	6.2

Rankings of screen time questions for children and adolescents (5-18 years)

Rank	Question number	Question	Overall rating (mean)	Revised rating (mean)
#1	24	For each of the past 7 days, mark how many hours (outside of school) did you spent sitting or lying down looking at a screen. Think about the time you spent watching TV and movies, playing video games, video chatting, text messaging, or surfing internet sites like Twitter or YouTube, for example.	7.1	7.2
#2	20	Did you do any of the following sitting down activities over the past 7 days? Watch TV; Watch videos/dvds; Play or watch handheld electronic games/movies etc; Use a computer for fun; Study, homework or extra tutoring; Read for fun; Chat on the phone; Hang out at home, park or shopping centre; Do hobbies/crafts; Music lessons/practice; Travel in a car, train, bus or boat/ferry; Go to church or Saturday school.	6.9	5.8
#3	10	How many hours per week does (child) spend watching TV or DVDs, or using the computer, iPad or tablet device (for the internet, to play games etc)?	6.7	6.4
#4	27	On how many of the past 7 days did you watch television, play electronic games, or use a computer (other than for homework) for a combined total of 120 minutes (2 hours) or more per day?	6.2	5.8
#5	13	Over the last 7 days, on how many days did you get at least 120 minutes (or 2 hours) of screen time (TV, videogames or computer use) per day outside of school hours?	5.8	5.4
#6	8	About how many hours on a typical weekday would you say that the child uses a computer at home? About how many hours on a typical weekend day, does the child use a computer at home?	5.6	5.3
#7	12	Thinking about the last seven days, in total how many hours have you spent using a computer at school? Thinking about the last seven days, in total how many hours have you spent using a computer at home? (Q12)	5.5	5.1
#8	31	On average, how many hours a day do you usually play video games or computer games, use the internet or chat online (including school days and weekends)? On average, how many hours a week do you usually play video games or computer games, use the internet or chat online (including school days and weekends)? (Q31)	5.2	5

Rankings of screen time questions for toddlers (1-2 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	10	How many hours per week does (child) spend watching TV or DVDs, or using the computer, iPad or tablet device (for the internet, to play games etc)?	6.7	5.3

Rankings of screen time questions for preschoolers (3-5 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	10	How many hours per week does (child) spend watching TV or DVDs, or using the computer, iPad or tablet device (for the internet, to play games etc)?	6.7	6.4
#2	8	About how many hours on a typical weekday would you say that the child uses a computer at home? About how many hours on a typical weekend day, does the child use a computer at home?	5.6	5.3

Rankings of non-screen sedentary time questions for adolescents and children (5-18 years)

Rank	Question number	Question	Round 1 rating (mean)	Revised rating (mean)
#1	20	Did you do any of the following sitting down activities over the past 7 days? Watch TV; Watch videos/dvds; Play or watch handheld electronic games/movies etc; Use a computer for fun; Study, homework or extra tutoring; Read for fun; Chat on the phone; Hang out at home, park or shopping centre; Do hobbies/crafts; Music lessons/practice; Travel in a car, train, bus or boat/ferry; Go to church or Saturday school.	6.8	5.5

Rankings of non-screen sedentary time questions for infants and toddlers (0-2 years)

Rank	Question number	Question	Round 1 rating (mean)
#1	4	Over the last week, about how much time did your baby spend doing the following activities. e. In a stroller or pram f. In a car seat or capsule g. In a cot or bed during the day h. In a high chair or other chair	5.7