Examining Physical Activity and Sedentary Behaviour Changes in Late Adolescence

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Examining Physical Activity and Sedentary Behaviour Changes in Late Adolescence

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"If you don't go after what you want,
you'll never have it.
If you don't ask,
the answer is always no.
If you don't step forward,
you're always in the same place."
- Nora Roberts

Abstract

Rationale

Physical activity declines from childhood to adulthood, on average. In late adolescence, prevalence of physical activity is low and sedentary behaviour is high. This is a concern because physical activity in adolescence is positively associated with health outcomes during adolescence and adulthood, and sedentary behaviour in adolescence is associated with negative immediate and later health outcomes. Further, during the normative transition out of secondary school, young adults are experiencing physical and mental development and situational changes in their place of residence, employment and study status, leading to altered social and financial independence. These adaptations to context and circumstances involve changes in habitual routines that may play a role in disrupting trajectories of physical activity and sedentary behaviour. The final secondary school years are, therefore, a critical time to intervene to influence future adulthood health. However, changes in physical activity and sedentary behaviour during the transition out of secondary school are poorly understood, and little is known about the underlying influences on these behaviours during this unstable period.

Objective

This thesis aimed to:

1. Examine physical activity and sedentary behaviour changes during the transition out of secondary school; and
2. Examine individual, social and environmental influences on physical activity and sedentary behaviour during the transition out of secondary school.

Methods

A pragmatic paradigm that employed both qualitative and quantitative methods was used to study the physical activity and sedentary behaviour of older adolescents. A narrative review of the literature was conducted to determine the literature gaps about how physical activity and sedentary behaviour change during the transition out of secondary school and underlying influences on these behaviours. This informed a qualitative study that used semi-structured one-on-one interviews via telephone or

face-to-face (*n*=29; 19-years-old; 55% women). Participants were recruited via social media and convenience sampling of recent school leavers. Interviewees were asked about their physical activity and sedentary behaviour before and after transitioning out of secondary school, and what they felt was influential. Verbatim transcripts were analysed using emergent coding. Thematic analyses identified perceived changes in and influences on physical activity and sedentary behaviour during the transition out of secondary school.

That inductive study helped to inform a prospective study that collected quantitative data from a cohort of Year 11 students (second last year of secondary school). Participants were recruited via social media and secondary schools. Three surveys were conducted, either interviewer-administered via telephone or self-administered online, spaced 12-months apart (baseline: *n*=1 022, 17-years-old, 74% girls; two-year follow-up: *n*=852, 19-years-old, 74% women). Regression models and generalised estimating equations were used to analyse associations of daily means of physical activity and sedentary behaviour with multiple individual, social and environmental attributes and changes in behaviour were examined according to situational transitions. Cross-sectional correlates, longitudinal determinants, and moderators of associations between situational transitions and changes in physical activity and sedentary behaviour were identified.

Overall findings

The narrative literature review found that studies focused on the transition between late adolescence and adulthood have examined sedentary behaviour less frequently than physical activity, examined behaviours retrospectively, had long follow-up periods, and included a wide age range that included children. Therefore, the specific transition out of secondary school is not well understood and may result in unique changes in physical activity and sedentary behaviour and underlying influences.

The qualitative exploration had a sample bias towards recent school leavers commencing tertiary education and not changing their place of residence post-school. Most interviewees perceived that they changed their physical activity and sedentary behaviour post-school, with few conveying that they maintained their physical activity (*n*=5) or sedentary behaviour (*n*=4). The directions of change were mixed (*n*=13 increased and *n*=11 decreased physical activity; *n*=13 increased and *n*=12 decreased sedentary behaviour). Recent school leavers described that the types of

behaviour that changed the most were active transport, occupational physical activity, sport, technology use, studying at a desk, sedentary transport and occupational sedentary behaviour. The main influences on physical activity during their transition out of secondary school were believed to be time-use and social support, and, for sedentary behaviour, tertiary education and social support.

The test-retest reliability of the ProjectADAPT survey was tested in a separate sample of Australian 17-year-olds (n=83) and was acceptable. Compliance with the National Physical Activity (53%) and Sedentary Behaviour (34%) Guidelines was poor, although higher than other studies. Mean discretionary physical activity was 77 mins/day and total sedentary behaviour was 9 h/day in Year 11. Cross-sectional correlates of physical activity in late adolescence were physical activity goal setting, self-efficacy and enjoyment, social network count and sedentary behaviour discouragement from friends or colleagues (all positive). In multivariate analyses, the only correlate of sedentary behaviour identified in late adolescence was physical activity goal setting (negative).

After participants transitioned out of secondary school, compliance with the National Physical Activity and Sedentary Behaviour Guidelines decreased. There were decreases in mean discretionary physical activity (-9 mins/day; p<0.001) and total sedentary behaviour (-44 mins/day; p<0.001). There were differences in changes in sedentary behaviour according to situational transitions, with recent school leavers who worked ≥20 h/wk, exclusively worked, did not study, lived independently, or studied while living independently decreasing sedentary behaviour more than respective comparison groups. Situational transitions did not affect changes in physical activity.

Longitudinally, physical activity enjoyment and goal setting at baseline predicted higher physical activity following the transition, while baseline television avoidance self-efficacy predicted lower sedentary behaviour. Numerous moderators of the associations between situational transitions and physical activity (12) or sedentary behaviour (2) during the transition out of secondary school were found. Common moderators were baseline levels of sedentary behaviour discouragement from family, friends or colleagues, co-participation in physical activity, electronic games, television and digital versatile discs (DVDs) with family, friends or colleagues. An example is those living with parents post-school had higher physical activity if they reported a high amount of physical activity equipment at home in Year 11.

Conclusion

Physical activity and sedentary behaviour patterns in late adolescence changed over time. Physical activity declined after Year 11, whereas sedentary behaviour declined after leaving the structure of secondary school. Working ≥20 h/wk and/or exclusively working resulted in the greatest declines in total sedentary behaviour during the transition. Correlates and determinants of physical activity and sedentary behaviour were mostly individual attributes, including physical activity goal setting, enjoyment and self-efficacy. In contrast, predominantly social attributes moderated associations between situational transitions and physical activity and sedentary behaviour during the transition out of secondary school, including sedentary behaviour discouragement and co-participation in physical activity with family. Therefore, to insulate older adolescents against the impact of the transition out of secondary school, initiatives are needed that aim to increase physical activity goal setting, enjoyment and self-efficacy, sedentary behaviour discouragement, and co-participation in physical activity with family. Future research is needed to identify effective, feasible and scalable strategies to inform interventions in multiple settings, including secondary schools, tertiary institutions, families and communities. This may result in the adoption and maintenance of higher physical activity and lower sedentary behaviour during time which are associated with positive health outcomes in adolescence and later adulthood.

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Glossary of key abbreviations

Abbreviation	Term
±	Standard deviation, unless otherwise noted
AIC	Akaike's information criteria
ANOVA	Analysis of variance
B	Correlation coefficient
CI	Confidence interval
DVD	Digital versatile disc
E-device	Electronic device
E-game	Electronic game
H	Hours
ICC	Intraclass correlation coefficient
IPAQ	International Physical Activity Questionnaire
IPAQ-A	International Physical Activity Questionnaire for Adolescents
LPA	Light-intensity physical activity
LTPA	Leisure-time physical activity
Max.	Maximum
Mins	Minutes
MPA	Moderate-intensity physical activity
MVPA	Moderate- to vigorous-intensity physical activity
N/A	Not applicable
No.	Number
PA	Physical activity
PC	Personal computer
PE	Physical education
Ref.	Reference group
SB	Sedentary behaviour
SD	Standard deviation
SE	Standard error
SEIFA	Socio-Economic Indexes for Areas
SEP	Socio-economic position
TV	Television
UK	United Kingdom
USA	United States of America
VCE	Victorian Certificate of Education
VPA	Vigorous-intensity physical activity
Vs	Versus
Wk	Week

Note: This glossary is intended to be referred to concurrently when reviewing chapters, especially alongside the tables therein.

Glossary of key terms

Key terms	Definition
Correlate	An independent variable that is associated with a dependent variable[1]. Derived from cross-sectional data[2]. Not necessarily on the causal pathway between the independent and dependent variables, as the direction of association cannot be established with cross-sectional data[2]. Can suggest what may partially explain behaviour that warrants further examination in longitudinal studies.
Cross-sectional study	Cross-sectional studies are based on data collected from participants at one point in time; in effect, taking a snapshot of the participants' behaviour.
Determinant	An independent variable that is a causal factor that results in differences in a dependent variable[2]. Derived from longitudinal studies and can be used to predict prospective changes[2]. They provide stronger evidence of factors that facilitate or inhabit dependent variables over time than correlates, since determinants precede the behaviour[2].
Late adolescence	For the purposes for this thesis, late adolescence is defined as 16-21-years-old. The World Health Organisation states the age range for adolescence is 10-19 years[3]. By 19-years-old, almost every Australian (98%) has left secondary school[4], signalling young adulthood and potential commencement of multiple situational transitions.
Longitudinal study	Longitudinal studies follow a cohort of participants over a period of time, taking periodic or pre-post measurements.
Moderator	A third variable that is an effect modifier. Different levels of the moderator result in different relationships between the independent variable's effect on the dependent variable[5]. Derived from longitudinal studies and intervenes with levels of a dependent variable over time.
Physical activity	Physical activity can be broadly described as movement by muscles that causes an increase in energy[6].
- Discretionary physical activity	Discretionary physical activity is one of the primary outcome variables in Chapters 4-8. It is the sum of moderate- to vigorous-intensity physical activity in leisure-time and transport domains. It does not include light-intensity, school-related or occupational physical activity time because these were not assessed by the ProjectADAPT survey. It represents non-utilitarian physical activity because active transport is arguably not discretionary for some, for example, young people, disadvantaged groups, those without driver/motor bicycle license or those without access to a car/motor bicycle.

Key terms	Definition
Sedentary behaviour	Sedentary behaviour is an activity that involves sitting, reclining, or limited movement, and low energy expenditure during waking hours[7]. Sedentary behaviour excludes sitting while active such as cycling.
- Total sedentary behaviour	Total sedentary behaviour is the other primary outcome variable in Chapters 4-8. It is the sum of sedentary behaviour in all domains (leisure-time, transport, education, work and domestic). Although the behaviours sought by the International Physical Activity Questionnaire (IPAQ) refer to 'sitting', the survey item asked about other postures as well (time lying down) which is more reflective of the term 'sedentary behaviour'[7].
Situational transition	These include life events and post-school pathways, such as changes in place of residence, employment, education, health and relationships. It is hypothesised that routines and habits around physical activity and sedentary behaviour may be disrupted as a result of situational transitions[8]. Although childbirth and marriage can affect physical activity[9, 10], these will not be examined because the median age of occurrence is older than the focus age range for this thesis (28.9 and 29.2-years-old for females, respectively[11]).
Year 11; Year 12	The penultimate year and final year of secondary schooling in the Australian school system, respectively.

Chapter 1

Thesis overview

It is well-known that physical activity has a dose-response relationship with health outcomes, with inadequate physical activity associated with coronary heart disease, type two diabetes mellitus, colon and breast cancers, and premature mortality[12]. Additionally, growing evidence indicates sedentary behaviour (sitting, reclining or limited movement, and low energy expenditure during waking hours[7]) is associated with cardiometabolic outcomes and all-cause mortality risk[13, 14]. Most adolescents do not meet Physical Activity and Sedentary Behaviour Guidelines[15]. This is compounded by physical activity tending to decrease and sedentary behaviour tending to increase with age[16] and, specifically, an average decrease in physical activity of 7% per year during adolescence[17]. Therefore, ensuring young people are sufficiently active and limit sedentary behaviour is critical.

How and why physical activity and sedentary behaviour change toward the end of adolescence during the transition out of secondary school is poorly understood. Late adolescence is a life stage where there is high variability and instability due to the wide range of life changes that occur, such as leaving secondary school, commencing tertiary education or commencing full-time employment. The life transition model[18] posits that transitions are a time when harmful changes in health behaviours patterns may occur that lay the foundation for the development of chronic health conditions and diseases. The model also hypothesises that those going through a transition are highly receptive to education, presenting an opportunity to embed resilience to harmful changes in behaviour and lifestyle prior to leaving secondary school. Therefore, intervening prior to the transition out of secondary school may set up health-promoting habits regarding physical activity and sedentary behaviour for the lifespan. To do so, and in keeping with the Behavioural Epidemiology Framework[19], key influences need to be identified that may protect against inadequate physical activity and excessive sedentary behaviour. The ecological model[20, 21] suggests assessing a range of potential individual, social and environmental influences. Despite there being studies that have reported influences on physical activity and sedentary behaviour in adolescence, including longitudinal studies, very little research has sought to examine influences on physical activity, and especially sedentary behaviour, during the transition out of secondary school in late adolescence (16-22-year-olds).

This thesis aims to examine how physical activity and sedentary behaviour change in late adolescence and to identify the individual, social and environmental influences underlying those two health behaviours. This thesis focusses on the time when students are in the final years of secondary school and in the immediate years after, ensuring the impact of the normative transition of leaving school on physical activity and sedentary behaviour is observed. The aims of this thesis are fulfilled using a sequential progression of data collection and analysis methods. Correspondingly, each chapter develops the evidence from previous chapters, expanding what is known about how and why physical activity and sedentary behaviour change during the transition out of secondary school. A mixed-method approach is used, including both qualitative (Chapter 3) and quantitative (cross-sectional and longitudinal; Chapters 4-8) analyses.

Chapter 2 presents a narrative review of existing literature on physical activity and sedentary behaviour in late adolescence. Descriptive epidemiology of the two health behaviours are discussed, as are the various influences. The gaps in the literature are highlighted throughout this chapter. Chapter 3 presents qualitative data from the LEAP (LEaving school and your Activity Patterns) study. The LEAP study involved interviews that captured the narratives, viewpoints and perceptions of recent secondary school leavers (18-22-year-olds). The topic guide focussed on changes in physical activity and sedentary behaviour, the impact of situational transitions, and individual, social and environmental influences on physical activity and sedentary behaviour during the transition out of secondary school.

Findings from the LEAP study were used to inform survey development for a two-year prospective study of school leavers named ProjectADAPT. Chapter 4 presents the baseline participant characteristics and test-retest reliability from ProjectADAPT. Chapters 5-6 outline cross-sectional baseline data from ProjectADAPT that provides a snapshot of behaviour patterns and identifies individual, social and environmental correlates of physical activity and sedentary behaviour in late adolescence.

In Chapter 7, longitudinal changes in physical activity and sedentary behaviour during the transition out of secondary school within the ProjectADAPT study are described. This chapter represents the first of two chapters involving quantitative longitudinal analyses, as the type of evidence examined in this thesis shifts from qualitative (Chapter 3) and quantitative cross-sectional data (Chapters 5-6).

Identifying how physical activity and sedentary behaviour change during the transition out of secondary school is important, and yet there have been few studies examining this period. This is despite exposure to multiple simultaneous changes in lifestyle and circumstance which could impact health behaviours. This chapter also describes the proportion who experienced various situational transitions after leaving secondary school, such as changes in education, employment and housing, and whether these are associated with changes in physical activity and sedentary behaviour.

Chapter 8 identifies longitudinal determinants of physical activity and sedentary behaviour during the transition out of secondary school. As such, the chapter builds on previous findings presented in this thesis by examining whether influences on physical activity and sedentary behaviour identified in the qualitative (Chapter 3) and cross-sectional quantitative (Chapters 5 and 6) studies are also important longitudinally. This chapter expands on the findings of Chapter 7 by identifying which baseline individual, social and environmental attributes moderate associations between situational transitions (for example, living independently from family) and physical activity and sedentary behaviour two years later, after transitioning out of secondary school. This chapter is novel because it examines a wide range of potential moderators, including environmental characteristics, and also includes sedentary behaviour; whereas, previous research of moderators during the transition out of secondary school has been limited to psychosocial variables and physical activity in one domain only (leisure-time)[22]. This research is important because it will inform interventions as to individual, social and environmental attributes on which to base strategies for school leavers, with further targeting possible for those who experience specific situational transitions.

The final chapter provides a concise synthesis of the overall findings and outlines a critical analysis of the research methods undertaken for this thesis by summarising key strengths and limitations. Recommendations are provided for preventative interventions that aim to promote the adoption and maintenance of physical activity and avoidance of excessive sedentary behaviour during the transition out of secondary school. Implications of the thesis findings for future research and practice are proposed.

Chapter 2

Literature review

2.1 Introduction

The aim of this chapter is to present a narrative literature review on physical activity and sedentary behaviour in late adolescence and the transition out of secondary school and the influences on these behaviours. This chapter begins with an overview of adolescence, then presents how physical activity and sedentary behaviour are defined, measured and affect health outcomes. The current National Physical Activity and Sedentary Behaviour Guidelines for adolescence are outlined, along with compliance estimates and a review of how physical activity and sedentary behaviour change over late adolescence. Theoretical models for understanding influences on physical activity and sedentary behaviour are described and correlates of these behaviours are reviewed. Associations between situational transitions and changes in physical activity and sedentary behaviour during the transition out of secondary school are introduced. Lastly, longitudinal determinants and moderators of the associations between situational transitions and physical activity and sedentary behaviour during the transition out of adolescence are summarised. This chapter concludes with the overall thesis aims that stem from the gaps in the literature.

2.2 Overview of adolescence

Adolescence has been defined as the life stage between 10-19-years-old that bridges childhood and adulthood[23]. The transition out of secondary school during late adolescence (15-19-year-old) has been identified as a critical time and important life stage for growth and development[23]. It is a time of change and instability due in part to a range of key life events that occur over this time[23]. Common situational transitions include leaving school, moving out of the family home for the first time, travelling, or commencing full-time employment or tertiary study. The transition is associated with a range of life changes, such as social, independence, setting, economic, developmental and lifestyle changes[23].

2.2.1 Social changes

Adolescence is a time when much maturation, character formation and emotional development occurs[23, 24]. During adolescence, there is generally an increase in social behaviour[23, 25]. A study reported that 15-19-year-olds adolescents spend an average of 1h 23mins socialising in the home and with friends on a weekday, and 4h 27mins on a Saturday[26]. This is opposed to 19-48 mins/day for parents[27]. Adolescent peer

groups are unstable since <50% of friendships last >1yr and between 33-50% of dissolve by adulthood[28].

2.2.2 Changes in independence

Adolescents are usually dependent on parents for food, shelter, transport and money. Compared to adults, adolescents spend more time studying, more time in recreation and less time driving[29]. Generally speaking, as adolescents transition into adulthood authority figures are questioned, autonomy increases, and dependence on parental figures is reduced[24]. Adults, such as parents and school teachers, typically impose boundaries on adolescents on what is acceptable to do and not acceptable. From approximately 18-years-old, gaining a license to drive unaccompanied is possible, which decreases dependence on parental figures for transport and increases independence. Also, approximately from 18-years-old, individuals are now legally able to access entertainment venues, such as bars, night clubs, and gambling facilities[30], and Australian citizens are required by law to vote in parliamentary elections (enrolment may occur from 16-years-old)[31] which may also increase independence.

2.2.3 Changes in setting

The secondary school setting is structured in nature; it is regimented, there are bells to prompt students to change locations, with timetabled classes, curricular and extra-curricular opportunities for sport and creative pursuits, and scheduled breaks for recess and lunch. However, post-secondary school, the structure of the weekday may change from early starts, scheduled breaks, and mid-afternoon end-times. An introduction to other settings may be a reason for the shift in structure and change in routine and behaviour during the transition out of secondary school.

In the workplace setting, sedentary jobs are an increasing population trend, with more persons employed in desk-based jobs than in previous decades[32, 33]. Thorp et al.[34] reported sedentary time accounted for 77% of time spent at work in office-based occupations, with almost half of this time spent in prolonged bouts of sitting ≥20 mins. Additionally, some desk-based occupations may have set business hours (for example, 9am-5pm) with one break for lunch, which is conducive to prolonged sitting bouts of up to 4h duration. However, the primary employment options for

young adults include part-time occupations that typically involve more standing than sitting, such as in the retail trade industry[35].

For those combining study and work, there are opportunities for physical activity during travel to and from the workplace, place of study and home. In higher education settings (universities and vocational training), the main activity is sedentary behaviour during classes, but there are opportunities for activity during breaks and when traveling to and from home. In the home setting, some young adults might experience changes post-secondary school. New expectations may include more domestic chores, financial contributions via rent or board, grocery shopping for the household, meal preparation and responsible pet ownership.

2.2.4 Economic changes

In Australia, to be able to work without significant restriction on the type and duration of employment individuals must be ≥15-years-old[36]. As of February, 2014, 12% of Australian 15-19-year-olds worked full-time and 32% worked part-time[37]. Gaining employment may increase responsibility and accountability. Increased access to income leads to economic independence from parents[24]. Adolescents with economic independence have increased opportunities for additional progress and change, such as being able to afford a car, to participate in a larger range of social activities, to travel, to rent and, therefore, move out of the family home.

2.2.5 Developmental changes

Biological changes occur during adolescence as the individual's body matures. Physiologically, adult-like features and functions become more prominent during late adolescence, as a consequence of puberty and high hormone levels[38]. Cognitive neuroscience research has shown that dramatic brain development occurs during adolescence, especially of the prefrontal cortex[25]. This part of the brain is involved in high-level cognitive functions, such as making decisions, planning ahead, social interactions, becoming self-aware, feeling self-consciousness, showing restraint, and being able to control impulses and inhibit behaviours[39]. Prior to the development of these high-level cognitive functions, adolescent brains have a heightened responsiveness to incentives[40]. This partially explains typical adolescent behaviours, such as spontaneity, unconsidered decision-making, expecting actions will be inconsequential, and nonlinear changes in behaviour[40].

2.2.6 Changes in lifestyle health behaviours

Lifestyle health behaviours continue to be learnt and practised during adolescence, including behaviours associated with social health, mental health, eating patterns, weight status, physical activity and sedentary behaviour. Experimentation and initiation of consumption of alcohol and cigarettes is common during adolescence[41] and from 18-years-old, Australians are able to legally purchase these substances. Further, risk-taking and novelty-seeking behaviours can be prevalent during adolescence[25] with the more serious examples being binge-drinking alcohol, illegal activities, illegal drug use, unsafe sex, and reckless driving[42]. Risk-taking behaviours may increase during adolescence and then rapidly decrease during the transition into early adulthood as impulse control develops[42]. Risk-taking behaviours tend to differ by sex in a similar way to puberty, with females starting and peaking earlier than males, males peaking at higher levels than females, and males reducing risk-taking behaviours more gradually than females[42].

How much people move and sit and what people eat are key modifiable lifestyle health behaviours. Eating patterns during adolescence mostly do not meet nutrition guidelines, with most adolescents not eating sufficient fruit and vegetables, and skipping breakfast on ≥5 days/wk[43, 44]. However, as adolescents transition into adulthood, eating behaviours become more aligned with nutrition guidelines[45]. Physical activity and sedentary behaviour are important and influential on aspects of social, physical and mental health, as described in the follow section. It is generally accepted that physical activity declines over adolescence[15, 17, 23], although less is known about how sedentary behaviour changes. This narrative literature review focuses on physical activity and sedentary behaviour because little is known about how and why these important health behaviours change during the transition out of secondary school.

2.3 Definitions, measurement and health outcomes

Although physical activity and sedentary behaviour are on the same movement and energy spectrum and, therefore, are interdependent, there are distinct implications that stem from each[46] that pose positive outcomes or negative burdens on public health. The health benefits of physical activity are well established and have a positive dose-response relationship, beginning with increments in activity >0[47]. Compared to research on physical activity and health, research on the deleterious health outcomes of sedentary behaviour are more recent and still emerging. For clarity, how physical activity and sedentary behaviour are defined and measured are summarised below.

2.3.1 Defining and measuring physical activity and sedentary behaviour

Physical activity is movement by the body by the skeletal muscles that causes an increase in energy expenditure[6] and is a behaviour that is directly modifiable. There are various terms to describe physical activity. Firstly, health-enhancing physical activities are performed in addition to 'baseline' activities (light-intensity activities of daily living, such as walking, standing and lifting light objects)[48]. Secondly, inadequate physical activity is an insufficient amount of health-enhancing physical activity[49], whereby recommended amounts for general health benefits are not achieved[50]. Physical activity may be categorised into domains, intensity, frequency, duration and type (Table 2.1).

Table 2.1 Physical activity information

Category	Definition
Domain	Leisure-time, occupational (including school or educational), transportation, and domestic[51].
Type	Walking, running, swimming, playing sport, cycling, taking public transport, gardening, vacuuming, and sweeping[52].
Intensity	Light, moderate or vigorous intensities are, respectively, 1.6-2.9, 3-5.9 and 6-9 times the metabolic equivalent of rest[53]. Examples are stretching, walking and running, respectively[52].
Frequency	How often it is performed.
Duration	Can be separated into bouts, such as a short, 10 mins bout or longer bouts. Total duration is the sum of bouts >10 mins[54].

In the past, people who achieved low amounts of physical activity were considered 'sedentary'[50]. Now, however, sedentary behaviour is known as distinct from physical activity[50], although arguably interdependent. Sedentary behaviour involves sitting, reclining, or limited movement, and low energy expenditure during waking hours[50] and is also a behaviour that is directly modifiable. Recreational screen time (as opposed to educational screen time) includes watching television, watching a movie at a cinema, using the internet on a computer, using a mobile phone, using handheld devices (tablets) or using consoles, such as Xbox (Microsoft, Redmond, Washington, United States of America (USA)) or PlayStation® (Sony Computer Entertainment Europe, London, United Kingdom (UK)). Educational screen time includes using devices at school to enhance learning[55] and to prepare for technology-use in the workplace[56]. Sedentary behaviour may also be categorised into domains, intensity, frequency, duration and type (Table 2.2).

Table 2.2 Sedentary behaviour information

Category	Definition
Domain	Leisure-time, occupational (including school or educational), transportation, and domestic[51].
Type	Reading, sitting at a desk, driving a car, sitting on public transport, playing piano, sewing, and screen time.
Intensity	These activities have a metabolic equivalent range of ≤1.5[50].
Frequency	Can be measured by bouts, whereby a bout can be started by sitting and finished or interrupted by standing or stepping[57].
Duration	Usually dichotomised into prolonged sitting, whereby sitting is uninterrupted for ≥20 mins[58] or interrupted sitting, whereby standing or stepping for ≥1 min interrupts the bout of sitting[57].

Common tools for assessing physical activity and sedentary behaviour are presented in Table 2.3. When choosing a suitable assessment tool for a population study, criteria to consider include cost, age-appropriateness and practicality for the sample size[59].

Table 2.3 Assessment tools for physical activity and sedentary behaviour

Tools	Strengths	Limitations
Self-report: survey, interview, log book, diary, recall questionnaire	Cost efficient[60], requires short term memory, and captures domain and context[61].	Potential bias from over-reporting and under-reporting[62].
Device-based: pedometer (stepping), accelerometer (sedentary, light, moderate and vigorous activity), inclinometer (sitting, stepping and standing)	Automatically collects activity information that is time and date stamped. Doesn't involve recall bias[61]. Better validity than self-report.	Cannot capture domain, context and co-participation information[63]. Devices may be expensive[61].

Self-reported assessment of physical activity and sedentary behaviour is common in population studies and involves participants reporting to researchers. Self-reporting captures data that devices cannot, such as the domain, the specific type of physical activity and sedentary behaviour, and non-ambulatory physical activity information. A major strength of self-reporting is cost efficiency[60]. It has been reported that self-reporting tools have fair to modest reliability and validity[61, 64, 65], and good reliability and validity of participant's recall of the frequency and ranking of physical activity, but typically not the duration[62, 66]. Confounding issues around bias, over-reporting, under-reporting, giving socially desirable answers and ability to recall are limitations of self-reported assessment tools for physical activity and sedentary behaviour[62, 66]. Favourably, statistical adjustments may be used to remove these confounders and allow the usual behaviour levels to be estimated[60].

Examples of self-reported assessment tools include log books, diaries and recall questionnaires. Log books and diaries ask participants to record details about behaviour, such as the frequency, intensity, duration, type and context of physical activity and sedentary behaviour each day. A major strength of a log book or diary is the cost efficiency[60, 67]; however, coding may be costly for large population studies[61] and some participants may find them burdensome to complete. Log books or diaries require short-term memory which improves the accuracy of self-reporting[67]. Recall questionnaires may be self- or interviewer-administered. Delivery options include face-to-face, telephone, mobile phone, online, computer, or on pen and paper.

Several self-reported assessment tools for large population studies are internationally compatible with versions for various age groups, such as the International Physical Activity Questionnaire (IPAQ) (http://www.ipaq.ki.se/). The IPAQ is for use with 15-69-year-olds. It is a recall questionnaire (for the past seven days) that has acceptable validity and reliability[54, 68]. It collects rich behavioural information on physical activity, including the frequency (days/wk), intensity (moderate and vigorous), duration (mins or h/occasion), type (including specific questions on walking and cycling) and domains of physical activity (domestic, transport, occupational and leisure-time). The IPAQ also includes some questions about sedentary behaviour. It has long, short, telephone- or self-administered versions. There has been a version developed specifically for adolescents (IPAQ-A) which additionally asks about physical activity at school[69]. A limitation of the IPAQ is that it does not find all health outcome associations previously reported using devices and underestimates some association strengths[70].

2.3.2 Physical activity and health

More evidence of the association between physical activity and health have been published in samples of adults and children, than adolescence. In Australian adolescents, youth obesity is at its highest rate[71] and type two diabetes mellitus is emerging at younger ages[72]. Physical activity is a modifiable risk factor for both of these conditions[73]. In a large study of healthy 4-18-year-olds (*n*=20 781), device-assessed moderate- to vigorous-intensity physical activity (MVPA) adjusted for sedentary time was negatively associated with waist circumference, systolic blood pressure, fasting insulin and fasting triglycerides, and positively associated with high-density lipoprotein cholesterol (HDL-C)[74]. Physical activity during adolescence in the settings of school[75] and active transport[76, 77] is associated with improved physical fitness and central fatness and notably, a large longitudinal study from the USA (*n*=1 718) estimated attribute risk and found obesity would decrease by 22% if 15-17-year-olds engaged in active transport ≥4 days/wk[78].

Physical activity during childhood and adolescence in the form of sport participation is associated with improved psychological and social health, particularly from team sports compared to individual sports and in an amount that is higher than what leisure-time physical activity (LTPA) elucidates[79]. For example, a large cross-sectional study of 10-19-year-olds from Iceland (*n*=32 456) reported MVPA is

associated with less depressive symptoms, especially from organised sport among girls[80]. Lastly, it is estimated that overweight or obesity would decrease by 11% and obesity would decrease by 26% if older adolescents played on ≥2 sports teams/year[78].

Importantly, health during adolescence tracks into adulthood. Formative work by Berenson et al.[81] studied children and young adults (2-39-years-old) and reported that the presence of risk factors, such as body-mass index (BMI), elevated blood pressure, dyslipidaemia and triglycerides increased with age. Further, these were associated with evidence of early-onset coronary and aortic atherosclerosis. This implies that multiple risk factors in childhood and adolescence may increase risk of cardiovascular disease in adulthood[81]. A large study by Venn et al.[82] found overweight and obesity in 7-15-year-old Australians (*n*=4 571) predicted obesity in early adulthood. Other cardiovascular disease risk factors, such as elevated blood pressure and atherosclerosis development also track from youth to adulthood[83, 84]. Studies also show that adolescent physical activity is associated with adult health outcomes of HDL-C (positive), total serum cholesterol to HDL-C ratio (negative), the sum of four skinfolds (negative), and obesity (negative)[85, 86].

Burden of disease is the loss in health from living with or dying early due to a disease or injury[87]. Worldwide, it is estimated that inadequate physical activity is associated with 9% of premature mortality worldwide and 6% of the burden of disease from coronary heart disease, 7% from type two diabetes mellitus, 10% from colon cancer, and 10% from breast cancer[12]. In Australia, the proportions are higher (11% from coronary heart disease, 19% from type two diabetes mellitus, 16% from bowel cancer, and 11% for breast cancer), with a total burden of disease contribution of 2.6% in 2011 that increases with age[87]. Inadequate physical activity is the second main, modifiable health behaviour risk factor (behind tobacco) contributing to the burden of disease, mainly via its association with coronary heart disease development[87, 88]. The total cost of inadequate physical activity in Australia in 2013 was estimated to be $805 million (approximately 80% direct costs to health-care system and 20% productivity), excluding the costs from dementia and uterine cancers[89].

2.3.3 Sedentary behaviour and health

Compared to physical activity, less evidence has accumulated to date that relates sedentary behaviour to health; however, the number of studies is growing. Currently, posture and energy expenditure are thought to be the casual mechanisms for the negative cardiometabolic outcomes of sedentary behaviour[90], with genetic expression also suggested[91-96]. Additionally, engaging in sedentary behaviour during leisure time may displace more active and healthier pursuits, such as light-intensity physical activity (LPA)[97]. The way that sedentary behaviour is accumulated has been associated with health outcomes, with a study finding that participants had better health outcomes for waist circumference, BMI, triglycerides and 2h plasma glucose if sedentary behaviour was broken up compared to engaging in prolonged bouts, adjusting for total sedentary time and MVPA[57]. Of the studies relating sedentary behaviour to health, most focused on adults, and very few focus on total sedentary behaviour and instead include indicators, such as screen time, sedentary transport, reading, sitting at school or sedentary occupations[98].

Some studies of sedentary behaviour and adverse health consequences, especially initially, have not accounted for physical activity to distinguish that health implications found are not caused by a lack of physical activity. Traditionally, studies used adjustments to control for physical activity but there is a recent shift to use compositional analyses, as our understanding develops of how physical activity and sedentary behaviour are on the same movement and energy spectrum and are interdependent. A recent, large dose-response and intensity-weighted time-use meta-analysis reported that the adult all-cause mortality risk threshold starts at seven uncompensated sedentary behaviour metabolic equivalent hours (USMh) for sitting (*n*=258 688) or 3USMh for television viewing (*n*=156 593)[14]. This study used data from six countries (China, Qatar, Australia, Denmark, USA and Spain) to consider the interdependence of sedentary behaviour and physical activity and argued that decreasing sitting time and increasing physical activity are equally important to offset all-cause mortality risk.

There is evidence that sedentary behaviour in adolescence is negatively associated with health outcomes with adjustment for physical activity in six studies[99-104]. Notably, two studies found sedentary behaviour was negatively associated with metabolic health[99, 100]. Firstly, a cross-sectional study of 13-17-year-olds (49% girls) found self-reported console game use positively associated with diastolic blood

pressure, mean arterial pressure, triglyceride and a score for cardiometabolic risk[99]. Secondly, in a study of children and adolescents (mean age 12-years-old; *n*=4 581), accelerometer-measured sedentary time was positively associated with blood pressure and fasting blood glucose, insulin, triglycerides and HDL-C[100]. These associations have serious implications since cardiovascular disease risk factors present during adolescence track into adulthood[84, 105, 106].

Additional evidence from studies that adjusted for physical activity includes two cross-sectional surveys of 11-15-year-olds in Europe and the USA that found screen time during adolescence was negatively associated with mental health, specifically self-image, life satisfaction, perceived health status and family relationships[101, 102]. A cross-sectional survey with a large sample of adolescents (*n*=1 234) and small samples of teachers (*n*=10) and parents (*n*=10) in Lima, Peru, found television viewing was negatively associated with self-rated health and academic performance[103]. A study of 16-year-olds from Iceland found that those who engaged in <5.3 h/day of self-reported screen time have a lower relative risk of life dissatisfaction, irrespective of frequency of participation in self-reported vigorous-intensity physical activity (VPA) more (risk ratio, RR: 0.30; 95%CI: 0.15, 0.61; $p<0.005$) or less (RR: 0.26; 95%CI: 0.08, 0.80; $p<0.05$) than four times/wk[104]. Specific to adolescent girls, a systematic review found 16 additional studies that adjusted for physical activity and reported screen-based sedentary behaviour is positively associated with BMI, waist circumference, body fat, energy intake, soft drink consumption, depression, and musculoskeletal pain[107].

In contrast, some positive benefits during adolescence from computer use, particularly on social and mental health have been found. A large study by Durkin and Barber[108] (*n*=1 304) reported that adolescents who played computer games, compared to adolescents who did not, had better interpersonal skills concerning engagement at school and relationships with family and friends, better intrapersonal skills (mental health and self-identity), less drug and alcohol use, and more involvement in sports and clubs outside of school. Further, screen-based sedentary behaviour is positively associated with family relationships in Western Europe and the quality of peer relationships in the USA and Europe[102]. However, evidence that sedentary behaviour has positive health outcomes is relatively rare. Future research is needed into the mechanisms as the findings may be related to specific aspects of computer use, such as restrictions on time or co-participation with parents.

2.3.4 Summary

Physical activity and sedentary behaviour are clearly defined and distinct health behaviours. There are many benefits to health from engaging in physical activity and negative consequences of performing inadequate physical activity and excessive sedentary behaviour. The negative consequences include significant economic burdens on health care costs and workplace productivity. This highlights the need to set recommendations and monitor how much physical activity and sedentary behaviour people engage in.

2.4 Guidelines

2.4.1 Physical Activity and Sedentary Behaviour Guidelines

The World Health Organisation, many governments and other peak organisations disseminate age-specific and evidence-based guidelines for physical activity and sedentary behaviour. The Australian Commonwealth Government's Physical Activity and Sedentary Behaviour Guidelines for adolescents[109] are generally consistent with guidelines internationally from the World Health Organisation[110] and governments in the UK[111, 112], USA[48], and Canada[113, 114]. It is currently recommended that 13-17-year-olds attain 60 mins or up to several hours of MVPA every day, and muscle and bone strengthening physical activity on ≥3 days/wk[109].

Sedentary behaviour guidelines for adolescents advise to break up prolonged periods of sedentary behaviour at home, in school, at work, in the community and when travelling as often as possible and in as many ways as possible[109]. Limiting the use of electronic media for entertainment to ≤2 h/day is advised[109]. In the UK, sedentary behaviour guidelines for adolescents advise minimising the amount of time spent sitting for extended periods[111]. Canadian sedentary behaviour guidelines for adolescents advise to limit recreational screen-time to ≤2 h/day and to minimise prolonged sitting, time indoors during the day, and motorised transport[113]. The USA does not currently have sedentary behaviour guidelines for adolescents endorsed by the government; however the American Academy of Pediatrics has media and screen time guidelines[115]. These are similar to guidelines from Australia and the UK in that it is recommended to limit recreational screen time to <2 h/day, no screen time for those <2-years-old, no screen time in bedrooms, and parents are encouraged to monitor, co-participate, model, plan and set rules and boundaries for screen-time behaviours.

2.4.2 Compliance

In 2013, the Australian Bureau of Statistics released data on compliance with the Australian Physical Activity and Sedentary Behaviour Guidelines among adolescents and adults, derived from the large, cross-sectional Australian Health Survey[15] (2011-2012; *n*=31 837). The survey compared its findings to the previous version of the guidelines (1999), as opposed to the latest guidelines (2019). Self-reported assessment of physical activity using a 7-day recall survey was used, which is susceptible to over-reporting[62, 66]. Table 2.4 presents the findings, as well as those from other high-income countries.

Table 2.4 Summary of proportion of populations who meet guidelines in various high-income countries

Country	**Age** (years)	**Guideline**	**Proportion of population meeting age-appropriate guideline** (%)
Australia[15]	15-17	≥60 mins/day of MVPA	5.8 (RSE: 18.5)
	15-17	<2 h/day of recreational screen time	18.5 (RSE: 12.5)
	18-24	150-300 mins/wk of MPA	59 (males), 48 (females)
Canada	12-16[116]	<2 h/day of recreational screen time	14 (male), 18 (female)
	18-25[117]	150 mins/wk of MPA	71.6
	18-19[118]		66 during school 41 post-school
UK[119]	'Youth': 2-18		30-40
USA[120]	12-17	150 mins/wk of MPA and PA that strengthen muscles and bones on ≥2 days/wk	16.3
	18-24		26.1

RSE: relative standard error.

Among Australian 15-17-year-olds, very few complied with the adolescent physical activity guideline and almost a fifth met the adolescent sedentary behaviour guideline[15]. The proportion of older adolescents who did not comply with both guidelines on all 7 days/week was 98.1%[15]. In 18-24-year-olds, two-thirds of males and almost a half of females achieved the Adult Physical Activity Guidelines from 1999 of 30 mins of moderate-intensity physical activity (MPA) on most days/wk[15]. As there was no specific duration limit for adult sedentary behaviour, there was no direct comparison available.

Consistent with Australia, <20% of Canadian adolescent girls and boys met the screen time guidelines of <2 h/day[116]. A considerably higher proportion of Canadian 18-25-year-olds met the physical activity guidelines (72%[117]) than Australian young adults. The difference is most likely due to the heterogeneity of measures, which impedes direct comparisons but still allows for evaluating trends. A narrative review by Ekelund et al. reported that a considerably higher proportion of youth in the UK (around a third) met the physical activity guidelines compared to Australian estimates, based on self-reported data[119]. In the 1999–2006 National Health and Nutrition Examination Survey in the USA, a higher proportion of a broad group of adolescents met the aerobic guideline only (14.7%) and the strengthening guideline only (21.3%) than in Australia[120]. Higher compliance than Australia was also found in young adults, as 52.4% met the aerobic activity guideline (similar to Australia) and 29.3% met the strengthening guideline[120, 121].

2.4.3 Summary

The Australian Guidelines are consistent with those in other developed countries. They include the frequency, intensity, duration, and type of physical activity required to achieve health benefits and prevent chronic diseases, and recommendations about breaking up prolonged sedentary behaviour and reducing sedentary behaviour. Compliance is very low among Australian older adolescents and young adults and was lower than other high-income countries including the Canada, UK and USA.

2.5 Changes in physical activity and sedentary behaviour in late adolescence

This section reviews studies that assess the type and volume of physical activity and sedentary behaviour in late adolescence via cross-sectional studies that contain participants of various ages or via longitudinal studies that follow-up a cohort over time. These studies are required to understand if and by how much physical activity and sedentary behaviour changes during the transition out of secondary school.

2.5.1 Cross-sectional studies

A narrative review by Sallis[122], summarised the evidence about age-relate declines in physical activity, and highlighted that the steepest declines were seen during adolescence. Another study confirmed age-related declines in physical activity, where young adults performed less physical activity than older adolescents[123]. This was a cross-sectional study of various age groups by Caspersen et al. and reported that 15-year-olds had higher LTPA compared to 18-year-olds, with large to very large (3-8%) annual declines. LTPA was similar for 18- and 21-year-olds suggesting that over these few years, LTPA amounts may have declined but then stabilised. Gender differences were noted, as men tended to engage in more physical activity than women. However, in addition to being cross-sectional, this study was based on a non-validated self-reported survey instrument, considered physical activity during leisure time only, and had incongruent data sources, as data collection assessment methods used for adolescence and adulthood physical activity differed. This makes it difficult to determine the extent to which physical activity changed between 15-21-years-old.

Other cross-sectional studies reported data on mean duration of physical activity and sedentary behaviour for older adolescents and young adults (18-24-year-olds) from other high-income countries. Cross-sectional data from the large Australian Health Survey 2011-2012[15] (*n*=31 837) showed that as age increased in groups of 15-17-year-olds vs 18-24-year-olds, self-reported MVPA was lower (62 vs 39 mins/day) and sedentary behaviour was higher (3 vs 5.5 h/day). This was consistent with previous studies over time[122, 123]. A European study[124] used devices and reported that adolescents spent more time than Australians engaging in sedentary behaviour (9 h/day) and similar time for MVPA (55 mins/day). A Canadian retrospective recall study[118] of 18-19-year-olds reported that the proportion of students who complied

with the recommended physical activity guidelines 2-months into the first year of university was lower than the proportion who complied in the final 2-months of secondary school, and VPA was also lower. Few qualitative studies in this area have been published. One such small study sampled first-year university students in the USA (*n*=19) and reported that those who used to be involved in sport during secondary school had an absence of regular physical activity after leaving school[125].

Cross-sectional studies are research projects that collect data from participants at one point in time; in effect, taking a snapshot of the participants' behaviours. Cross-sectional studies may not accurately reveal individual variations in physical activity and sedentary behaviour over time but do allow for between-group comparisons[123]. Strengths of cross-sectional study design are the ability to collect data from a large sample size containing a broad range of ages in a brief period of time. Further, the findings are more likely to have external validity and study drop out and attrition are not a concern[123]. Notably, cross-sectional studies do not follow the same cohort of people over time so cannot describe adequately or examine in-depth age-related behaviour change[126, 127].

2.5.2 Longitudinal studies

Longitudinal studies follow a cohort of participants over time, taking periodic or pre-post measurements. Longitudinal designs allow for the examination of how behaviours track, which involves monitoring the group mean, or whether an individual's rank or position within a cohort is maintained or changed over time[128]. Tracking correlation coefficients have been categorised as small (0.10-0.29), moderate (0.30-0.49) or large (≥0.5)[129]. A recent systematic literature review of physical activity and sedentary behaviour during the transition from adolescence to early adulthood reported low to moderate tracking of behaviours, physical activity generally decreased and sedentary behaviour usually increased[130]. It also reported few studies assessed sedentary behaviour, most studies used self-reported measures and studies often categorised behaviours differently[130].

Physical activity

In adolescence, physical activity decreases on average 7% per year, according to a systematic review and pooled analysis of 26 international longitudinal studies of 10-19-year-olds[17]. Appendix 2.1 presents a summary of prospective longitudinal studies published since 1994 that reported the tracking of and/or changes in physical activity as children and adolescents transition into adulthood. In summary, 15 prospective longitudinal studies from seven countries assessed physical activity across the transition; specifically, Australia, Canada, Finland, Netherlands, Northern Ireland, Norway and Sweden. Most studies did not additionally assess sedentary behaviour. The sample sizes ranged from 105 to 7 794, age at baseline ranged from 10-18-years-old, and the duration of follow-up intervals ranged from 7 to 25 years. There was a pattern for weak or fair tracking of physical activity[106, 131-133], with stronger tracking in males than females[106, 131]. Most studies demonstrated a general trend for decreasing physical activity over time[85, 134, 135].

Some longitudinal studies noted intra-individual seasonal variances[106, 131, 132] but not all studies stated whether adjustment was made for this confounder. The studies tended to begin in mid-late adolescence and have a long interval to follow-up (up to 25 years). This large follow-up interval included other age-related transitions that might mask the effects of the specific transition out of secondary school and would not capture short-term and interim changes in behaviour. With the exception of one[136], most studies were limited by the use of self-report assessment tools and few[137] reported the reliability and validity of the assessment tool used. Direct comparison of data was impeded by studies analysing data differently and therefore reporting correlation coefficients, odds ratios and/or mean change; however, general trends were able to be described and physical activity mostly declined over time.

Reporting correlation coefficients is a limitation, as not all of the studies reported that they considered common confounding variables of weather, smoking, area-level socio-economic position (SEP), individual-level SEP (maternal and paternal education), remoteness, or English as the primary language spoken at home. Furthermore, correlation coefficients report the strength of association and comparative within-group rank, which could distort the variation in behaviour over time[127].

Sedentary behaviour

Compared to physical activity, fewer prospective longitudinal studies report the tracking of, and changes in, sedentary behaviour as adolescents leave secondary school. A study that followed Estonian 9-year-olds for 9-10 years and Swedish 15-year-olds for six years and used devices (accelerometers) found no change in sedentary time from adolescence to early adulthood[138]. A New Zealand birth cohort study[139] followed 1 013 individuals until 26-years-old, assessing time spent watching television by self- and proxy-report (parent). A daily mean±SD of television time at 15-years-old was 3.58±1.79h for males, and 3.19±1.71h for females. At 21-years-old, there was a decrease in both sexes, to 3.07±1.73h for males and 3.07±1.79h for females. Television time was correlated between 15-21-year-olds (r=0.42, $p<0.001$). Using the same cohort, Landhuis et al.[140] reported a decrease in the mean weekday television time of 5-15-year-olds from 2.3±0.9h to 1.9±1.4h for 32-year-olds (r=0.33, $p<0.001$). In contrast, two longitudinal studies reported on screen-time more broadly and found increases from adolescence into adulthood. A seven-year follow-up study of 11-21-year-olds (at baseline) from the USA found the proportion who achieved ≤14h/wk of screen-time decreased by17%[141]. Lastly, a 10-year follow-up study of 10-year-old Belgians found the proportion who did >2h/day of screen-time increased on weekdays (12 to 51%) and weekend days (41 to 64%)[142].

Limitations of longitudinal studies of sedentary behaviour include a lack of diversity of type of sedentary behaviour assessed, since watching television may be overshadowed now by concurrent sedentary behaviour and prevalent use of recreational screen time on portable electronic devices. More longitudinal studies of sedentary behaviour in adolescence are needed that have varied countries of origin, smaller intervals of assessment rather than large intervals that may have masked changes within assessment periods, and contemporary measures of youth sedentary behaviour.

2.5.3 Summary

Cross-sectional studies reported differences in average volume between age groups that suggest lower physical activity and higher sedentary behaviour with age, with young adults spending more time in sedentary behaviour and almost half the amount of time in physical activity per day compared to older adolescents. Longitudinal studies have reported poor or fair tracking of physical activity from adolescence into adulthood, and a decline in the volume of physical activity. There is a lack of prospective longitudinal studies that observe sedentary behaviour or the specific years during the transition out of secondary school. A better understanding of the tracking and changes in physical activity and sedentary behaviour is needed, as well as what the underlying influences are on these behaviour changes.

2.6 Explaining physical activity and sedentary behaviour in late adolescence

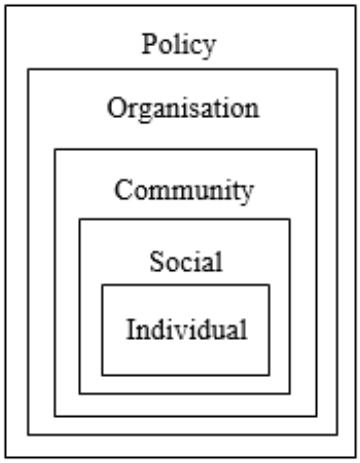
To understand physical activity and sedentary behaviour during the transition out of secondary school, theories and models can be tested and various types of cross-sectional and longitudinal associations may be examined.

2.6.1 Theories and models of behaviour

Theoretical and conceptual frameworks and models from various fields of study may help understand health behaviours and why they change[143]. Frameworks and models may be used to guide research development by identifying key areas, such as particular settings, correlates, determinants and moderators of health behaviours[143]. Different theories and models often have overlapping constructs[144]. However, in regard to health behaviour, constructs may be separated into choice-driven or choice-enabling, such as intrapersonal theories and macro-environment models[144]. Theories have evolved from being based on an individual, choices and preferences that were limited in scope and did not consider external influences. There are now comprehensive theories and models with multiple constructs. Two such theories and models that may be applied to understand health behaviour in adolescence are outlined below.

The ecological model (Figure 2.1) may be applied to health behaviours and has separate categories of individual, social and environmental[20, 21]. This model identifies organisations, communities, and public policy as potential influences on health behaviours. It is widely used, especially in health behaviour research, due to the extensive range of influences on behaviour. This model is inter-disciplinary in its formation because it encompasses theories from multiple fields of sociology, psychology and public health. It hypothesises a reciprocal relationship between influences across the levels. Although, the specific relationship between the constructs are not well addressed within the model[20], it may provide a framework for research whereby influences on behaviour change from multiple levels would be examined.

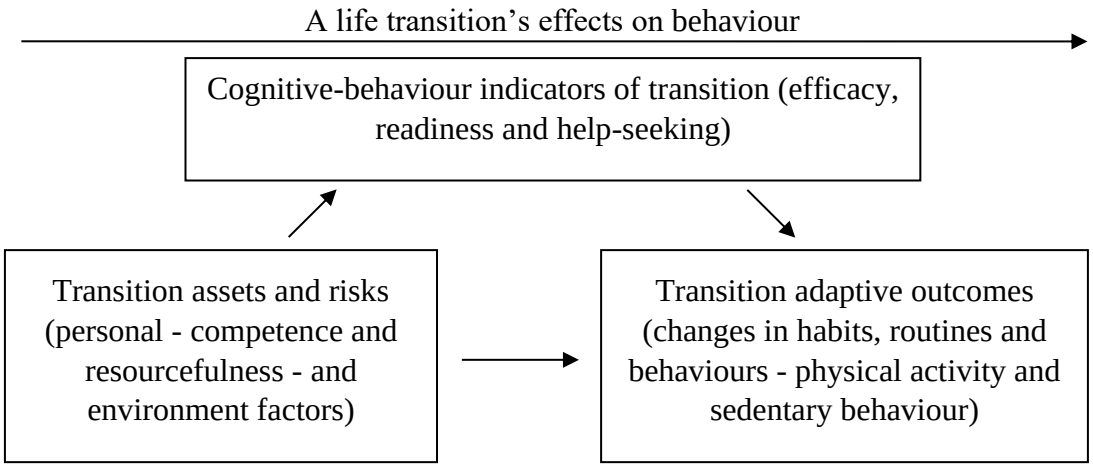
Figure 2.1 The ecological model's categories of influences on behaviour. *Adapted from Owen et al.[21], 2011*



While the ecological model is all-inclusive, there are some models that incorporate broad, systemic influences for groups or life stages that include more specificity. For example, the life transition model (Figure 2.2) was developed to assist public health nurses in understanding and influencing women and children's health and health behaviours over life transitions[18]. This model highlights contributing influences during a transition while also suggesting that individual and environmental constructs may impede the quality of the transition and the adoption of new health-promoting behaviours. It lists examples of constructs as obesity, race, age, mood, relationships, support, physical facilities and transportation. Kaiser et al.[18] defines a transition as an experience containing a period of time, change, variability and

uncertainty. Transitions are a disturbance, interruption and a shift from one stable period of time to another, where the individual has to adapt to changes. Some individuals have better outcomes post-transition than others. A goal of health providers is for the uptake of a healthier choice of behaviour to be adopted prior to or over a transition and then maintained. This is one of the few models that is specific to transitions and provides a useful framework for understanding behaviour changes during the transition out of secondary school.

Figure 2.2 Life transition model. *Adapted from Kaiser et al.[18], 2009*



2.6.2 Key correlates of physical activity and sedentary behaviour

In this section, the key correlates of physical activity and sedentary behaviour in late adolescence are categorised according to the ecological model[20, 21] and a summary is presented in Table 2.5. The majority of studies presented in Table 2.5 are quantitative as few qualitative studies in this area have been published. Two such qualitative studies sampled older adolescents but were not focussed on the transition out of secondary school specifically[145, 146].

Table 2.5 Summary of key correlates of physical activity and sedentary behaviour in late adolescence

Category	Physical activity	Sedentary behaviour
Individual	Sex (+; male)[147] Perceived competence (+)[147] Physical self-perceptions (+)[145, 150] SEP (+)[151] PA enjoyment (+)[146] Lack of time and technology (-)[145] Desire to achieve academically (-)[146]	Age (+)[148] Ethnicity (+; non-white)[148, 149] Parental education (-)[149] SEP (-)[148, 149]
Social	Support from parents and family (+)[147] Teachers, peers and competition (-)[145]	Parental modelling (+)[148] Parental restriction (+; enforcement of rules and limits)[148] Parental discouragement (-)[148]
Environmental	Land-use mix (+)[152] Residential density (-)[152] Presence of high-quality sport facilities (+)[155] Shop walkability (+)[155] Sport facilities at school (+)[155] Distance to public recreational facilities from home (-)[145, 155] Access to shops and the size of shops (+; males)[155] PA equipment at home (+; white females)[155] Cost of using facilities (-)[145]	Cul-de-sac density (+)[153] TV in bedroom (+)[154] TVs and computers at home (+)[148] Reported crime (+)[153] Avoidance of risk (+; outdoor safety concerns)[148] Parental perception of good neighbourhood sport facilities (-)[153]

Individual correlates

Individual correlates may include demographic, biological, psychosocial and behavioural characteristics. A systematic review by Bauman et al.[147] included three systematic reviews and identified sex (male) and perceived competence as the key correlates of higher physical activity at the individual level in 10-18-year-olds. Additionally, it was reported that BMI or anthropometry were examined but there was consistently no association with physical activity in adolescence, and that there was inconclusive evidence that ethnicity (white), self-efficacy, barriers to physical activity and smoking were correlates of physical activity in adolescence. Since those

systematic reviews, there has been some original research that has reported physical self-perceptions[150] and SEP[150, 151] as individual correlates of physical activity in 12-17-year-olds.

Individual correlates of sedentary behaviour were reported by a systematic review of 2-18-year-olds[148] and one of 13-18-year-olds[149]. Key individual correlates of sedentary behaviour in adolescence were age (older), ethnicity (non-white), parental education and SEP. No association was consistently found for birth weight and sedentary behaviour. Mixed findings were found for the association of BMI and sex with sedentary behaviour.

Social correlates

The social environment encompasses who an individual resides with and spends time with, including parents, friends, siblings, and peers[156]. A systematic review by Bauman et al.[147] included four systematic reviews on adolescence (10-18-year-olds) and identified support from parents and family for physical activity as the key social correlate of higher physical activity. Additionally, parental activity and perceived parental role models were examined but there was consistently no association with physical activity[147]. Additionally, a systematic review by Pate et al.[148] reported correlates of sedentary behaviour in children and adolescents (2-18-year-olds) were parental modelling, avoidance of risk (outdoor safety concerns), parental restriction (enforcement of rules and limits) and parental discouragement. There was consistently no association between parental concerns for excess television and sedentary behaviour[148].

Environmental correlates

The environment is also referred to as the physical environment, built environment (man-made structures), natural environment, domain, setting, or context. Environments that physical activity and sedentary behaviour takes place in include home, school, work, and neighbourhood[21, 157]. Both perceived and objective characteristics of the environment are useful to understanding behaviour, which is especially true for parental perceptions of the household environment, due to parent's ability to impose boundaries on adolescents[158]. Systematic reviews by Ding et al.[152] and Davison and Lawson[155] found environmental correlates of higher physical activity in adolescence (12-18-years-old) were land-use mix, residential density, sport facilities, the ability to walk to shops, sport facilities at school, short distance to

public recreational facilities from home, access to shops and the size of shops (males), physical activity equipment at home (white females), and the number of recreation facilities and parks close to home (females). There was consistently no association between perceived presence of paths or street connectivity, and greater access to local shops (females) and physical activity in adolescence. Inconsistent evidence was found for access to parks, recreation facilities, street connectivity, social incivilities, walking and biking facilities, traffic speed and volume, and unspecified traffic safety.

There are limited data on environmental correlates of sedentary behaviour in adolescence. Some studies have reported that environmental correlates of higher sedentary behaviour are the number of televisions and computers per household, having a television in the bedroom, cul-de-sac density, reported crime, and poor parental perception of neighbourhood sport facilities[148, 153, 154]. Some of these studies had wide ranges that included children so may not reflect unique correlates of older adolescents.

2.6.3 Determinants of physical activity and sedentary behaviour

For the purpose of this review, determinants have been categorised according to the ecological model[20, 21]. No studies were found that assessed individual, social and environmental determinants of both physical activity and sedentary behaviour in the one study. Studies used samples that also included childhood and early and mid-adolescence. Table 2.6 summarises findings and highlights the higher amount of studies that focus on a wider variety of determinants of physical activity compared to sedentary behaviour.

Table 2.6 Summary of determinants of physical activity and sedentary behaviour in late adolescence

Category	Physical activity	Sedentary behaviour
Individual	VPA planning (+)[159] Intentions (+)[161] Planning (+)[161] Self-efficacy (+)[161]	Age of puberty onset (-)[160]
Social	Perception of parental modelling and physical activity (+; female)[162] Family support (+)[159, 163] Perception of peer physical activity levels (+)[159] Perception of paternal care for fitness (+; male)[163]	Perception of maternal encouragement to be active (-; female)[163]
Environmental	Number of gymnasium facilities (+; males)[164] Crime (-)[164] Landscape diversity (-; in those who did not move to a new house)[164]	Television in adolescent's bedroom (+)[165]

Individual determinants

One study[159] assessed individual determinants of changes in meeting physical activity guidelines during the transition from late adolescence to early adulthood and found planning of VPA was important. Another study reported intentions, planning and self-efficacy were individual determinants of higher physical activity[161]. Limitations of this study were a wide age range of the sample that included younger adolescents that might have masked variances in determinants in late adolescence and a short follow-up of <3-months[161].

While no studies were found that considered the individual determinants of sedentary behaviour during the transition out of secondary school, one study had a sample that included older adolescents[160]. It reported age of puberty onset was an individual determinant of higher sedentary behaviour. Limitations of this study were the wide age range of the sample that included younger adolescents which might mask variances in determinants in late adolescence, and limited range of sedentary behaviour considered: only television, videos or video games on the computer on school days.

Social determinants

Three studies have reported social determinants of physical activity, one of which also measured sedentary behaviour, and had a sample that included older adolescents and young adults[159, 162, 163]. Social determinants of higher physical activity were child perceptions of parental modelling (female)[162], parental physical activity (female)[162], peer physical activity[159] and paternal care for fitness (male)[163]. Perceptions of maternal encouragement to be active (female) was a social determinant of lower sedentary behaviour[163]. Limitations of these studies included a wide age range of the sample as one study also included children[162] that might mask variances in determinants during the transition from late adolescence into early adulthood. Additionally, most had long follow-up periods that might miss behaviour change due to the specific transition out of secondary school[162, 163] and only a small range of social variables were considered.

Environmental determinants

There is a lack of studies on the environmental determinants of physical activity and sedentary behaviour across all ages groups[166]. No studies have considered the environmental determinants during the transition out of secondary school of changes in sedentary behaviour nor changes in both physical activity and sedentary behaviour. One study followed-up 12-15-year-olds and reported that the presence of a television in the adolescent's bedroom was a determinant of higher self-reported television viewing during leisure-time over two years[165]. Another study used National Longitudinal Study of Adolescent Health data from the USA and found determinants of higher physical activity were the number of gymnasium facilities (males), low crime and low landscape diversity in the neighbourhood (in those who did not move out of the family home)[164]. Limitations of these data were the long seven-year follow-up period, only the neighbourhood environment was considered (physical attributes of university campus residences, schools, homes or workplaces were excluded), only one aspect of physical activity was considered (leisure-time frequency) and the baseline sample included secondary students as well as some who had already transitioned out of secondary school.

2.6.4 Situational transitions and changes in physical activity and sedentary behaviour

The transition out of secondary school has been highlighted as important, although not well understood or well-studied[167]. This is a normative transition and coincides with multiple simultaneous situational transitions that occur over a short time period[168]. Possible consequences of situational transitions include new support bases (both social and financial); altered access to neighbourhood facilities; reformed social environments, such as meeting colleagues at a new job, meeting peers during tertiary studies, and a shift in friendship groups away from secondary school friends; altering relationships, such as starting a relationship with a significant other or separating; and, uncommonly, changing physical status due to an illness, injury, or a disability[9, 10].

A systematic review by Allender et al.[10] reported the associations between situational transitions and changes in physical activity from 19 observational studies that were mainly cross-sectional and used self-reported recall assessment tools. Allender et al. reported that commencing paid work, having an illness in childhood, changing place of residence and unemployment was associated with lower physical activity. Further, those who started work earlier (at 18-years-old) were less likely to be as physically active than those who started work later (at 25-years-old). A large four-year longitudinal study by Brown and Trost[9] similarly examined associations between the situational transition of entering the workforce on physical activity among 18-23-year-old Australian women (*n*=7 281) at baseline. Women had 15% higher odds of not complying with physical activity guidelines at follow-up if employed. In contrast, those experiencing the situational transition of returning to study or changing work hours had 18-23% lower odds of not complying with physical activity guidelines at follow-up. In comparison to physical activity, there is a dearth of studies of the associations between situational transition and sedentary behaviour, television viewing, sitting, screen time, or electronic media use.

Commencing tertiary studies

A narrative review by Nelson et al.[169] reported the transition from secondary school to tertiary study was a unique developmental stage. Dramatic changes in lifestyle were found, weight gain was highly prevalent, and the proportion meeting physical activity guidelines dropped from 34% to 13%. Nelson et al. found that most commencing tertiary students had declines in aerobic fitness, which were unlikely to reverse with age. Nelson et al. also reported higher levels of watching television, studying or using a computer for ≥30 h/wk. Few qualitative studies in this area have been published. One such study used focus groups of first-year university students from the USA and found that those who described being involved in sport during secondary school perceived an absence of regular physical activity after leaving school[125].

Of the few quantitative studies assessing change in physical activity and sedentary behaviour during the transition from secondary school to tertiary study, directions of change were mixed. However, decreasing television viewing was a consistent finding. A 7-month follow-up study by Edmonds et al.[170] reported 17-20-year-old Canadian women in the first year of studying decreased self-reported television use[170]. An 8-month follow-up study by Pullman et al.[171] reported 17-20-year-old Canadian men did not change slow aerobic physical activity, strength training and flexibility, but increased computer use and study time, and decreased television use[171]. A two-year follow-up study reported 18-20-year-old Americans self-reported no change in total exercise, decreased aerobic exercise and increased stretching[172]. Lastly, a cross-sectional retrospective study found 18-19-year-old Canadians self-reported a decrease in VPA and compliance with physical activity guidelines[118].

Simultaneously commencing tertiary studies and moving out of home

Quantitative studies in the USA and Canada[170, 171, 173] have researched associations between simultaneously commencing tertiary education and moving out of the family home into on-campus student residences and changes in physical activity and sedentary behaviour. Butler et al.[173] surveyed females in the USA at the start of the first semester of university and 5-months later and reported a decline in self-reported total physical activity. The study by Pullman et al.[171] surveyed males in Canada in the holidays prior to commencing university, at the end of the first semester (2-5-months later) and at the end of the second semester (6-8-months later). At the final

follow-up, computer use and time studying increased, fast aerobic physical activity and television time decreased and no change was seen in slow aerobic physical activity, strength training, and flexibility training. From the same university in Canada, the study of first year women by Edmonds et al.[170] collected survey data in the holidays prior to commencing university, 3-months later and 7-months later[170]. VPA and computer use increased, MPA and watching television declined, and strength-building physical activity did not change.

In their qualitative study in the USA, Cluskey and Grobe[125] explored students' experiences using focus groups at the end of the first year of university. Students described struggling to adapt previous physical activity into a new routine and perceived that physical activity decreased. Students described a change in social roles and responsibilities, modelled the behaviour of new roommates, and were influenced by social norms. Participants described that lack of experience, changes in routines and the absence of family support influenced poor choices regarding physical activity. A common limitation of the above four studies[125, 170, 171, 173] is that physical activity and sedentary behaviour were not assessed before the transition out of secondary school.

2.6.5 Moderators of associations between situational transitions and physical activity and sedentary behaviour

The following section will review how moderators may help to understand how situational transitions and influences work together to understand physical activity and sedentary behaviour during the transition out of secondary school.

Conceptualising moderating variables

Three ways that moderators vary the effect of an independent variable on a dependent variable are linear (positive or negative association), quadratic (the association exponentially increase or decrease) and step[5]. The step method of variance is when a moderator partitions the independent variable's effect size on the dependent variable into groups[5]. In this case, moderation has occurred if the strength (Figure 2.3) or direction (Figure 2.4) of the association between a situational transition and physical activity or sedentary behaviour is dissimilar for a dichotomised moderator.

Figure 2.3 The step method with a dichotomised moderator altering the strength of the association between the independent variable (situational transition) and the dependent variable (physical activity/sedentary behaviour). *Adapted from Baron and Kenny[5], 1986*

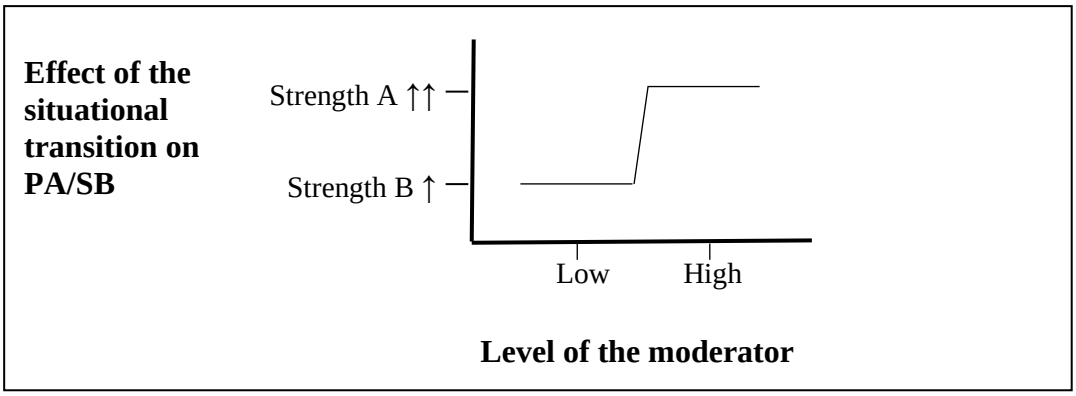
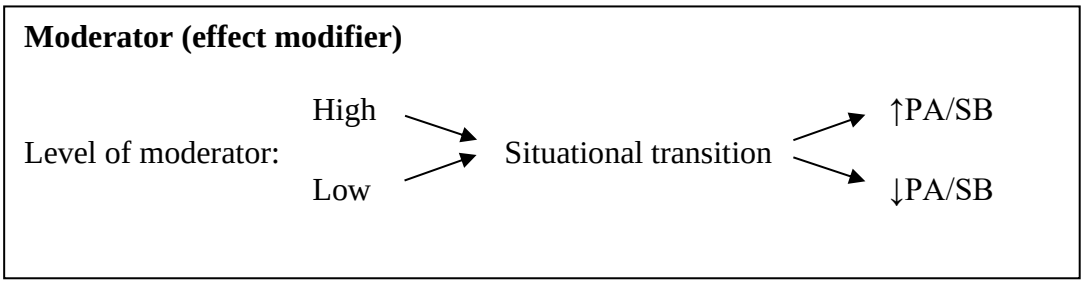


Figure 2.4 The step method with a dichotomised moderator altering the direction of the association between the independent variable (situational transition) and the dependent variable (physical activity/sedentary behaviour). *Adapted from Bauman et al.[2], 2002*



The step method of moderation will be tested in this thesis because it clearly identifies whether high or low levels of influences impact behaviour over time in at-risk or protected population groups. The findings in relation to effect modifiers can inform interventions as it helps to pinpoint what to target for different people. The findings elucidate what adolescents need to be equipped with prior to the transition out of secondary school to protect against lower physical activity and higher sedentary behaviour associated with specific situational transitions.

Conceptually, the identification of protective attributes aligns with a resilience model of health promotion[174]. Resilience is defined as a being able to constructively progress, even though substantial challenges are present[175]. The transition out of secondary school may pose substantial challenges since adolescents typically experience multiple simultaneous changes in circumstance. Determining what promotes resilience is important for informing interventions[174]. Implementing

strategies for specific target groups or tailoring techniques to a group or individual risk profile[176] is an evidence-based way to maximise the efficacy of a health behaviour change intervention and has been used in interventions aimed at diet, smoking, alcohol consumption and breast cancer screening[177, 178].

Moderators

A two-year study from Australia reported moderators for the associations between situational transitions and changes in LTPA during the transition of leaving secondary school[22]. It reported those who did not belong to a sporting club in Year 12 decreased LTPA over time more if they worked full-time post-school compared to those not working full-time. As belonging to a sporting club may be, arguably, part of the outcome, future research needs to examine whether there are other moderators for physical activity. There is a research gap for longitudinal studies examining individual, social or environmental moderators of the association between situational transitions and sedentary behaviour during the transition out of secondary school. Because of the lack of studies in the older adolescent population group, studies of other population groups are reviewed next to inform potential moderators of physical activity.

In other population groups, moderators of physical activity include social support from friends and family in Hispanic women[179], habits moderating the association between intention and total MVPA in older adults[180], weight status moderating the association between motivation and physical activity in disadvantaged youth[181], and retirement status moderating the association between park proximity to home and recreational walking in mid-older aged adults[182]. Comparatively, moderators of changes in sedentary behaviour in any population group includes positive communication with parents in African American adolescents[183], and urban location moderated the association between co-participation in physical activity with family and sedentary behaviour in children (5-12-years-old)[184]. Variables examined were categorised according to categories of the ecological model[20, 21] of individual[180, 181], social[179, 183, 184] and environmental[179, 181, 184]. These findings provide an idea of potential moderators during the transition out of secondary school to investigate. As a comparison, in other fields of study, such as psychology, common moderators to situational transitions or stressful life events include self-efficacy and competence[185].

2.6.6 Summary

This section highlighted how theories and models can be applied and tested to explain behaviour, including the ecological model[20, 21] and the life transition model[18]. There are also various types of associations that can partially explain behaviour including correlates, determinants and moderators. Individual, social and environmental correlates of physical activity and sedentary behaviour in adolescence include SEP, parental support, neighbourhood sport facilities and neighbourhood walkability. Individual, social and environmental longitudinal determinants of physical activity and sedentary behaviour include SEP, perception of parental support and the number of sport facilities in the neighbourhood. Situational transitions that appear to influence physical activity include commencing work and changing place of residence, while commencing tertiary study appears to influence physical activity and sedentary behaviour. Limited studies have examined moderators of associations between situational transitions and physical activity or sedentary behaviour during the transition from late adolescence out of secondary school.

A limitation of the body of correlates, determinant and moderator research is that most of the studies incorporated early, mid- and late adolescence samples, making it difficult to understand why physical activity and sedentary behaviour change from late adolescence during the transition out of secondary school. Additionally, previous research has not comprehensively examined a range of modifiable individual, social and environmental influences, meaning there may be undiscovered unique explanations for physical activity and sedentary behaviour during the transition out of secondary school. Further, there are few longitudinal studies whereby physical activity and sedentary behaviour were assessed prospectively from before leaving secondary school, with most asking participants to reflect and rely on memory (retrospective). Therefore, there is a need to examine the individual, social and environmental correlates, determinants and moderators of physical activity and sedentary behaviour during the transition out of secondary school. Prospective research is also needed to determine effects on physical activity and sedentary behaviour of different simultaneous situational transitions, such as changes in study, employment, and place of residence.

2.7 Conclusion and thesis aims

This chapter presented a narrative literature review on physical activity and sedentary behaviour in late adolescence and the underlying influences. Late adolescence is regarded as a time of great change and behavioural instability. Simultaneous life changes occur, such as an increased social life, more independence, economic growth, and physical development. Because inadequate physical activity and excessive sedentary behaviour are associated with negative health outcomes in adolescence and adulthood, more research is needed into understanding these behaviours during the transition out of secondary school. Cross-sectional studies have reported that as age increases during the transition out of secondary school, physical activity is lower and sedentary behaviour is higher. Longitudinal studies have observed similar findings but sometimes assessed change over large intervals that missed the specific transition out of secondary school. Very little is understood about sedentary behaviour trajectories. There is a need to better characterise changes in physical activity and sedentary behaviour, as the transition out of secondary school may be a key time to intervene to influence adult health and the associated costs to the public health system and burden of chronic disease.

While there are some known correlates of physical activity and sedentary behaviour in adolescence and adulthood, correlates in late adolescence may be unique. Transitioning out of secondary school is a life event with multiple, simultaneous and rapid changes that may stabilise or destabilise health behaviours. Situational transitions of commencing tertiary education or full-time employment may be associated with changes in physical activity and sedentary behaviour during the transition, but little research has been done on this so far. Further, there are limited longitudinal data on determinants of physical activity and sedentary behaviour during the transition out of secondary school, and while identifying moderators of these relationships is important to inform interventions, few studies have examined individual, social and environmental attributes that may moderate these associations. Findings will inform the development of tailored strategies in school settings or within interventions that aim to prevent declines in physical activity and increases in sedentary behaviour and improve adolescent and adult health.

This thesis' purpose is to understand physical activity and sedentary behaviour during the transition out of secondary school by addressing the research gaps highlighted in this chapter. To achieve this, a mixed methods approach will be utilised. Specifically, this thesis aims to:

1. Examine how physical activity and sedentary behaviour change during the transition out of secondary school; and
2. Examine individual, social and environmental influences on physical activity and sedentary behaviour during the transition out of secondary school.

Chapter 3

A qualitative exploration of influences on physical activity and sedentary behaviour during the transition out of secondary school

3.1 Introduction

Physical activity and sedentary behaviour are important health behaviours, as argued in the previous chapter; however, 15-17-year-old Australians engage in low physical activity, excessive sedentary behaviour and do not meet recommendations[15]. Most longitudinal studies have demonstrated a trend for physical activity to decrease over time and many studies report low physical activity tracks from childhood/adolescence into adulthood[130, 186]. These trends are concerning and warrant exploration into why they occur, especially since physical activity and sedentary behaviour during adolescence are early-life exposures that may partially explain some health outcomes in adulthood[16, 85, 86].

Leaving secondary school and entering into adulthood is considered a critical time for growth and development[23]. Changes in physical activity over time may be influenced by situational transitions[8, 10]. Examples of situational transitions are leaving school, travelling, changing place of residence by moving out of the family home for the first time, commencing casual, part-time or full-time employment, changing relationships, and commencing further education. For each of these, various personal and social contextual factors may exist in alternate ways and have varying impact on the amount physical activity and sedentary behaviour that individuals engage in.

Very little research has been conducted about the transition out of secondary school and looking to quantitative research provides limited clarity. A two-year follow-up study of final-year Flemish students reported household composition moderated associations between changes in individual variables (self-efficacy and health-related barriers) and a decrease in leisure-time sports[187]. Other quantitative studies[160-165, 187-189] have measured influences on changes in physical activity and sedentary behaviour during the transition out of secondary school; however, they lacked depth and a detailed understanding of the context of physical activity and sedentary behaviour; therefore, qualitative exploration is needed to gain further insight.

Few qualitative studies in this area have been published[125, 190-192]. These studies mainly explored the transition to tertiary education[125, 190, 191] or to work[192]. As such, they are limited in their ability to provide insights regarding influences on changes in physical activity and sedentary behaviour for other situational transitions, such as changing place of residence, travelling or commencing further study while working.

The studies by Cluskey and Grobe[125] and Nelson et al.[190] focussed on weight gain and physical activity, but not sedentary behaviour. The study by Deliens et al.[191] framed the study around behaviours related to weight and eating but also provided insights in physical activity and sedentary behaviour. The study by Koehn et al.[192] explored influences on changes in physical activity during the transition out of school into work but excluded sedentary behaviour and other situational transitions of further education and travelling. Also, most of those (88%) participants had left school only 2-months ago and this brief window may not reflect enough time for post-school changes in physical activity to occur. Other qualitative studies of influences on physical activity have only sampled older adolescents[145, 146, 193] or young adults[194] and have not focussed on the transition out of secondary school or explored sedentary behaviour.

In summary, the few qualitative studies that explored influences on physical activity and sedentary behaviour during the transition out of secondary school mainly focussed on physical activity and limited the situational transitions to commencing further education.

3.2 Chapter aims

The specific aims of this chapter are to:

1. Explore perceived changes in physical activity and sedentary behaviour during the transition out of secondary school among recent school leavers;
2. Explore how situational transitions impact physical activity and sedentary behaviour during the transition out of secondary school among recent school leavers; and
3. Explore perceptions of individual, social and environmental influences on changes in physical activity and sedentary behaviour during the transition out of secondary school among recent school leavers, and how these may differ by situational transitions.

3.3 Methods

Common types of qualitative methods include one-on-one interviewing and focus groups. One-on-one interviews have several advantages over focus groups, including facilitating explorations[195] and providing an opportunity for participants to express personal views free from constraint. In contrast, a group setting may not allow equal chance to speak and differing opinions in the group may cause participants to conform or not be forthcoming[196]. Semi-structured one-on-one interviews is a commonly adopted type of interview method providing a scaffolding of key topics for the interviewer to broach, rather than closed questions[197]. This allows participants to steer the interview so that it remains focussed on what is most relevant to them and allows the researcher to ask follow-on questions that expand on points made by the participant[197].

3.3.1 Study design

The LEAP (LEaving school and your Activity Patterns) study was a qualitative investigation that collected data on the perceptions of recent secondary school leavers (<3-years post-school). Perceptions were gained via one-on-one semi-structured interviews that explored experiences and views about how physical activity and sedentary behaviour had changed during the transition out of secondary school, and what these changes were attributed to. Interviews were conducted via the telephone or face-to-face. Ethical approval was obtained from Deakin University's Human Ethics Advisory Group - Health.

Three theories or models underpinned this study. The methodological orientation initially was grounded theory[198], which is inductive and guided what type of coding to use during data preparation (emergent). However, the ecological model[20, 21] guided how the influences were grouped during thematic analysis and reporting, which does not align with a grounded theory approach. Lastly, the life transition model[18] highlighted that there are cognitive-behavioural indicators of transitions that are assets or risks to adaptations. That model posits that situational transitions may disrupt roles and was used in this chapter to guide the analysis, reporting and interpretations of the findings.

The consolidated criteria for reporting qualitative research (COREQ) guidelines[195] (Appendix 3.1) was used for this study. It is a 32-item checklist that ensured inclusion of theories in the study design; noting potential bias from the research team, interview setting and the presence of non-participants; count and reasons for participant withdrawals; the number of coders; a coding tree; noting software used; quotes that illustrate the themes; and clear major and minor themes.

3.3.2 Participant recruitment

As this was an exploratory qualitative study, a target sample size could not be predetermined. The sample size was guided by data saturation: the point at which no new themes or ideas emerged from the interviews[193]. However, it was anticipated that between 27-32 participants would be needed, based on similar previous studies[146, 193]. The inclusion criteria for participants were that they: 1) had left secondary school <3-years ago; 2) were 18-21-year-olds; 3) could speak and comprehend adequate English; and 4) currently resided in Australia.

Recruitment commenced in November, 2014 and continued until no new information was raised in the interviews (rolling recruitment until data saturation) which occurred in June, 2015. Participants were recruited via a combination of methods, specifically, social media, convenience sampling, flyers and snowball sampling. For each of the four recruitment methods described in detail below, potential participants contacted the student investigator directly via email to express interest.

1. Social media: A study Facebook page was made, and an advertisement was placed on Facebook to be delivered to Australian 18-21-year-olds with a Facebook account. The advertisements 'boosted' (shared) either the page or a post from the page that included the study email address. In Australia, social networking sites were the number one online activity for most (83%) Australian 16-29-year-olds in 2010 and most (93%) social networking site users had a Facebook account in 2011[199]. When the advertisement was clicked on, potential participants were forwarded to the study page. By the end of recruitment (June, 2015) the page had 71 likes and 26 posts on the page. The posts received, in total, two likes, three comments and two shares. The page provided the study email address as the means of expressing interest in participating. Visitor posts were disabled in the page's security settings to limit the chance of spam or inappropriate posts. The

advertisements were run for 21 days, cost $65.90/day, and there was an average of 137 impressions/day delivered (2 877 total impressions). Impressions refer to the number of times an advertisement is shown and do not necessarily reflect the number of individuals who saw it.

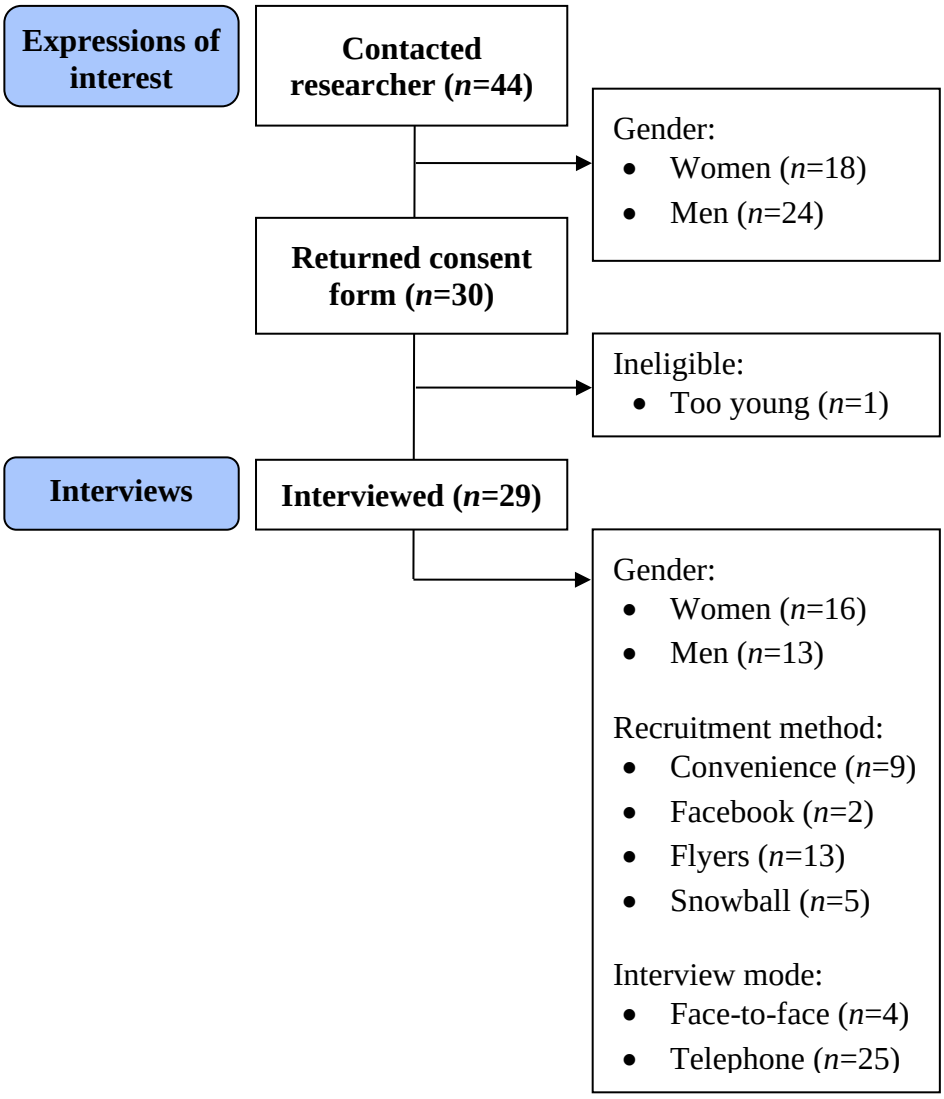
2. Convenience sampling: Existing personal and professional networks of the student investigator were emailed information about this study, a flyer, the link to the study page and the study email address to request further information. Networks were asked to forward the information on to people who they thought might be eligible and interested.

3. Flyers: Flyers were displayed in public areas such as the Burwood campus of Deakin University and community noticeboards. The flyers directed potential participants to the study page and email address for more information about this study. The initial flyer was succeeded by flyers that only sought male participants.

4. Snowball sampling: the study flyer, Facebook page link and email address were provided within emails to the student investigator's social network and to participants after completing their interviews. The email asked for the information to be forwarded on to people who they thought might be eligible and interested.

When an expression of interest was received, potential participants were emailed a detailed plain language statement and consent form, which included permission to be recorded and for de-identified quotes to be used. Potential participants were asked to complete the form and return it via email. Participants were not formally screened by the researcher, as the plain language statement outlined the inclusion criteria and participants confirmed they met these criteria on the consent form. Within the consent form, participants nominated whether they wished to be interviewed via the telephone or face-to-face in a private room at Deakin University's Burwood campus, and provided their availability. Only those who returned a completed consent form that confirmed eligibility took part in this study (Figure 3.1). Consent to participate was freely provided and participants were informed that they could withdraw at any time. The consent form collected some basic demographic information about the participants including age, sex, and the year that they left secondary school.

Figure 3.1 Study flow diagram



3.3.3 Protocol

The topic guide (Appendix 3.2) was pilot-tested on three young adults to gauge the duration and the flow of the interview topic guide, as per recommendations for qualitative studies[197]. Although there was a slight risk that participants may have felt self-conscious during a face-to-face interview, this was minimised by adopting a friendly, welcoming and calm approach during the interview. Participants were reassured that they did not need to answer questions that they would rather not and that they could end the interview at any time, for any reason.

Participants were sent an email with details of when (and where, if necessary) the interview was scheduled, according to their availabilities. Participants received a reminder email either the day before or on the morning of the interview, depending on whether the scheduled interview was early or late in the day.

The interviews took place between November, 2014 and June, 2015. The interviews were one-on-one with the student investigator. The duration of the interviews ranged from 11-30 mins and averaged 20.9±6.1 mins (SD). All interviews were recorded using a digital voice recorder. The participant's name was not mentioned during the interview. A $20 gift card for a major department store was offered to participants at the completion of the interview to compensate for their time involved in participating.

The digital recordings and transcripts of the interviews were labelled with the participant's unique identifier code for storage, cleaning, coding and analysing. This re-identifiable form meant illustrative quotes could be reported with minimal descriptive information, including age, gender, duration since leaving secondary school, employment status (work/study), and whether they had moved out of the family home post-school. Identifiable data (consent forms and participant database) and re-identifiable data (recordings and transcripts) were stored separately.

3.3.4 Measures

Participants were taken through a semi-structured interview topic guide (Appendix 3.2) that was comprised of open-ended questions to generate discussion, surrounded by a scaffolding of key topic questions. The topic guide included an opening, introduction, key questions and an ending. General questions asked participants for their perceptions, views and experiences with physical activity and sedentary behaviour during secondary school and post-school, and to expand on any changes. If changes had occurred, participants were asked why and encouraged to explain influences on the changes. Lastly, participants were asked what could be actioned in various settings (university, workplace, home or socially) to prevent a decrease in physical activity and an increase in sedentary behaviour.

The final part of the interview (Appendix 3.2) involved noting third parties present and the setting the interviewee was in, as per COREQ guidelines[195] (Appendix 3.1). This is because bystanders may have biased the informer's narrative. It has been

recommended[197] that participants of qualitative studies should be in a comfortable environment in order to feel unrestricted when speaking and to willingly and honestly share information without hesitation with the interviewer.

3.3.5 Data analysis

NVivo version 12 Plus (QSR International) was used for data preparation and analyses.

Data preparation

The recordings were transcribed at a level of intelligent verbatim (no utterances such as ah, um and err). Six recordings were sent to a professional service called Transcriber Online (www.transcriberonline.com) for transcribing and the student investigator transcribed the remaining recordings. Rather than applying preconceived codes to the interview transcripts, the codes were formed based on the participant narratives (emergent coding). A coding tree (Appendix 3.3) was developed from the interview transcripts that represented frequent topics. The tree was used to code the paragraphs, sentences and phrases within the transcripts, as applicable. Codes were then grouped into categories.

A second researcher cross-coded 10% of the interview transcripts. To ensure appropriate code allocation and data interpretation, discussions took place between investigators to provide consensus when decisions were not clear. This approach to qualitative analysis is commonly recommended[200-203], including within the COREQ guidelines[195].

Descriptive analyses

Demographic characteristics were summarised; age and duration since leaving secondary school were collected on the consent form and analysed using means and standard deviations in Stata (version 12 for Windows, 2012, StataCorp LP).

Thematic analyses

For an overview of the recent school leavers' perspectives, the most frequently mentioned words were visualised using word clouds. Word clouds give insight into exploratory textual analysis by quickly clearly communicating the most mentioned points that might reveal patterns and steer further analysis. Word frequency queries

on the transcripts overall and by gender were used. Words were grouped with stemmed words (as opposed to other groupings: exact, synonyms, specialisations or generalisation) and no minimum word length was chosen. Exclusions were discourse markers (oh, well, now, then, you know, I mean), discourse connectives (so, because, and, but, or), interjections, exclamations, fillers and utterances. The twenty words most used were identified and graphically presented.

Thematic analyses of interview transcripts from semi-structured interviews allows meaning to emerge authentically from participants' discourses[204]. Nodes were added to descriptions of static or changed physical activity and sedentary behaviour and summarised using *n* and proportions (Aim 1). Coding queries (compound coding query, coding comparison query and group query) were used on the reason nodes to identify emerging themes (Aims 2 and 3). Reasons were ranked by the most frequently mentioned. Major themes were mentioned by >14 participants. The next seven most-mentioned reason nodes were categorised as the minor themes (mentioned by ≤14 participants), and the rest of the nodes were categorised as uncommon.

Matrix coding queries were used which cross-tabulated nodes of interest to determine links between attributes and influences. Firstly, a matrix coding query was used between the direction (positive or negative) and the influences. This allowed examination of the main direction of each influence and variances in the direction. Secondly, a matrix coding query was used between the influences and multiple personal attributes. Attributes explored were gender, area-level SEP, age when interviewed, years since leaving school, whether participants changed residence post-school, whether participants went straight into tertiary education post-school, current employment status, change in physical activity and sedentary behaviour, and change in friendship groups. Area-level SEP was determined using the postcode provided on the consent form and national census data of Socio-Economic Indexes of Areas (SEIFA) of relative advantage and disadvantage to stratify into lowest, mid and highest tertiles of socio-economic area. Following the ecological model[20, 21], influences were grouped when reporting the findings into individual, social and environmental. In the following section, the results of the multiple coding queries are presented, along with pertinent quotes selected that illustrate themes or queries.

3.4 Results

3.4.1 Description of participants

Table 3.1 describes the demographic characteristics, situational transitions and activity of the participants post-school. Women and men were approximately evenly represented in the sample. The average age of participants was 19-years-old and most had finished secondary school >1-year ago. All participants were living in an urban area and most participants were living in a least-disadvantaged neighbourhood (the highest tertile of socio-economic area). A third of participants were living in a different residence or had changes in household composition post-school. Most of the participants were concurrently working and studying.

During the interviews, participants reported that most were alone except for four; one participant was sitting in a public setting (on a train), one had his mother sitting next to him at home, and two had one other person present at home. An almost even proportion of the sample described increases or decreases in physical activity and sedentary behaviour post-school, and less than a fifth of the sample discussed that they had maintained physical activity and sedentary behaviour.

Table 3.1 Sample profile (*n*=29)

Characteristics	
Demographic characteristics	
Women, *% (n)*	55% (16)
Age, *mean years±SD*	19.1±1.0
Duration since leaving secondary school, *mean years±SD*	1.4±0.8
Lowest tertile of socio-economic area, *% (n)*	17% (5)
Mid tertile of socio-economic area, *% (n)*	31% (9)
Highest tertile of socio-economic area, *% (n)*	52% (15)
Situational transitions, % (n)	
Changed residence	35% (10)
Commenced tertiary education	86% (25)
Studying only	31% (9)
Studying and working	62% (18)
Working only	79% (2)
Perceived physical activity post-school, % (n)	
Increased	45% (13)
No change	17% (5)
Decreased	38% (11)
Perceived sedentary behaviour post-school, % (n)	
Decreased	41% (12)
No change	14% (4)
Increased	45% (13)

3.4.2 Word clouds

Word clouds for the overall sample and by gender are presented in Figures 3.2-3.4. The word cloud for the overall sample suggests that recent school leavers perceived multiple settings of physical activity and sedentary behaviour to be important, since the words ‘university’, ‘home’, ‘work’, and ‘schools’ were frequently used.

Figure 3.2 The 20 words most frequently said by the overall sample

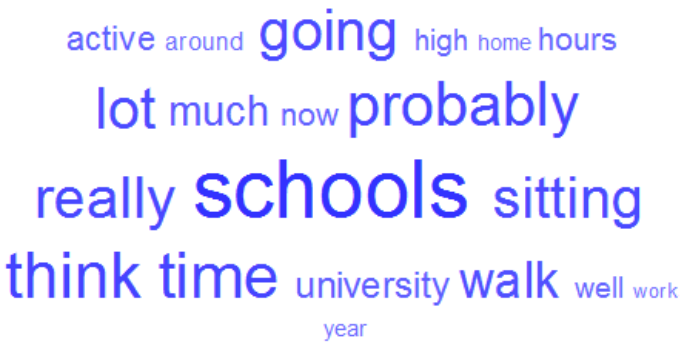


Figure 3.3 The 20 words most frequently said by participants who identified as women

Figure 3.4 The 20 words most frequently said by participants who identified as men

The words most frequently used differed by gender and warrant further exploration, since word clouds may provide a snapshot of findings and reveal patterns to inform thematic analysis. Although men and women frequently described ‘walking’, terms specific to physical activity such as ‘gymnasiums’, ‘playing’ and ‘sport’ were among the top 20 words mentioned most by men but not women. This may reflect the common types of physical activity men engage in during the transition out of secondary school. ‘People’ and ‘friends’ were among the top 20 words mentioned most by women but not men. This may be indicative of social aspects of physical activity and sedentary behaviour being more important and influential to women than men. ‘Breaks’ and ‘standing’ were among the top 20 words mentioned most by men

but not women. This may suggest that men intentionally break up sedentary behaviour with standing or moving to decrease sedentary behaviour and increase physical activity more than women. Although men and women frequently described 'sitting' in general and a specific type of sedentary behaviour 'studying', 'television' was among the top 20 words mentioned most by women but not men.

3.4.3 General life changes

Some participants described a range of general life changes since they had left secondary school. These included having more independence, less stress, and changes in social networks. Other general life changes experienced by participants post-school were more responsibilities (notably financial responsibilities), getting a driver's license, getting a car, moving out of the family home, getting a job, and having more responsibilities at home.

> *I've the responsibility of cleaning the house and cooking and … paying bills. Having to work more to be able to afford that. I guess getting my license as well, I got that a year and a half/two years ago. So, with that, petrol and car bills* (Woman, 20-years-old, 2.5-years post-school, changed residence post-school, university student, working).

> *I'm expected to do a bit more because I'm home more* (Man, 19-years-old, 1.5-years post-school, living with parents, university student, working part-time).

Frequently, participants mentioned that they experienced changes in social circles post-school, with most participants describing losing or drifting apart from friends post-school. Some participants described making new friends at the place of tertiary education or work.

> *Basically, I stopped seeing everyone from high school. You just kind of drift apart and you make new friends in your classes at university or through work instead. It's a bit different because you're not seeing those people every day* (Woman, 19-years-old, 1.5-years post-school, living with parents, university student, working two part-time jobs).

> *I still have all my old friendships, but I have a lot of new friendships now and I probably prefer them more in a way* (Woman, 19-years-old, 0.5-years post-school, living with parents, university student, working two jobs).

Some participants described having more independence post-school and how the strict boundaries that were imposed on them by parents and teachers during secondary school had been lifted.

> *I am a little bit more independent now in the sense that [my parents] are not necessarily worried if I stay up until two or three. Whereas in VCE* [Victorian Certificate of Education], *yeah* (Man, 18-years-old, 0.5-years post-school, living with parents, university student, working).

Some participants described feeling less pressure and stress post-school because they perceived that university was more flexible than secondary school, and they experienced more enjoyment from studies than what they felt at secondary school.

> *Once school finished, I feel that it was a lot less stressful than it was, because exams take a toll on you after a while. You have a bit of a clean slate* (Woman, 18-years-old, 0.5-years post-school, living with parents, university student, working casually).

> *University is way more flexible with my workload. … I am only in two or three times a week. … I got a bit more lazy with my courseload. Certainly a lot less stressed … because I enjoy what I do and there is not as much pressure* (Man, 20-years-old, 1.5-years post-school, living with parents, university student).

3.4.4 Descriptive exploration of physical activity and sedentary behaviour

Participants, generally, were better able to articulate, had more things to say, and were quicker to answer the questions about physical activity, than questions about sedentary behaviour. During interviews, most participants asked for clarification, examples or repetition of the definition of sedentary behaviour, but did not do the same for physical activity.

> *I think a lot of people don't really realise. I don't think people think as much about sedentary behaviour and that being a bad thing. I think the education and how things are sort-of constructed is more very much focussed on how much physical activity to get and not much on educating people on sedentary behaviour* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student).

Participants were asked to describe physical activity and sedentary behaviour while they attended secondary school and post-school, then to summarise changes (Aim 1). Five domains of physical activity and sedentary behaviour, leisure-time, domestic, transport, occupational and school, emerged from the data.

Physical activity and sedentary behaviour during the school years

Commonly, participants described participating in less physical activity during senior years when they were studying towards receiving their leaving certificate - Victorian Certificate of Education (VCE) - compared to earlier years of secondary school. Some participants described the various reasons why physical activity reduced and sedentary behaviour increased during school years. Reasons included physical education classes were only compulsory for students in earlier years of secondary school, they felt like they did not have to prioritise school workload over physical activity pursuits in the earlier years, they needed to study more in the later school years, and some had a personal preference for sitting.

> *Well, after Year 10 we no longer had PE anymore. … I would probably go for walks maybe two or three days a week, but that sort of died down a bit as I got into Year 12* (Woman, 18-years-old, 1-year post-school, living with parents, student, working).

> *[I was] sedentary for most of the time. Other than scheduled sport time, pretty much all of it was sedentary* (Man, 18-years-old, 0.5-years post-school, living with parents, university student, working).

> *It was just difficult doing an hour of physical activity [per day] because of my VCE studies* (Woman, 18-years-old, 0.5-years post-school, living with parents, university student, working casually).

> *Once I got to Year 11, my study load obviously increased a little bit and I had to pick between either the sport or creative arty stuff and I went for the creative side. And then, VCE, I had to drop that as well; so, Year 12 I did nothing but focus on my school work and I was school captain at the time, so I focussed on that* (Woman, 20-years-old, 2.5-years post-school, changed residence post-school, working).

> *Towards the end [of school, I was] not very [active]. I used to sit there* (Man, 19-years-old, 1.5-years post-school, changed residence post-school, university student).

Video game use during secondary school years was discussed by two participants (both men) as being 15h/wk or 10h/wk, on average. One participant spoke about how the main type of sedentary behaviour that he engaged in during the earlier years of school was playing video games, but this changed to studying during his senior years.

> *Not really in the later years of high school. I did it [engaged in video game use] up to Year 11 a fair bit. But after that, I focussed on study (*Man, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

Some participants described preferentially choosing sedentary behaviour pursuits during leisure-time during the school years such as mobile phone use, rather than engaging in physical activity. Some participants raised that their sedentary behaviour habits at school continued on at home, saying that they engaged in a high amount of sedentary behaviour both during school hours and after school hours at home. These participants also commonly discussed that they were tired, that school was tiring, and that they felt like they needed to rest.

> *Pretty high [mobile phone use], to be fair. I should have been a fatty. … I think every teenager does [use of mobile phones a lot during late adolescence]* (Man, 18-years-old, 0.5-years post-school, living with parents, university student).

> *Mostly it was pretty bad. If I didn't have much homework, I would be really happy about it and be like 'Oh yeah, I can sit on my computer for eight hours', or something. I did become pretty addicted to going online and things. And time spent watching movies on my laptop is another thing I liked to do as well. So yeah, it wasn't good (laughs)* (Woman, 18-years-old, 1-year post-school, living with parents, university student, working).

> *Because I was just tired from school, I just wanted to come home and sit and do nothing. Even though I had been sitting but it still takes it out of you. I'd come home and just sit and relax for the rest of the night* (Woman, 20-years-old, 2.5-years post-school, living with parents, university student, working).

> *It was amusing: you'd sit down all day at school and come home and feel like you needed a rest and sit down a bit more* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student, volunteering).

> *I just mainly sat* (Man, 19-years-old, 1.5-years post-school, living with parents, university student, working).

Physical activity and sedentary behaviour changes post-school

Findings for whether physical activity and sedentary behaviour changed post-school were mixed (Table 3.1), as similar proportions of participants perceived that they had increases and decreases. Only five respondents felt that physical activity had not changed post-school and only four described maintaining sedentary behaviour.

Leisure-time physical activity and sedentary behaviour

Structured physical activity, such as a sport, was mentioned frequently by participants. Many participants discussed that they engaged in sport during and post-secondary school around 1-2 times/wk, but some did not at either stage, and a few did during school only. Notably, there was no mention of an uptake of structured physical activity post-school among participants. The sports that the participants were involved in were swimming, netball, La Crosse, mixed martial arts, basketball and Australia Rules Football. Mostly, those who said that they were engaged in sport did not usually engage in walking for transport. Some participants considered that they had maintained sport post-school, while few described a reduction. Other LTPA described by participants commonly included strength training at a community or home gymnasium.

Types of leisure-time sedentary behaviour in the home environment described were playing video games, using tablets and mobile phones, and watching television or movies. The frequency of using these types of sedentary behaviour was mostly described as daily. Sedentary screen use and technology were mentioned frequently. The participants who raised mobile phone use mostly perceived that this reduced post-school. The time spent using video games post-school decreased for one participant but increased for another who, when asked to give an example duration of time spent playing video games post-school, replied with:

> *Lots. Lots and lots* (Man, 20-years-old, 1.5-years post-school, living with parents, university student).

Watching television was not popular. It was common to discuss low or no television watching during and post-school or a reduction post-school. The reasons given included a lack of interest in what was being programmed on television, a preference for watching videos on YouTube, some did not feel the need to use screen-time to 'destress' because they had less stress post-school, watching movies on laptops instead, or watching a television series via a streaming service. The one participant who said that he watched more television post-school reasoned that this was due to the new streaming services for movies and television shows that were not available during secondary school.

> *I reduced television because there really isn't that much on that I like now, so I just don't find anything that I have an interest in* (Man, 19-years-old, 1.5-years post-school, living with parents, student, working).

> *Probably less [sitting] now. Purely because of workload and it was just crazy in Year 12. … I think during Year 12, because I was fairly stressed, I would go on my mobile to de-stress, or what I thought was de-stressing. Nowadays, I kind of think, 'Well, I've got to do that. Well, sure.' There's just not that much pressure. I'll just do the work and then I'll do something else. Yeah, I think more technology then than now* (Woman, 18-years-old, 0.5-years post-school, living with parents, university student).

Study-related sedentary behaviour

Most participants described that they frequently studied during secondary school and that it was almost exclusively a sedentary behaviour. Those who commenced tertiary education (*n*=25) described similar sedentary experiences at school and university. Tertiary students spoke about sedentary behaviour twice as often as physical activity. An inference from this that a greater amount of sedentary behaviour than physical activity may take place at tertiary institutes. Respondents reflected that sedentary behaviour at university occurred mostly during lectures and while in the library. Participants who stood for 2h during laboratory classes at university were a rare exception.

> *It's still pretty bad at the moment. So, university, whenever I'm at university, as long as it's not practical, I'm usually sitting down. Whether that be studying in the library, in a lecture, in a tute; I'd generally be in the sedentary position* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student, volunteering).

Some participants, when prompted, described prolonged sitting (>30 mins of sitting time that is not broken up by standing or moving) during secondary school and immediately post-school, with instances more common post-school. Prolonged sitting was mostly referred to when describing studying and was repeatedly perceived as bad but unavoidable. One participant described an estimated increase in prolonged sitting to 2-3h per occasion while at university, compared to <1.5h per occasion while at secondary school. Frequently described settings for prolonged sitting were secondary school, university and home. The dominant setting differed depending on age; prolonged sitting was commonly reported to take place in the classroom during secondary school or at home for tertiary students. Some tertiary students described intentionally trying to break up prolonged sitting regularly by standing, stretching or making cups of tea. It was common for respondents to believe that long periods of uninterrupted sitting were part of normal university life because of the hours of study required.

> *At school it was always prolonged periods. Not so much during the breaks, but in classes you would be sitting down for at least an hour. At home, similar sort-of thing, you'd sit down for probably about 1-hour bouts, I reckon, maybe even 1.5-hour bouts. … [and compared that to now, at university] During the rest of the day, so, a lot of the time, I'd probably sit down and study. That is probably the biggest portion of my sedentary time. I try and get up about once every half hour, if I can remember. Sometimes I'd be sitting down for 2-3 hours straight* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student, volunteering).

> *I try and do that thing where you have a break every thirty minutes in your studying, that's meant to help [you] study better. That doesn't always happen, basically, if I'm on a roll* (Woman, 19-years-old, 1.5-years post-school, living with parents, university student, working two jobs).

> *I know that you're meant to get up and stretch every so often, but sometimes you just sort of get pretty engrossed in what you're doing. Even if I'm studying and then want a break, I might lay down on my bed which is more sedentary activity* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student).

Transport and domestic-related physical activity and sedentary behaviour

When transport methods were described by participants, active modes, such as walking or cycling, were discussed as often as sedentary modes, such as driving. As mentioned earlier, those who said that they played a sport said that they did not usually engage in walking for transport. Participants raised that the overall frequency of commuting was mostly reduced post-school and the most common change was substituting active transport with driving. When prompted, participants described engaging in domestic physical activity, such as doing chores (sweeping and washing up dishes), gardening, and standing to cook.

Work-related physical activity and sedentary behaviour

Almost all of the participants held employment during secondary school and/or post-school. Post-school, some respondents described ceasing work to study exclusively. However, most had paid or volunteer employment (three held two jobs and one held three jobs) and the number of work shifts ranged from 1-5/wk. Some respondents who continuously worked during the transition out of secondary school perceived changes in physical activity and/or sedentary behaviour at work. There was an increase in those who held sedentary occupations over time (*n*=1 during secondary school vs *n*=4 post-school), one of whom transferred from an active job to a sedentary job.

Overall, participants had more active jobs than sedentary jobs during and post-school. The number of participants with active occupations declined over time (*n*=16 during secondary school vs *n*=13 post-school). Participants reflected that active jobs involved walking more often than standing. Some participants increased the h/wk at an active job post-school and few participants changed from not working to having an active job. These changes are not necessarily positive, as a physically active job has previously been associated with a high prevalence of depression and high stress levels[205] perhaps due to a lack of choice to be active at work.

3.4.5 Situational transitions during the transition out of secondary school

Participants experienced multiple situational transitions post-school. Some participants perceived that these situational transitions were somewhat responsible for changes in physical activity and sedentary behaviour they experienced (Aim 2). The main situational transitions discussed were: 1) commencing tertiary education,

2) changing residence (moving from a rural area to an urban locality, moving from the family home into share houses within the university student residence buildings on campus or community share houses), and 3) commencing full-time work. The impact on physical activity and sedentary behaviour from these three situational transitions are mentioned briefly in this section and will be explored in the following section. Additionally, simply leaving secondary school was also considered influential on changes in physical activity.

> *I feel like you stop being as active as you used to be. There used to be badminton clubs and table tennis, swimming, carnivals, practise and I used to go to everything. Then once high school finishes, it just stops* (Woman, 18-years-old, 0.5-years post-school, living with parents, university student, working casually).

Several participants discussed their perceptions of why situational transitions were partially responsible for changes in physical activity and sedentary behaviour (Aim 3). For instance, of those who commenced tertiary education (*n*=25), some attributed changes in physical activity and sedentary behaviour to this situational transition. Also, an active or sedentary degree choice such as exercise science or arts/laboratory-based science was thought to be influential on physical activity and sedentary behaviour changes.

> *Just by the nature of my degree, I would definitely say that it [the amount of physical activity that I do] is more than what I would have done at school* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student, volunteering).

Changing residence by moving from a rural location into an urban suburb was thought by some participants to influence physical activity and sedentary behaviour. Specific examples they gave of reasons why included more co-participation in physical activity with neighbours, more parks, better neighbourhood aesthetics, less access to physical activity facilities and less traffic in rural compared to urban areas. Further, moving out of the family home was also said to influence physical activity and sedentary behaviour due to more independence from parents, fewer rules and boundaries from parents, and more responsibilities such as domestic chores and having to pay for internet and mobile phone bills. The directions of changes in physical activity and sedentary behaviour because of these situational transitions differed between participants.

I came from the country. I did all my primary school in the country. Thinking back then, we still had the internet, still had that kind of stuff. Probably because I'm [now] in more of the dense area, I don't know my neighbours that much. I used to go out and play with my neighbours pretty much every day and we had parks right next to each other and you could go and kick a soccer ball. Because I live in a city [now], it's less physical activity (Man, 19-years-old, 0.5-years post-school, living with parents, university student, working part-time).
If I'm ever bored or anything I just go for a walk. I don't have to tell anyone where I'm going, I can just decide: 'Oh, I'm going to go somewhere, or go and do something'. I'm responsible for cleaning the house, doing the washing, domestic chores. … A lot more independence (Woman, 19-years-old, 1-year post-school, changed residence post-school, university student, working).

A change in employment was a situational transition that was perceived to change physical activity and sedentary behaviour post-school by some participants, in positive or negative directions. Active or sedentary job types were described as a key reason and participant occupations included retail (cafés, supermarkets and department stores), sport team coach, pizza delivery driver, door-to-door charity donation collector and debating adjudicator.

3.4.6 Influences on changes in physical activity and sedentary behaviour during the transition out of secondary school

This section reveals the findings from thematic analyses of the perceived influences on changes in physical activity and sedentary behaviour during the transition of leaving secondary school (Aim 3). Table 3.2 lists examples that represented the themes and Table 3.3 lists the major, minor and uncommon themes. Social support was a major theme for physical activity and sedentary behaviour and the other themes differed minimally. For physical activity, time use was as a unique major theme and weight was as a unique minor theme. For sedentary behaviour, tertiary education was a unique major theme and technology was a unique minor theme. Although the impact of tertiary education, remoteness and occupation have been briefly summarised already in this chapter, these will be discussed more in this section alongside multiple illustrative quotes.

Table 3.2 Examples and the emergent hierarchical order of the perceived influences on changes in physical activity and sedentary behaviour post-school

First order (Examples)	**Second order** (Codes/ nodes)	**Third order** (Categories)
Friends Family Housemates School peers Health practitioners	Social support	Social support
Size and quality of grounds, play equipment, and facilities School sport teams Studying, assignments, exams, and homework	School	Education
Studying Time on campus (contact hours) Choice of course Grounds and facilities of campus	Tertiary education	
Computer use Mobile phone use Television watching Playing video games	Technology	Technology
Free time Spare time Routines and regimented days Holidays	Time use	Independence
Driving Public transport use Commute duration and distance Car ownership Active transport (walking/cycling for transport)	Transport	
Moving out of home More responsibilities at home Doing more chores Paying board	Home life	
Choice of occupation Changes in occupation	Occupation	Occupation
Body image Weight status (overweight/underweight) Weight loss Weight gain	Weight	Internal
Maturity and attitude Feelings of shame/embarrassment Mental health and depression Personal preference (likes, dislikes, being bored, attention span, interest, and enjoyment)	Internal	

Table 3.3 Major, minor and uncommon themes of the perceived influences on changes in physical activity and sedentary behaviour post-school

	Physical activity	**Sedentary behaviour**
Major themes	Time use Social support	Tertiary education Social support
Minor themes	School Tertiary education Transport Home life Occupation Weight Internal	Time use Transport School Occupation Internal Technology Home life
Uncommon themes	Income Availability of facilities Pet ownership Remoteness Priorities Independence Age Food Habits	Income Remoteness Availability of facilities Priorities Independence Habits Food Age Pet ownership

Participants discussed the direction of the perceived influences on changes in physical activity and sedentary behaviour post-school, which are summarised in Table 3.4.

Table 3.4 Summary of individual, social and environmental influences on changes in physical activity and sedentary behaviour post-school, by direction of influence

Influences	Positive perceived impact	Negative perceived impact
Individual		
Physical activity	Desire to lose/maintain weight Physical activity type preferences Physical activity enjoyment Tertiary course (science degree) More responsibilities	Different priorities Poor time management Routine change Tertiary course (art degree) Less sleep
Sedentary behaviour	*None mentioned.*	More free time Change in transport mode from active to car Car ownership
Social		
Physical activity	Behavioural modelling (parent weight loss) Desire to gain weight (men) Encouragement Independence Social support	Parental rules
Sedentary behaviour	*None mentioned*	Behavioural modelling Co-participation in sitting Encouragement Fewer rules post-school Independence Social support Subjective social norms
Environmental		
Physical activity	Occupation (active) Increased working hours Remoteness change (rural/urban)	Unstructured university contact hours
Sedentary behaviour	Fewer hours on campus Lack of internet access Flexible university classes	Increased study requirements Increased technology access/use Increased working hours Increased commute duration

Individual influences

Individual influences on changes in physical activity

Reasons described by this sample for changes in physical activity post-school that may be considered individual influences included priorities, time management, changes in routines, independence, preference for types of physical activity, physical activity enjoyment, and desire to lose weight (all in a positive direction). Poor time management, prioritising work/study over being active, poor sleep, and changes in routines were perceived to negatively influence physical activity for some.

> *Not having the time to fit it in as well as going to work, so yeah, because everything else just kind of topples, topples down* (Woman, 19-years-old, 1-year post-school, changed residence post-school, university student, working).

> *Work and trying to fit in exercise into all that is really hard, and often I will exercise on my own time or say: 'Okay, I have free time now, I'll go for a run' … so, time management could probably be better, I think* (Woman, 19-years-old, 1.5-years post-school, living with parents, university student, working two jobs).

> *It is hard to find the time to go to the gym in between classes, and things like that, because it is not as structured - nine to three thirty - as school. Here, you could have an hour here or there, but it is not really enough time to go to the gym to do a good session* (Man, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

An increase in responsibilities and independence post-school was mentioned to positively influence physical activity. Some participants described how they took on the responsibility for being active themselves post-school, as they could no longer rely on the free opportunities provided by schools to be physically active.

> *At high school ... it would just sort-of happen, but now, I go out of my way to do it. … Now it is only something that I get if I pursue it* (Man, 20-years-old, 1.5-years post-school, living with parents, university student).

> *It's all just consciously deciding to be active rather than having to be* (Man, 19-years-old, 1.5-years post-school, changed residence post-school, university student).

> *I do what I want now. My personal preferences have changed since high school* (Man, 18-years-old, 0.5-years post-school, living with parents, university student, working).

Some participants believed that age, personal preference and enjoyment of types of physical activity were positive contributors to their physical activity post-school. One participant mentioned that her age positively influenced changes in her physical activity as she was now able to access a gymnasium alone since turning 18 so she bought and used a gymnasium membership.

> *Going out to town at night is very active if you're dancing as well. Being 18, that's a fun way to be active too* (Man, 19-years-old, 1.5-years post-school, living with parents, university student, working part-time).

> *I've gotten more motivated to do physical activity now. In high school, it was just like: 'I'm going 'cause I have to go', and now I'm like: 'I've started to do it, I enjoy doing it, I want to get fitter and get more healthy now'. So, I suppose my mentality around it has changed a bit* (Woman, 19-years-old, 1.5-years post-school, living with parents, university student, working two jobs).

> *I just like being active. That's pretty much it. Even when I am sitting, I always fidget, move my legs and things like that, to try and keep moving as much as possible* (Man, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

Some participants mentioned that the desire to lose weight was an impetus for increasing physical activity. One said that since starting to drink alcohol, he has put on weight so is now more active to try to rectify that.

> *Because I was a bit overweight … so now I exercise to keep that off* (Man, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

Individual influences on changes in sedentary behaviour

Of the multiple reasons participants gave for changes in sedentary behaviour post-school, individual influences were sometimes mentioned, such as having more time available, obtaining access to a car and getting a driver's license, and more independence.

> *Probably more [sitting] because I have got more free time* (Man, 20-years-old, 1.5-years post-school, living with parents, university student).

> *Beforehand, when I first started going to the gym, I used to walk or ride my bike. Now I drive. Especially during winter because it's cold. … Getting to my girlfriend's place, I used to have to get the bus and walk nearly half an hour to get there, … now I just drive. … Basically, anywhere where I used to walk, whether it be a friend's place, or gym, or girlfriend's place, or whatever, I basically drive now, I don't walk* (Man, 20-years-old, 1.5-years post-school, had not changed residence, university student, working in retail).

> *When you get public transport, obviously you're walking quite a lot and everything. But driving, you just drive straight there, so you don't have to* (Woman, 19-years-old, 0.5-years post-school, living with parents, university student, working two jobs).

Independence was a perceived influence on physical activity and sedentary behaviour. Some participants felt that having more independence meant that they faced consequences of a decrease in physical activity and an increase in sedentary behaviour if they were not responsible, were not organised, or did not get enough sleep.

> *If you get less amount of sleep, then you're probably less likely to get up and go for a run or get up and maybe go somewhere. As well as that, if you plan to ride your bike to, say, work, or something like that, however, you slept in or you've had a late night, or something like that, then you have to take the car and that's definitely affected physical activity and sedentary as well* (Man, 19-years-old, 0.5-years post-school, living with parents, university student, working part-time).

Social influences

Several common reasons participants gave for changes in physical activity and sedentary behaviour post-school may be considered social influences, including social support, behavioural modelling, encouragement, co-participation in physical activity or sedentary behaviour, and subjective social norms. Of those, support from social networks was often described as influential on changes in physical activity and sedentary behaviour post-school. The social network was described as including friends, family, housemates, peers, and health practitioners. Some participants considered social support and social networks to positively or negatively influence physical activity or sedentary behaviour, while others did not consider them influential at all. Some participants mentioned that their social network provided positive or negative support at different times regarding co-participation; for

example, one participant's social network included housemates who he sat with, but also friends who he engaged in physical activity with.

Social influences on changes in physical activity

Participants described a number of perceived social influences on changes in physical activity post-school. These included behavioural modelling (parent weight loss), a desire to gain weight (in men) due to subjective social norms, encouragement from social networks, social support, independence from parents (described by those no longer living with parents), and parental rules (negative; described by those still living with parents).

As an example, a change in dependence on parents for transport was perceived to positively influence physical activity. Two participants described how their parents used to drive them to school, but their parents would not drive them to university. This meant that they felt forced to become more self-reliant and independent. They believed that this change had resulted in an increase in physical activity. A change in dependence on parents was an influence that appeared to be universal, regardless of situational transitions experienced post-school.

> *I don't have my parents driving me around, so I just have got public transport* (Woman, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

> *At high school, I didn't do as much activity. I was driven to school. I didn't really participate in sports. But now that I have taken up tertiary education, I am responsible for my own transport, so I walk everywhere and sort myself out* (Man, 19-years-old, 1.5-years post-school, living with parents, student, working).

Sometimes the same person within the participant's social network provided both positive and negative support at different times; for example, a participant's mother initially encouraged her to go for a walk frequently but then banned it because her poor mental health was exacerbated by time that she spent alone.

> *The main influence originally was probably my mum. She, like, lost a fair lot of weight through exercise, and that, which [made me] start doing that* (Man, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

A few men described that a desire to gain weight so that they were not skinny anymore resulted in more physical activity post-school. Previous work suggests that this motivation may stem from subjective norms creating a desire in some men to look masculine and muscular[206]. This appeared to be a universal influence regardless of situational transitions experienced post-school.

> *I was quite small when I was in high school; I was rather thin and underweight because of the running I was doing. From there, I think I changed my perspective and thought I've got to put some weight on now. So, I went and started doing that. At the gym, I'll do weights. I'll eat more* (Man, 20-years-old, 1.5-years post-school, had not changed residence, university student, working in retail).

> *I turned 19, 20, and I was still skinny* (Man, 19-years-old, 1.5-years post-school, changed residence post-school, university student).

> *I've probably put on a little bit of weight since school. But I've sort of been aiming to do that. I've been quite a thin build* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student).

Social influences on changes in sedentary behaviour

Social influences specific to changes in sedentary behaviour post-school included having to be more independent, behavioural modelling, encouragement, co-participation in sitting, social support, fewer parental and school rules, and seasonal changes. Social networks appeared to play a key role in sedentary behaviour. One participant described co-participation in television viewing with family and some participants, all men, said that they play video games with friends. They perceived that co-participation, behavioural modelling, subjective norms, and encouragement from friends increased their video game use. This appeared to be universal influence regardless of situational transitions experienced post-school.

> *I only watch a little bit of [television] in the evening when my parents have the television on* (Woman, 18-years-old, 1-year post-school, living with parents, student, working).

> *It's, like, a social thing for me as well because a lot of my friends do the same thing* (Man, 20-years-old, 1.5-years post-school, living with parents, university student).

> *Sometimes, a mate will call me and tell me to jump on a game and I'll go and sit down for the next few hours and play with him* (Man, 19-years-old, 1.5-years post-school, changed residence post-school, university student).

Participants described experiencing rules and boundaries set by secondary schools about certain types of sedentary behaviour such as mobile phones use that resulted in less sedentary behaviour. One participant described how mobile phones would be confiscated if they were seen at school. Some participants described experiencing an increase in mobile phone use post-school because these rules and boundaries no longer applied. This also appeared to be a universal influence regardless of situational transitions experienced post-school.

> *If you got busted [using your mobile phone], you had to hand it in and only get it back at the end of the week; so, that was a big deterrent, I guess* (Man, 19-years-old, 1.5-years post-school, living with parents, university student, working part-time).

Seasonal changes (e.g. winter) and being on holidays were believed to result in more sedentary behaviour because of a reduction in people available to socialise with. This was a minor finding and appeared to be limited to those who experienced the situational transition of commencing tertiary education.

> *Well, because I'm on holidays, it's more than what it should be. … I actually think that I sat more during school holidays because everyone was busy at the same time* (Woman, 19-years-old, 1-year post-school, changed residence post-school, university student, working).

> *If maybe some of my friends ask me out then I would go out with them. But if I don't have any dates, I would just sit at home* (Woman, 22-years-old, 2.5-years post-school, living with parents, university student, working part-time).

Environmental influences

Some of the topics in this section, such as tertiary education, employment and living independently or with parents were briefly mentioned in section 3.4.5; however, more information and alternate examples for these topics are presented here.

Environmental influences on changes in physical activity

Participants reported that the choice of university course had influenced physical activity. For example, some participants studied exercise and sport science, science, or nursing degrees. They reported that they stood during laboratory classes, were sometimes active during class time or were active while working because of the nature of the course's content.

> *Another big reason has been just, I've learnt how important any daily exercise is for health. Because I am studying nursing, so when we were learning about different conditions like arthritis, osteoporosis and obesity, I just really caught onto to how simple it is to prevent or reduce the effects of things like that by just using your body and going for walks* (Woman, 18-years-old, 1-year post-school, living with parents, university student, working).

Some participants spoke about how they believed that they did more physical activity at secondary school because it had more contact hours than university. They mentioned large ovals at school, more sport clubs, and compulsory sport carnivals that influenced more physical activity. Some participants said that their tertiary institute did not have these same attributes or offer these opportunities and, therefore, did not encourage as much physical activity as their school did.

> *I was at school more than university, so there was a lot more walking there* (Man, 19-years-old, 1.5-years post-school, changed residence post-school, university student).

Conversely, other participants mentioned that because there was more flexibility with the university classes compared to structured secondary school timetable, they were able to do more physical activity and the presence of staircases on the grounds of universities and the sprawled layout of the university buildings encouraged more physical activity.

> *You get more opportunity to get up and do stuff than there was in high school. In high school it was sort of limited what you're doing, in university you choose to – I'm going to get up and walk around, I'm going to do this instead of going to the lecture or I'm going to do this after the lecture so I can move around* (Woman, 19-years-old, 0.5-years post-school, living with parents, university student, working two jobs).

Some participants commented about how they believed that moving from a rural area to a city influenced physical activity. Specifically, they mentioned that in rural communities, they had less traffic, had better neighbourhood aesthetics, but had less physical activity equipment and facilities.

> *For example, in terms of running, even moving up to the city, there's not many running tracks. It's crowded. You've got to wait for traffic a lot of the time. Whereas in the country there was a lot less traffic, there was more running spots, there was more interesting areas so there was more motivation to be involved in physical activity in that means. I guess, in terms of gym equipment and facilities, it's probably a lot more limited but it just depends on your training and your goals* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student, volunteering).

Employment changes were believed to influence changes in physical activity with increased hours at work post-school described as a reason for less physical activity in some participants.

> *... generally, workloads are a lot higher so I'm less likely to get away at a decent hour [from work] to kind-of go to the gym and do that stuff* (Woman, 20-years-old, 2.5-years post-school, changed residence post-school, working).

Conversely, the choice of an active occupation was raised as influential to increasing physical activity. One participant with an active occupation as a team coach and in the fitness industry partially attributed an increase in his physical activity to the nature of his employment. However, because he was tired from working, he decreased his time spent at the gymnasium during his leisure-time after business hours. This experience may be consistent with a 'compensation' hypothesis[207, 208].

> *I think the main thing for me is that it's part of my career and so, I'm motivated in that sense because I get paid for it, does that make sense? That would be the biggest motivator. ... The main [reason] was that fitness, or work[ing] in the fitness industry, for me has meant that my physical activity is directly associated with my career. That's the main reason really. I'm inclined to be active because of that* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student, volunteering).

Environmental influences on changes in sedentary behaviour

Several participants studying at university believed that they had increased their sedentary behaviour compared to when they were at secondary school. It was reasoned that this was because of more assessments, they studied more, exams were

harder, the commute was longer, and they now cared more about doing well academically because they had chosen the subjects themselves. One participant said that she always sat during her classes because she was studying an art degree that required her to sit.

> *Studying more than at high school. At high school there was only a little bit of homework to do and anything extra is on you. … Exam period for university is more intense than exam period for high school. I definitely do way more work than I would a few years ago. I think the workload is a big factor. I think the units I've chosen are ones I want to do good in, rather than those that have been assigned to me. They probably make me sedentary a bit more because I want to do better, so I'll sit for more time* (Man, 19-years-old, 1.5-years post-school, living with parents, university student, working part-time).

> *I'd say more-so at university. Definitely a lot more sitting now. I think that I'm taking education a bit more seriously now that I'm at university* (Man, 20-years-old, 2.5-years post-school, changed residence post-school, university student).

> *The travel on university days and that, sitting on the train. So many hours wasted on the train (laughs). In high school, you didn't have that* (Woman, 19-years-old, 1.5-years post-school, living with parents, university student, working two part-time jobs).

One participant described how she felt that universities had expectations that she should sit more and that sitting more was normal for her peers. Subjective norms about an increase in sedentary behaviour was common for those who experienced the situational transition of commencing tertiary education.

> *I would say expectations. I have to live with the expectations that is set from my university so that is probably why I probably have to sit more than I would in high school. But I feel that I sit more, but I don't really feel the change even. I feel like it is just normal for university* (Woman, 18 years, 0.5 years post-school, no residential change post-school, university student, working casually).

Conversely, a few participants who had commenced tertiary education talked about sitting less compared to when they were at secondary school, and partly attributed this to more flexibility and less contact hours at university compared to secondary school.

> *I think [my sitting time] has decreased somewhat [since] school just because the contact hours [of university] have decreased* (Man, 18-years-old, 0.5-years post-school, living with parents, university student, working).

A few participants mentioned that an increase in the access to and use of technology (laptops, tablets, mobile phones, social media, and the internet) influenced an increase in sedentary behaviour post-school. Conversely, a participant mentioned that having no internet access after moving out of the family home resulted in less television watching and mobile phone use.

> *I feel like a lot of people just, if you have a break, they just grab their phones. … You know what, a big thing is technology. Just because there's technology there, I mean that's like, a massive reason* (Woman, 18-years-old, 0.5-years post-school, living with parents, university student, working casually).

> *As soon as you go on [social media], you get hooked and you stay on there for a little while. Definitely, instead of either going out. I'm sitting at home either on the laptop or on the phone* (Man, 19-years-old, 0.5-years post-school, living with parents, university student, working part-time).

> *I don't have internet at home at the moment, so I can't sit for hours watching television and shows. … I think that I'm starting to use [my mobile phone] less, especially because I have got no internet on my phone* (Woman, 18-years-old, 0.5-years post-school, changed residence post-school, university student).

Both participants who commenced full-time work post-school described increases in sedentary behaviour and partially attributed this to the sedentary nature of their work. One participant talked about the increased use of a mobile phone while sitting that was associated with her job, as a contributor to her increased sedentary behaviour post-school.

> *I think because I have a desk job and [my mobile phone] is just there. I work in an office* (Woman, 20-years-old, 2.5-years post-school, living with parents, working).

> *It depends on obviously how busy work is. I am in a corporate environment and we've gone through an organisational restructure. There's a lot less staff … I work in an office, so I do spend quite a lot of time [during] the day sitting. Usually that is for longer periods, but I do try and stand up, walk around a little bit, go outside when I can. But it is quite sedentary* (Woman, 20-years-old, 2.5-years post-school, changed residence post-school, working).

3.5 Discussion

The aims of this chapter were to explore perceptions of how and why changes in physical activity and sedentary behaviour occur during the transition out of secondary school among recent school leavers. This sample had mixed findings for how physical activity and sedentary behaviour changed, with an almost even number of responders reporting increases and decreases. This finding is inconsistent with most of the previous literature which has reported an average trend for a decline in physical activity post-school using large-scale surveys[15, 85, 106, 118, 123, 132-135, 186]. This highlights that although there may be an overall decline in physical activity on average, not all people have the same experience.

Thematic analyses revealed that social support was a major perceived influence on physical activity and sedentary behaviour changes post-school, though not for all participants. Minor themes for physical activity were changes in time use, transport, home life, occupation and weight, and minor themes for sedentary behaviour were tertiary education, time use, transport, home life, occupation and technology. Themes for physical activity and sedentary behaviour were mainly consistent and differed minimally. The unique theme for physical activity was weight and the unique theme for sedentary behaviour was technology. Of note, no influences were raised that supported a maintenance of physical activity and sedentary behaviour over time; participants only discussed influences that were perceived to result in changes (increases or decreases).

The direction of influences on physical activity and sedentary behaviour were sometimes mixed. The perceived changes in social support and increase in free time and independence post-school were believed to influence physical activity and sedentary behaviour. Some participants believed that these influences increased physical activity, while others said that they increased sedentary behaviour. This suggests that in different people, changes in free time, independence and social support may facilitate physical activity or sedentary behaviour. This finding is consistent with previous research that similarly reported that peers and free time were facilitators and barriers to health behaviours[125]. Instead of one clear reason for these interpersonal differences between participants, possible explanations include characteristics of the social support network and peer group profile, gender, age, geographic region and what situational transitions they experienced post-school.

The three main situational transitions participants mentioned experiencing were commencing tertiary education, changing residence and employment changes. Some participants partially attributed changes in physical activity and sedentary behaviour to these situational transitions. Participants discussed multiple reasons behind the perceived associations between situational transitions experienced post-school and changes in physical activity and sedentary behaviour. A novel finding was that these perceived influences were specific to the situational transitions. If students commenced full-time employment post-school, influences were what kind of job they had (whether they now had physically demanding work), working hours (consistent with a previous study[188]) or technology access/use. These were novel compared to a qualitative study about the transition from school to work that alternatively found a motivation for health, peer norms, and independence from parents were important[192]. If students changed residence post-school, the influences were increased traffic, domestic responsibilities and independence from parents (less rules and boundaries), less access to physical activity facilities or poorer neighbourhood aesthetics. These findings are novel compared to a previous quantitative study about household composition of tertiary students that found self-efficacy and health-related barriers were important[187]. Lastly, if students commenced tertiary education post-school, common influences were choice of active or sedentary tertiary course (novel), and increased free time, commute time or hours studying. Additional comparisons of these findings with other studies about transitions to tertiary education[125, 189-191] are discussed in the subsequent paragraph.

The findings of this study were mostly consistent with the few previous qualitative research studies in this area, and these studies mainly focussed on those who commenced tertiary education. Cluskey and Grobe[125] conducted focus groups about weight gain and, similar to the current study, they reported a perceived decline in physical activity due to less social support and structured routines, and that good family role modelling during school years influenced a perceived increase in physical activity post-school. Nelson et al.[190] conducted focus groups and interviews about weight gain in students and similarly reported a decline in physical activity post-school was influenced by a lack of time, poor time management, a lack of motivation, seasonal changes such as winter, and poor social support. Deliens et al.[191] conducted focus groups of third-year university students and, consistent with the current study, they reported that the influences on physical activity and sedentary

behaviour were perceived enjoyment, time management, convenience, parental control, modelling, social support, availability and accessibility of facilities, and commute time and distance. They reported that media and advertising were influential, which was inconsistent with the current study. Lastly, Deforche et al.[189] conceptualised that moderators of associations between situational transitions and changes in physical activity and sedentary behaviour could be extrapolated from qualitative cross-sectional data. Consistent with the current study, they reported that the associations between influences and changes in physical activity and sedentary behaviour appeared to be moderated by living on campus, an increase in social life, and the academic pressure to study. Although qualitative findings may generate hypotheses, these proposed moderating relationships need to be confirmed using quantitative longitudinal data[5].

In general, some participants gave the impression that they had not thought that sedentary behaviour was important to health, a health behaviour to be aware of, or needed to be reduced. More insights were given on physical activity than sedentary behaviour, potentially because of a lack of familiarity with sedentary behaviour. A lack of cognizance may be due to the relatively recent addition of sedentary behaviour recommendations within the National Physical Activity Guidelines[109, 209] and the paucity of corresponding public awareness campaigns.

One of the underpinning theories of this study, the life transition model[18], aids understanding of the findings in reference to the process of achieving measurable optimal transition outcomes. The model posits that there are cognitive-behavioural health indicators of transitions that are assets or risks for a transition experience, such as personal efficacy, engagement, health behaviours and service use. Some attributes that were perceived by the participants to positively or negatively influence physical activity and sedentary behaviour fit the description of the model's indicators of assets (physical activity enjoyment, social support, gymnasium use) or risks (independence, time management). The model further postulates that situational transitions are personal experiences that involve disruption and changes in roles that require adaptation. All the participants in this sample perceived that they experienced one or more situational transitions such as changes in education, residence, employment and relationships, and most described disruption to their physical activity and sedentary behaviour routines because of these. Future application of this model should include testing moderating effects of the components of cognitive-behavioural health

indicators of transitions (assets or risks) on the association between changes in physical activity or sedentary behaviour over time and situational transitions post-school.

Strengths and limitations

This chapter addresses key gaps in the literature, including providing understanding via exploration of changes in physical activity and sedentary behaviour during the transition out of secondary school. Advantages of a qualitative approach include the extrapolation of detailed data that highlights understudied viewpoints[210]. A rich discussion was provided by the one-on-one interview format. Rolling recruitment until data saturation ensured the data provided a thorough understanding of experiences, perceptions and viewpoints[195]. Importantly, participants were engaged and were not hesitant to divulge information. There may have been selection bias from health-conscious individuals who volunteered for a study about physical activity and sedentary behaviour, whose offered views may have been influenced by social desirability of a physically active lifestyle. However, some participants openly discussed participating in low physical activity and high sedentary behaviour.

The COREQ guidelines[195] (Appendix 3.1) were followed, which add rigour to qualitative research and require double-coding, collecting setting information such as presence of non-participants, clearly reporting major and minor themes, and acknowledging bias. As stated in the COREQ guidelines[195], the possible reflexivity must be noted. This stemmed from interviewer characteristics and potential biases that may have affected the direction of interviews and the interpretation of the findings. These include the interviewer's gender (woman), credentials, limited experience and brief interview training. Further, the nine participants recruited via convenience sampling either had an established direct relationship with the interviewer or an indirect relationship, that the interviewer had established relationships with those participants' relatives or friends. To counter this and reflexivity, future qualitative research is recommended to include multiple interviewers[204], which also includes the process of reaching consensus, which in-turn fosters reliability.

The key limitation of this study stems from a minimally diverse sample. Participants lived in urban areas and most lived in a least-disadvantaged neighbourhood. Participants were a homogenous group with university students overrepresented,

very few full-time employees, and no early school leavers, apprentices or trainees. The findings may differ from a random sample since those who work full-time or left school early may have unique experiences and influences on their behaviour that differ to others in this sample, such as income, demands on time, and their peer group profile. Although there were participants employed full-time, their views may not be well represented in this study. Another limitation was collecting data via retrospective recall, including the levels of and influences on physical activity and sedentary behaviour during secondary school. Relying on memory and the potential presence of human recall bias would be alleviated in future qualitative studies that use a prospective longitudinal design to follow-up school leavers during their transition into early adulthood.

A variety of recruitment methods (convenience sampling, flyers, snowball sampling and social media) were used until data saturation was achieved. The social media strategy was the least successful (*n*=2), was expensive ($1 383.90AUD) and had poor engagement (few likes, comments or shares). This is despite social networking sites being very popular in this age group in Australia and almost all users of social networking having a Facebook account[199]. However, there may have been too many steps involved to express interest in participating in the study, as the advertisements and page provided the study email address only. Future studies of this age group are recommended to use a variety of recruitment strategies, and if using social media, to reduce the number of steps/'clicks' to express interest, such as having advertisements redirect to an online registration form or directly to a website to find out more and complete a consent form.

This qualitative research study provided explorations of viewpoints and experiences that can complement and inform quantitative research[204]. An ideal quantitative sample would have variation in SEP and situational transitions and include early school leavers, apprentices and trainees (minority groups[211]), full-time workers, tertiary students and those living independently from family. This would allow further investigation into what this study found[212]. In particular, a prospective longitudinal research study is needed to examine changes in physical activity and sedentary behaviour during the transition out of secondary school. This may identify how changes in physical activity and sedentary behaviour differ according to multiple situational transitions and importantly, a range of underlying modifiable influences.

Conclusion

This study provided rich information about recent school leavers' viewpoints on perceived changes in physical activity and sedentary behaviour during the transition out of secondary school and the influences. As qualitative data can be used to generate hypotheses, the following could be tested using longitudinal data. Firstly, findings about perceived physical activity and sedentary behaviour suggest that sedentary behaviour will be common in late adolescence and the direction of changes after leaving school will be mixed and without a clear pattern, and few will maintain levels. The findings of this chapter may point to altered social support, commencing tertiary education and new demands on time as the main influences underlying changes in physical activity and sedentary behaviour. Another hypothesis from this chapter's findings is that some influences will be specific to the situational transitions experienced post-school such as full-time study or work and moving out of the family home. Future research needs to test these hypotheses by comprehensively examining how and why physical activity and sedentary behaviour change during the transition out of secondary school using a prospective cohort study.

Chapter 4

ProjectADAPT methodology

4.1 Introduction

ProjectADAPT was a prospective study that observed a cohort of older adolescents annually during the transition out of secondary school. Physical activity and sedentary behaviour during the specific transition out of secondary school is rarely studied. Previous research has employed retrospective study designs[125, 170, 171, 173] or included a long follow-up period that missed the specific transition out of secondary school[106, 136, 137, 213, 214]. In Chapter 3, recent school leavers described perceived social support as a major influence on changes in physical activity and sedentary behaviour during the transition out of secondary school. Time use emerged as potentially more influential for physical activity than sedentary behaviour, and aspects of tertiary study appeared as more influential for sedentary behaviour than physical activity. The participants perceived similar minor influences on changes in physical activity and sedentary behaviour of school, transport, home life and occupation. Chapters 4-8 will use data from ProjectADAPT to build on Chapter 3 to identify quantitative cross-sectional and longitudinal influences on physical activity and sedentary behaviour. Understanding these associations will inform interventions and translational research, identify key groups for policy makers to target, and pinpoint strategies that promote resilience to inadequate physical activity and excessive sedentary behaviour.

4.2 Chapter aims

The specific aims of this chapter are to:

1. Describe the demographic characteristics of ProjectADAPT participants at baseline;
2. Identify the test-retest reliability of key survey items; and
3. Examine the distribution of individual, social and environmental independent variables at baseline.

4.3 Methods

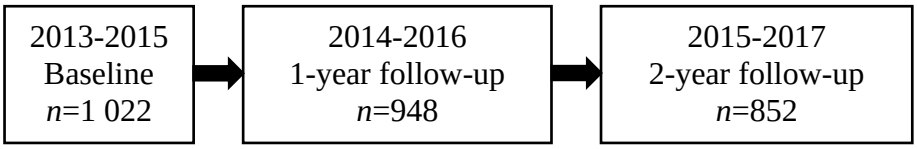
ProjectADAPT was funded by a Discovery Project grant from the Australian Research Council (DP130101078). ProjectADAPT was a collaboration between researchers from Deakin University, University of Tasmania and University of South Australia. ProjectADAPT aimed to understand changes in physical activity,

sedentary behaviour and eating behaviours (excluded from this thesis) during the transition out of secondary school. The following sections describe the study design, sampling, protocol and measures for ProjectADAPT. Ethical approval was obtained from Deakin University's Human Ethics Advisory Group - Health.

4.3.1 Study design

ProjectADAPT was a two-year prospective cohort study of secondary school students in Victoria, Australia. A baseline survey was completed during Year 11 (second-last year of secondary school in the Australian school system) and two follow-up surveys were conducted annually at the same time of year as the baseline measurement (Figure 4.1). This design negates potential intra-individual seasonal variations on outcomes. Further, this overall design captured the experiences of early school leavers or those who completed Year 12, and various post-school pathways (situational transitions). Surveys were either interviewer-administered via a telephone or self-administered online. Test-retest reliability of survey measures was established (methods are described in section 4.3.5).

Figure 4.1 Study design and timeline



4.3.2 Participant recruitment

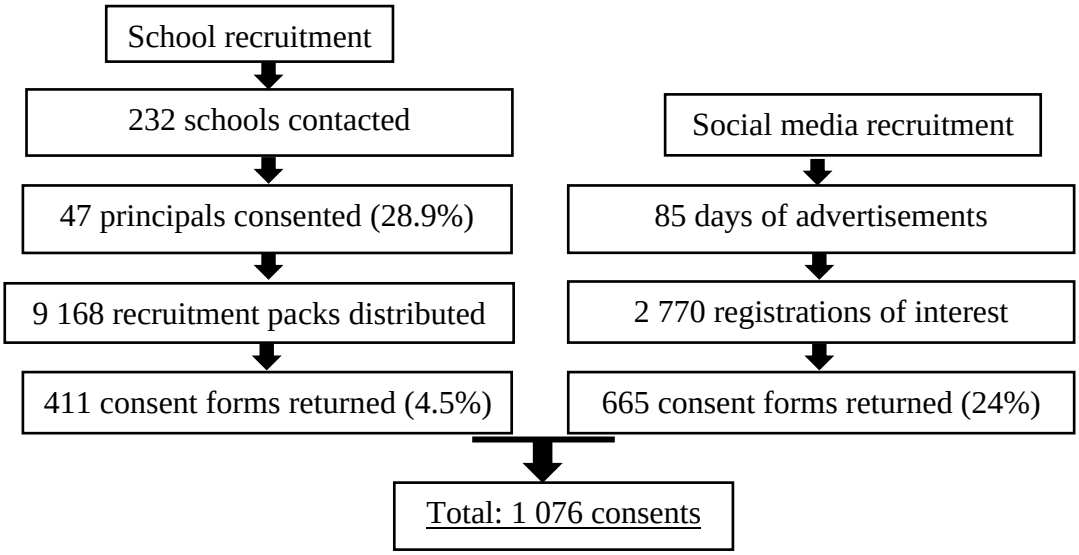
Participants were recruited via State, Catholic and Independent secondary schools in the state of Victoria, Australia or via social media advertising. Secondary schools were identified through a listing on a website (www.education.vic.gov.au). Schools were stratified as urban (major city) and rural (inner regional, outer regional and remote), based on the Remoteness Structure of the Australian Statistical Geography Standard according to postcode[215]. Schools were also stratified by lowest, mid and highest tertiles of socio-economic area based on national census data of SEIFA of relative advantage and disadvantage[216] at the level of the school postcode. Schools within the resulting six categories were randomised using the random number

allocator in Statistical Package for the Social Sciences then approached to participate in the study.

School recruitment (Figure 4.2) was from July, 2013 to September, 2014. In total, 232 Victorian secondary schools (out of 571) were provided with information about the study and invited to participate, excluding special needs schools and schools with <50 Year 11 students. Of these, 47 principals provided consent. Recruitment packs were either: 1) delivered by post to be handed out by a teacher; or 2) distributed by project staff to interested students following a short presentation about the study. Recruitment packs contained a plain language statement and consent form, reply paid envelope and a pen branded with the study name. As shown in Figure 4.2, the response was low (<5%).

During 2013, participants only had the option of completing the survey via a telephone interview. From January, 2014, participants had the option to complete the surveys online or via telephone. Additional changes were made to make it simpler to return consent forms (returned by mail or emailing a photo or scan) and schools were asked to distribute not only hardcopy recruitment packs but also a digital version to parents via email or the school intranet. Despite improvements in response, participation targets according to power calculations (described in section 4.3.6) were still not being met. To address this, paid social media advertising was placed on Facebook (www.facebook.com) as an additional recruitment strategy over five months from September-November, 2014 and April-May, 2015. Advertisements were run over a 42-day period from in 2014 and a 43-day period in 2015 (these were not run every day).

Figure 4.2 Participant recruitment flow diagram



Social media advertisements were restricted to 16-17-year-olds from Victoria, Australia. Clicking on the advertisement redirected individuals to a study webpage hosted by Deakin University. The webpage provided brief information about the study and asked participants to register interest and confirm eligibility (Year 11 student; live in Victoria, Australia). On receipt of registrations of interest, the plain language statement and consent form were emailed to the potential participants. The name of the secondary school was recorded on the consent form. The response and the number of completed valid consent forms returned was higher than recruitment via schools (Figure 4.2).

4.3.3 Protocol

The survey was hosted by an online survey software tool called Qualtrics (www.qualtrics.com). The survey was programmed into Qualtrics, along with question skips, prompts and clarifications. The survey was designed to be short and was confirmed in piloting to take 30 mins by telephone to complete. Participants who elected to complete the survey online were emailed a unique link to the baseline survey and instructions. If these participants had not completed the online survey within two weeks, a reminder email and text message were sent every two weeks (maximum three reminders).

Participants who elected to complete the survey via telephone provided availability within a consent form and the interview was scheduled based on those preferences. A

letter was posted to these participants two weeks prior to the scheduled survey day and a reminder text message or email was sent the day before. The reminders asked the participants to contact the researchers to reschedule the telephone interview if necessary. On the scheduled day, participants received a reminder text message in the morning and no response at the interview time resulted in follow-up calls at 30-minute intervals (maximum three attempts). During telephone interviews, participant responses were noted by research staff either directly into an online version of the survey or onto hard-copies of the survey then later entered online.

Follow-up methods

Data were collected from August, 2014 to June, 2017 for the one- and two-year follow-ups. The follow-up surveys were scheduled for a weekday as close as possible to the baseline anniversary. A two-page newsletter of interesting facts about the cohort that were not relevant to the main aims of the study accompanied a reminder letter or email sent to participants two weeks prior to the scheduled survey day. If the reminder was returned as undeliverable, the participant was telephoned. If the participant was unreachable, the friends and family nominated on the consent form were asked to provide updated contact details of the participant. The procedures at the follow-ups otherwise mirrored those at baseline.

Cohort maintenance

Multiple strategies were used to maximise retention. Firstly, participants received a $20 gift voucher for a major department store after completing the first two surveys, and $25 after completing the final survey, as compensation for time. Secondly, as mentioned above, the consent form requested contact details of friends or relatives who could be contacted if participants were unreachable by telephone, email or mail prior to the one- and/or two-year follow-ups. Lastly, annual birthday and season greetings cards were posted to participants, accompanied by a small gift. Gifts were branded with the study name and included a pen, fridge magnet to prompt participants to update contact details (between baseline and the first follow-up) and Universal Serial Bus (USB; between first and second follow-up). All correspondence included a reminder to email project staff if contact details changed.

4.3.4 Measures

The survey (telephone; two-year follow-up version) is presented in Appendix 4.1. The survey included items on physical activity, sedentary behaviour, and diet. However, items relevant to diet are not described here as they are beyond the scope of the thesis and not used in analyses. Most questions were repeated at each timepoint. The one- and two-year follow-up surveys included additional items regarding whether the participant had left secondary school (question 55a), was studying at a tertiary institution (question 55c), and what was mostly occupying their time (question 57c). Additionally, multiple survey items based on qualitative findings from the LEAP study (Chapter 3) were added. These asked about contact hours at the tertiary institution (questions 55d-f), main mode of transport (public transport, active transport and driving; question 61b) and changes in the main mode of transport (question 61c). The following section describes the relevant measures from the survey used in this thesis. The test-retest reliability of the variables was tested in a sub-study using a separate sample to ProjectADAPT, which is described in section 4.3.5.

Physical activity variables

The survey included items assessing LTPA (walking, other MPA and VPA during leisure-time), active transport (transport-related cycling and walking), school-related physical activity and occupational physical activity. Discretionary physical activity was a primary outcome variable and was the sum of physical activity in leisure and transport domains.

Survey items were adapted from the IPAQ telephone-administered long form version (www.ipaq.ki.se) and adolescent version (IPAQ-A)[217]. The IPAQ survey was chosen as it separates walking, moderate- and vigorous-intensity physical activity undertaken in different domains (leisure-time; transport; home/household & occupational). Two modules from IPAQ were included in this current survey: parts four “recreation, sport and LTPA" and five “time spent sitting”. Two modules from IPAQ-A were included: parts one “school-related activity” and three “transportation physical activity”. Instead of using the occupational activity IPAQ module, a more concise survey item was used from the Behavioral Risk Factor Surveillance System Questionnaire by the Centers for Disease Control and Prevention (www.cdc.gov/brfss/questionnaires/pdf-ques/2001brfss.pdf)[218]. The housework,

house maintenance, caring for family and gardening modules of IPAQ and IPAQ-A were only included in the final follow-up survey and were, therefore, not included in any analysis in this thesis. The domestic activity modules have been found to collect over-reported physical activity[219] and were considered not entirely appropriate for the focus of this study and age group.

Before answering the following questions, participants were provided with the definitions from the IPAQ of physical activity and the intensities. Participants were asked how many days in a usual week they walked or cycled to go from place to place for ≥10 mins at a time (questions 20c-f), and walked and did VPA and MPA in leisure-time for ≥10 mins at a time (questions 21a-f). Participants were offered 10 response options, being 0-7 days, 'Don't Know' and 'Refused'. Secondly, participants were asked how much time in total was usually spent doing those physical activities on one of those days and were offered units of per day or per week. Reliability and validity of these questions have been tested in adults and are substantial (0.8) and fair (0.3), respectively[54]. However, these questions were adapted for this study to try to improve compliance and completeness, including replacing the open-ended response options with categorical response options for the questions on the frequency of types of physical activity.

IPAQ guidelines were applied for data cleaning (www.ipaq.ki.se). Responses with 'hour and/or minutes' units were converted to minutes. Frequency ('days/week') responses were multiplied by the duration ('time spent on one of those days') to compute total mins/wk, then divided by seven to provide mean mins/day. Mean mins/day <10 were excluded and >180 were truncated to 180 because it was deemed over-reporting, as per the IPAQ scoring protocol (www.ipaq.ki.se). Even though walking is usually categorised as MPA[52], it was assessed and reported separately to MPA.

Three variables were generated by summing respective components. Total LTPA was generated by summing walking, other MPA and VPA. Total active transport was generated by summing cycling for transport and walking for transport. Lastly, discretionary physical activity was generated by summing total LTPA and total active transport. Discretionary physical activity was dichotomised at ≥60 mins/day to indicate meeting National Guidelines[109] at each timepoint. Although the participants

would have been >18-years-old at the time of the two-year follow-up, the adolescent cut-point applied to allow comparison with baseline and the one-year follow-up.

School-related and occupational physical activity

The survey at baseline and the first follow-up assessed four components of school-related physical activity. Participants were asked: "How many physical education or PE classes do you usually have per week?"[217;] "Do you belong to any school sport teams or participate in any other organised school sport activities?"; "How many school sport teams or squads do you belong to?"; and "During morning recess and your school lunch break, would you say you mostly sit, mostly stand, mostly walk, mostly do moderate activity (e.g. shooting hoops) or mostly do vigorous activity (e.g. running)?"[218]. The validity of the IPAQ-A, including the question about physical education classes (or physical activity at school), has been tested in 15-18-year-olds and was fair (0.22)[217]. However, in this survey, that question had wording and response option modifications to be more concise, namely, not asking for the time spent doing physical activity during physical education classes. The response options were "None", "1 class", "2 classes", "3 classes", "4 classes", then "Other". The item assessing physical activity during school breaks was adapted from a question about occupational physical activity (described below)[218].

The survey item that assessed occupational physical activity (question 56i) asked participants what best described their activity levels at work. The four discreet response options were whether participants mostly sat, stood, walked or did heavy labour or physically demanding work. It was tested in a sample of adults and test-retest reliability was moderate (0.40-0.45)[218].

Sedentary behaviour variables

Total sedentary behaviour

Participants were provided the definition from the IPAQ to consider before answering the following questions, that said to include time spent sitting or lying down while awake. Two items (questions 26a and b) requested total time spent in a usual week sitting on a weekday and weekend day, respectively, including time spent sitting at home, school, work and leisure-time (free time). These items were based on the IPAQ (www.ipaq.ki.se) and excluded sitting in a motor vehicle. Continuous data that included minutes were converted to hours, as recommended in the IPAQ guidelines (www.ipaq.ki.se). Sitting on weekdays for >20 h were divided by five, and on weekend days >20 h were divided by two, as it was deemed over-reporting. The h/day sitting on a weekday was multiplied by five and h/day sitting on a weekend day was multiplied by two, then summed to generate total h/wk, then divided by seven to provide mean h/day.

Sedentary transport (questions 20a-b) was also sourced from IPAQ (www.ipaq.ki.se) and defined in the survey as sitting in a motor vehicle, such as a train, bus, car and tram. Participants were asked how many days in a usual week they travelled in a motor vehicle. Response options were modified compared to its source, as the frequency response options were changed from open-ended to 10 options (0-7 days, 'Don't Know' and 'Refused') to improve compliance and completeness. Participants were also asked how much time on one of those days was usually spent travelling in a motor vehicle and the response option units were hours and/or mins per day/wk. Frequency/wk was multiplied by the duration/day, to generate total h/week, then divided by seven to provide mean h/day. Data cleaning involved exclusion of results <10 mins/day and truncating >3 h/day to 3h because it was deemed over-reporting.

These IPAQ survey items had substantial (0.7) test-retest reliability and fair-to-moderate (0.3-0.5) validity in comparison to accelerometers in adults[220].

Recreational screen time

The survey also included items related to recreational screen time (h/day). Total recreational screen time was comprised of three categories of behaviours, specifically, watching television, digital versatile discs (DVDs) and videos (questions 27a-b), using a computer, laptop or tablet (questions 28a-b), and playing electronic games (questions 29a-c). The survey specified to report only time spent sitting while doing these behaviours. If participants did not play electronic games while sitting, question 29 b-c was coded as 0 mins/h. Participants were asked to report the total time from Monday-Friday, and total time Saturday-Sunday, usually spent engaging in each of the three categories of recreational screen time. Previously reported reliability in adults was moderate for total recreational screen time (Kappa 0.41; 95%CI: 0.25-0.54), high for watching television, DVDs and videos (Intraclass correlation coefficient (ICC): 0.82; 95%CI: 0.75-0.87) and substantial for using a computer (ICC: 0.62; 95%CI: 0.48-0.73)[221].

For each of the three categories of screen time behaviours, reported time was converted to hours and truncated to 10 h/day. Next, each screen time behaviour was summed to create total recreational screen time, which was truncated to 18 h/day or excluded if >24 h/day. This variable was dichotomised at ≤2 h/day to indicate meeting National Guidelines[109]. As there are no national dose-specific sedentary behaviour recommendations for adults, the recreational screen time data for all three time-points were compared to the adolescents guidelines[109].

School-related and occupational sedentary behaviour

The school-related sedentary behaviour measure was part of the survey item that assessed the main activity level during school breaks that was adapted from the occupational sedentary behaviour survey item[218]. The occupational sedentary behaviour measure was part of the survey items that assessed the main activity level at work (question 53i). Data were each dichotomised to indicate if participants mostly sat during school breaks and as part of their work. It was tested in a sample of adults and test-retest reliability was moderate (0.40-0.45)[218].

Independent variables

Table 4.1 describes the independent variables assessed in the survey and used in this thesis, including data treatment (summed or averaged; if applicable), sources, scoring of response options and internal reliability (if applicable). Some of the variables were identified in Chapter 3, specifically, social support, internal influences (enjoyment, competence and self-efficacy), priorities and habits (goal setting), technology access (electronic devices and televisions) and facilities. These variables were used to identify cross-sectional correlates of physical activity and sedentary behaviour in late adolescence (Chapters 5-6), longitudinal determinants of physical activity and sedentary behaviour during the transition out of secondary school (Chapter 8), and moderators of associations between situational transitions and physical activity and sedentary behaviour during the transition out of secondary school (Chapter 8).

The independent variables include characteristics traditionally specific to physical activity or sedentary behaviour, for example, physical activity enjoyment and goal setting, television avoidance self-efficacy, and the number of physical activity equipment and electronic devices at home. The rationale for examining this varied range of influences on both physical activity and sedentary behaviour is the interdependency of these two health behaviours. Firstly, previous literature has reported these health behaviours are associated with each other[74, 222]. Secondly, while there is time for both of these health behaviours across the day, device-assessed sedentary time and LPA is strongly negatively correlated in adults[223] and children[224], that is, commonly displaced by each other. It is therefore important to examine the complex relationship that exists between physical activity and sedentary behaviour and the possibilities of additional explaining influences.

Table 4.1 Treatment and scoring of individual, social and environmental survey items, and internal reliability

Variable names, survey items and original sources		Scale/response options and scoring	Cronbach's alpha coefficient
Individual variables (scores)			
PA enjoyment (3 items summed)	I enjoy doing physical activity.[225] I enjoy playing sport. I enjoy going for walks or walking places.	5 part: 1=strongly disagree, 5=strongly agree	0.74
PA goal setting (3 items summed)[226]	How many times in the past month did you… Set a goal for how much physical activity you would like to do? Plan particular days on which you would do physical activity? Meet someone to do physical activity with?	6 part: 1=never/rarely, 2=<1/wk, 3=1/wk, 4=2-3/wk, 5=4-6/wk, 6=every day	0.72
PA competence (1 item)	I am good at physical activity.	5 part: 1=strongly disagree, 5=strongly agree	-
PA barrier self-efficacy (5 items summed)[227]	How confident are you that you could do physical activity even when you… Are tired? Feel sad, stressed or in a bad mood? Are on holiday? Feel you don't have time? When it's raining?	5 part: 1=not at all, 5=extremely	0.85
TV avoidance self-efficacy (5 items summed)[227]	How confident are you that you could… Watch less TV even when you are bored? Turn off the TV even when there is a program you enjoy? Watch less TV even when it is raining? Watch less TV even if others want to watch it? Turn off the TV when you are doing something else?		0.84

Table 4.1 Continued

Social variables			
Family (scores):			
E-games co-participation (1 item)[228]	During the past 6 months, how often did a family member play electronic games with you?	5 part: 1=never, 5=very often	-
PA co-participation (1 item)[225, 228]	During the past 6 months, how often did a family member do physical activity with you?		-
TV/DVDs co-participation (1 item)[228]	During the past 6 months, how often did a family member watch TV or DVDs with you?		-
PA social support (3 items summed)[225, 228]	During the past 6 months, how often did a family member… Do physical activity with you? Encourage you to be physically active? Take you to places where you can be active?		0.72
SB discouragement (1 item)[229, 230]	During the past 6 months, how often did a family member discourage you from sitting too much (e.g. watching too much TV)?		-
Friends/colleagues (scores):			
E-games co-participation (1 item)[228]	During the past 6 months, how often did friends or work colleagues play electronic games with you?		-
PA co-participation (1 item)[225, 228]	During the past 6 months, how often did friends or work colleagues do physical activity with you?		-
TV/DVDs co-participation (1 item)[228]	During the past 6 months, how often did friends or work colleagues watch TV/DVDs with you?		-
PA social support (3 items summed)[225, 228]	During the past 6 months, how often did friends or work colleagues… Do physical activity with you? Encourage you to be physically active? Take you to places where you can be active?		0.81
SB discouragement (1 item)[229, 230]	During the past 6 months, how often did friends or work colleagues discourage you from sitting too much?		-
Social network count (3 items summed)	How many adults aged 18 years or over usually live in your household? What about children or young people aged less than 18 years? How many close friends would you say you have?	3 part: *n*+*n*+*n*	-
Gym membership (1 item)[226]	Over the past 6 months, have you been… A member of a gym or fitness club?	2 part: 0=no, 1=yes	-

Table 4.1 Continued

Environmental variables			
Home environment:			
E-devices, no. of (count of 6 items)[231]	Do you have access to the following at home… mobile phone, laptop, tablet/iPad, desktop computer (PC or Mac), active games console (Wii or Kinect), other games console?	2pt: 0=no, 1=yes	-
PA equipment, no. of (count of 5 items)[231]	Do you have access to the following at home… treadmill or other gym equipment, basketball/netball ring, bicycle, tennis court[232], swimming pool?		-
TVs, no. of (1 item)[231]	How many TVs do you have in your house?	1 part: *n*	-
Neighbourhood environment (scores):			
Noise (1 item)[233]	There is a lot of noise in my neighbourhood.	5 part: 1=strongly disagree, 5=strongly agree	-
Walking environment (4 items summed)[233]	Local sports clubs and other facilities in my neighbourhood offer many opportunities to get exercise. I often see other people walking in my neighbourhood. I often see other people exercising (for example, jogging, bicycling, playing sports) in my neighbourhood. In my neighbourhood, it is easy to walk places.		0.73
Safety (2 items summed)[233]	I feel safe walking in my neighbourhood, day or night. My neighbourhood is safe from crime.		0.78
Social cohesion (2 items summed)[233]	People around here can be trusted. People around here are willing to help their neighbours.		0.76
Land use mix diversity (count of 8 destinations within 10 mins)[234]	If you walked to them, about how long would it take to get from your home to the nearest… milkbar, convenience or small grocery store, supermarket, fruit and vegetable shop or market, fast food outlet, café or restaurant, public transport stop (bus, tram, train), your school, and your work if you have one?	5 part: 1=1-5 mins, 1=6-10 mins, 0=11-20 mins, 0=21-30 mins, 0=>30 mins, 0=N/A, 0=don't know	0.81
Recreation facilities (count of 5 destinations within 10 mins)[234]	If you walked to them, about how long would it take to get from your home to the nearest… park, bicycle or walking track, indoor recreation or exercise facility such as a gymnasium, swimming pool, and playing fields such as football ovals or tennis courts?		0.64

Adaptations

Most independent variables were adapted. This was to simplify, apply a Victorian- or Australian-context or vernacular, increase applicability to the late adolescence age group, aide interpretation or improve clarity. Most of the individual variables were adapted. Physical activity enjoyment[225] included newly developed survey items about sport and walking. Physical activity goal setting[226] was originally called 'Behavioural skills in the past month', had minor wording modifications for clarity, an additional response option was added to one item and other items had higher frequencies added as response options (2-3/wk, 4-6/wk and daily). Physical activity self-efficacy[227] had minor wording and response option modifications that changed the statements into questions, 'exercise' was changed to 'physical activity', 'vacation' was changed to 'holiday' and 'snowing' was removed. Television avoidance self-efficacy was adapted from physical activity self-efficacy score and the choice of wording aimed to similarly represent overcoming barriers and relapse resistance.

Most social variables were adapted. Co-participation in electronic games, physical activity and television/DVD, and social support for physical activity from family, friends or colleagues[225, 228] had modified response options of 'very often' rather than 'every day'. Of these, the sedentary behaviour measures were adapted from the physical activity measures. The discouragement of sitting from social networks was added to a scale[230] to represent social sabotage[229]. Gym membership[226] was originally named 'Club membership' and included one survey item about engagement in 'sport, exercise, or outdoor recreational group or club'. This was reduced to only 'gym or fitness club' and a timeframe of the previous six months was added.

Most environmental variables were adapted to simplify and apply context-specific vernacular. The wording and response options for the number of electronic devices at home[231] item were changed from continuous and open-ended to binary ('yes/no'), examples were added, only six of the 13 original response options were included, and 'cell phone' was changed to 'mobile phone'. The number of physical activity equipment at home[231] item included only five of the 14 original response options and tennis court was added. Neighbourhood noise[233] was originally part of a six-item measure for aesthetic quality. Lastly, neighbourhood walking environment included only four of the 10 original components, neighbourhood safety included two of the

three original components and neighbourhood social cohesion included two of the four original components[233].

Known reliability and validity

Few of the independent measures have known reliability and validity from testing in other samples that did not always include adolescents. Firstly, the reliability of enjoyment of physical activity via computer administer survey was poor[235] (ICC: 0.13, 95%CI: 0.00, 0.45)[225] in a small sample of adolescents (*n*=32) from the USA. Secondly, the number of electronic devices, physical activity equipment and televisions in the home were tested in a sample of 15-year-olds (50.7% girls) and were moderate-to-high[235] for the scales (ICC: 0.60-0.87) and fair-to-high[235] for the individual items (ICC: 0.38-0.88)[231]. Thirdly, neighbourhood environment variables of noise, walking environment, safety and social cohesion had high[235] internal consistency (0.73-0.77) in a large sample of 44-year-olds (*n*=5 988; 54% women) from the USA, and moderate-to-high[235] test-retest reliability using a subset from the same study (0.60, 95%CI: 0.47, 0.71; to 0.88, 95%CI: 0.83, 0.91)[233]. Lastly, the neighbourhood environment scores for land use mix diversity and recreation facilities had acceptable internal consistency and substantial-to-high[235] test-retest reliability (ICC: 0.72-0.87) in a sample of 12-18-year-olds from the USA[234].

Internal reliability

Internal reliability of the scales is presented in Table 4.1 and was identified using Cronbach's Alpha[236]. Four of these variables initially had unacceptable internal reliability (<0.7[237]). Of those, recreation facilities score was used in further analyses unmodified to maintain heterogeneity with its source[234] and because access to recreation facilities reflects physical conditions and not a not a psychosocial construct. The remaining three variables were modified. Firstly, the newly developed scores for co-participation in sedentary behaviour with 1) family or 2) friends or colleagues were split into the individual survey items (electronic games and television/DVDs). Secondly, traffic was dropped from the walking environment score, consistent with its source[233], because it improved the internal reliability (≥0.7[237]).

Socio-demographic variables

Gender and school attended were noted on participant consent forms. The survey (Appendix 4.1) collected additional socio-demographic information. Dates of birth were used to calculate age in years along with the surveys' completion dates. Primary place of residence postcodes were collected to identify remoteness as urban or rural and area-level SEP as lowest, mid or highest tertiles. Data were collected on employment status and type (volunteer, casual or part-time), the number of jobs held, and income (five categories ranging from <$50/wk to >$550/wk). Lastly, information on the highest level of school of participants' parents or carers, the birth country of participants and parents or carers, and whether English was the most commonly spoken language at home were ascertained. Data cleaning of the socio-demographic measures included checking for implausible responses.

4.3.5 Test-retest reliability sub-study

Survey development and robust standards of data quality are explored within the field of psychometrics[238]. Although all assessment tools contain some degree of measurement error, a reliable survey is imperative for ensuring that data reflects what is being measured[238]. One type of reliability testing is repeatability via test-retest which assesses the ability of a survey to yield compatible results[239].

To address Aim 2, the test-retest reliability of survey items was identified. There were four key reasons for this. Firstly, it will aid critical assessment of the survey and result interpretation[240]. Secondly, previous reliability and/or validity testing of some survey items mostly sampled adults[54, 218, 221, 233, 241]. Thirdly, as outlined in the previous section, some survey items were newly developed and most other survey items were adapted compared to the sources. Lastly, testing the sedentary behaviour survey items is important because a limited amount of sedentary behaviour surveys have undergone psychometric testing[242] and of those that have, few have acceptable reliability[243].

Study design and procedures

Ethical approval for the test-retest reliability study was obtained from Deakin University's Human Ethics Advisory Group - Health. The test-retest study design included participants completing an online survey on two occasions, approximately two weeks apart (15.8 days on average). The survey was a consolidated version of

the baseline, one- and two-year follow-up surveys of the main study. It contained all unique survey items, excluding inappropriate questions about leaving secondary school.

A sample of Year 11 students separate to the main cohort was recruited via two waves of advertising on social media in September-November, 2015 and May-July, 2016. The advertisement was delivered to 16-17-year-olds in states of New South Wales and South Australia in Australia. After seeing an advertisement, interested individuals clicked the advertisement and were taken to a Deakin University webpage to fill out an online form to register interest. Individuals who registered interest were emailed a plain language statement and a consent form for themselves and a parent/guardian to complete and return. Upon receipt of the completed consent forms (n=90), participants were emailed a unique link generated within Qualtrics to the first survey and instructions to follow. Two weeks after completing the first survey, participants were emailed a unique link for the follow-up survey and asked to complete it as soon as possible and within two weeks. If the baseline or final survey was not completed within one week of emailing the unique link, a reminder email was sent weekly (maximum two reminders). As compensation for time, a gift card redeemable at several stores was posted to the participants after the final survey was completed.

4.3.6 Data analysis and power calculations

For this and the remaining chapters, data cleaning, management and analyses were conducted using Stata (version 12 for Windows, 2012, StataCorp LP) and statistical significance was set to $p<0.05$ for all analyses. Survey data were downloaded from the Qualtrics website in .csv files and the three survey data files were merged. Chapters 5 and 6 used all available baseline data, whereas complete case analysis took place for Chapters 7 and 8. Missing data were not imputed.

Participant characteristics at baseline are described using cross-tabulations or means and the distribution of independent variables at baseline was described using means and SD. Significance testing of continuous variables used t-tests for binary subgroups (gender and remoteness) and one-way analysis of variance (ANOVA) for area-level SEP. Lastly, significance testing of categorical variables used Pearson's chi-squared statistics.

For the test-retest reliability study, to detect an ICC of 0.8, based on alpha=0.05 and beta=0.2, a sample size of approximately 39 was required[244]. Psychometric literature steered the choice of reliability tests used[245-248]. Firstly, dichotomised and non-ordinal categorical variables were assessed using percentage agreement[245] and Kappa statistics. Secondly, ordinal categorical variables were assessed using percentage agreement[245], weighted Kappa and ICC[246]. Lastly, continuous variables were assessed using ICC. Reliability rating was based on the highest score of these tests. Agreement was classified as poor (≤0.2), fair (0.21-0.4), moderate (0.41-0.6), substantial (0.61-0.8) or high (0.81-1.0)[235].

Power calculations for ProjectADAPT revealed that to detect an R-Squared of 0.04 attributed to 14 independent variables using an F-Test with a significance level of 0.05 and 80% power, a sample size of approximately 500 at the two-year follow-up was required[129]. This accounted for the design effect based on clustering by baseline school (using the cluster size of seven and assuming 70 clusters in total with an ICC of 0.1 for continuous variables). The sample obtained at baseline (*n*=1 022) included participants from 299 schools, and the two-year follow-up sample (*n*=852) were from 273 schools at baseline. The study is, therefore, adequately powered.

4.4 Results

4.4.1 Description of participants at baseline

Table 4.2 presents the participant characteristics at baseline (Aim 1) for the overall sample and according to gender, remoteness and area-level SEP. A higher proportion of participants identified as girls (74%), lived in an urban area (71%), lived in the highest tertile of socio-economic area (46%), were recruited via social media (63%) and took the surveys online (93%). Common (n>20) occupations were retail assistant, fast food team member, cashier, waitress and customer service officer.

There was only one significant gender difference found, and that was between the recruitment methods of schools and social media, with a higher proportion of boys than girls recruited via schools and a higher proportion of girls than boys recruited via social media. Demographic characteristics by remoteness and area-level SEP are presented in Appendix 4.2. Most demographic characteristics differed by remoteness. A higher proportion of those who lived in an urban area also lived in the highest tertile of socio-economic area, and a higher proportion of those who lived rurally also lived in the lowest tertile of socio-economic area. A higher proportion of those who lived in an urban area, compared to the rural counterparts, completed the survey online, were unemployed, had tertiary-educated parents, were recruited via social media, had ≤1 job, did not primarily speak English at home, were born in a country other than Australia and had parents also born in a country other than Australia. Some demographic characteristics differed significantly between area-level SEP, with a higher proportion of those who lived in the highest tertile recruited via social media, completed the survey online, lived in an urban area, had tertiary-educated parents, and earned <$150/wk, compared to those living in the lowest and mid tertiles.

Demographic characteristics by mode of the survey (telephone/online) and recruitment method (school/social media) are presented in Appendix 4.3. A higher proportion of participants who took the survey via the telephone were recruited via schools, were younger, lived rurally, and had parents born in Australia, compared to those who took the survey online. A higher proportion of those recruited via social media took the survey online, were older, identified as girls, lived in an urban area, and were employed, compared to those recruited via schools.

Table 4.2 Sample profile (*n*=1 022)

	Overall	Gender	
		Girls	Boys
	%	%	%
(n)	(1 022)	(754)	(267)
Recruitment via schools, *n=1 022*	37.4	**35.4***	43.1
Survey delivery, online, *n=1 022*	92.6	92.6	92.5
Age (mean years±SD), *n=1 008*	16.9±0.4	16.9±0.4	16.9±0.4
Gender, girl, *n=1 021*	73.9	-	-
Remoteness, urban, *n=1 022*	70.6	72.0	43.8
Tertiles of area-level SEP, n=1 021			
Lowest	23.8	22.7	27.0
Mid	30.1	29.8	30.3
Highest	46.1	47.3	42.7
Parent tertiary educated			
Mother, *n=1 018*	54.4	54.2	54.7
Father, *n=1 017*	43.8	42.3	47.9
Employment, n=1 016t			
Not employed	41.6	40.5	44.9
Casual	42.4	43.0	40.8
Part-time	20.8	21.5	18.7
Income <$150/wk, n=805	68.4	67.9	69.7
Birth country (Australia)			
Participant, *n=1 015*	84.4	84.1	85.8
Mother, *n=1 011*	61.6	60.9	64.0
Father, *n=1 004*	61.2	60.6	62.9
English as primary language spoken at home, n=1 018	85.2	85.3	85.0

**p<0.05: Pearson's χ^2 test of significance.*

4.4.2 Test-retest reliability of survey items

Of the 90 consent forms returned for the test-retest reliability sub-study, 89 completed the first survey and 83 (73% girls) completed both surveys. Participants were 16.9±0.6-years-old. The test-retest reliability scores of the physical activity and sedentary behaviour variables are summarised in Table 4.3 and Table 4.4 presents the test-retest reliability of the independent variables. Correspondingly, Appendix 4.4 presents the test-retest reliability for each individual survey item. The test-retest reliability scores were mostly high. Five individual survey items had poor test-retest reliability. These were co-participation with friends or colleagues in watching television and DVDs, discouragement of sedentary behaviour from friends or colleagues, the number of close friends, access to a mobile phone, and access to physical activity facilities. However, the latter three were part of sub-scales with acceptable test-retest reliability.

Table 4.3 Test-retest reliability results of the survey items for physical activity and sedentary behaviour variables

	Test-retest reliability statistics				
	Kappa/ weighted Kappa		**ICC**		**Percentage agreement** %
	Sub-scale	**Individual items**	**Sub-scale**	**Individual items**	
Physical activity:					
Total LTPA (mins/day)[1]	0.59	0.46-0.70	0.58	0.57-0.79	-
Total active transport (mins/day)[1]	0.62	0.59-0.68	0.54	0.39-0.66	-
School PA:					
Main activity level during breaks (%)	-	0.65	-	-	90.0
PE classes/wk (%)	-	0.82	-	-	95.4
Participate in school sport (%)	-	0.76	-		88.0
School sport teams, *n* (%)	-	0.62	-	-	75.0
Occupational PA:					
Main activity level at work (%)	-	0.54	-	-	74.1
Sedentary behaviour:					
SB (excluding transport) (h/day)	-	-	0.72	0.60-0.74	-
Sedentary transport (h/day)[1]	-	0.55	-	0.34-0.83	-
Total recreational screen time (h/day)	-	-	0.95	0.04-0.78	-
School SB:					
Main activity level during school breaks (%)	-	0.65	-	0.84 (0.76, 0.90)	90.0
Occupational SB:					
Main activity level at work (%)	-	0.54±0.09	-	-	74.1

[1] *ICC and Kappa statistics are presented for the continuous and categorical components (Appendix 4.4).*

Note: all were significant ($p<0.05$).

Table 4.4 Test-retest reliability results of the survey items for the independent variables

	Test-retest reliability statistics				
	Kappa/ weighted Kappa		ICC		Percentage agreement %
	Sub-scale	Individual items	Sub-scale	Individual items	
Individual variables (scores)					
PA enjoyment	0.54	0.51-0.73	0.72	0.57-0.77	88.7
PA goal setting	0.57	0.54-0.59	0.87	0.70-0.86	88.6
PA competence	0.72	0.72	-	-	88.9
PA self-efficacy	0.57	0.41-0.59	0.86	0.71-0.84	88.1
TV avoidance self-efficacy	0.52	0.44-0.56	0.75	0.63-0.74	85.1
Social variables					
Family (scores):					
E-games co-participation	0.37	0.37	0.58	0.58	86.0
PA co-participation	0.61	0.61	0.71	0.71	85.9
TV/DVDs co-participation	0.47	0.47	0.72	0.72	82.2
PA social support	0.57	0.47-0.61	0.86	0.75-0.89	86.4
SB discouragement	0.25	0.25	0.71	0.71	85.5
Friends/colleagues (scores):					
E-games co-participation	0.50	0.50	0.39	0.39	84.4
PA co-participation	0.43	0.43	0.79	0.79	79.7
TV/DVDs co-participation	0.35	0.35	0.13	0.13	79.4
PA social support	0.42	0.34-0.43	0.77	0.64-0.76	82.7
SB discouragement	0.33	0.33	0.15	0.15	86.6
Social network count	-	-	0.95	0.00-0.96	-
Gym membership	-	0.76	-	-	91.5
Environmental variables					
Home environment (counts):					
E-devices, no. of	0.49	0.55-0.88	-	-	61.5
PA equipment, no. of	0.56	0.36-0.79	-	-	66.3
TVs, no. of	-	-	0.96	0.96	95.0
Neighbourhood environment (scores):					
Noise	0.30	0.30	0.44	0.44	80.0
Walking environment	0.39	0.19-0.46	0.74	0.51-0.78	83.2
Safety	0.49	0.50-0.55	0.70	0.60-0.68	85.9
Social cohesion	0.43	0.45-0.46	0.72	0.65-0.71	88.6
Land use mix diversity	0.65	0.54-0.80	0.92	0.76-0.92	91.3
Recreation facilities	0.62	0.58-0.68	0.86	0.71-0.86	89.7

Note: all were significant ($p<0.05$).

4.4.3 Distribution of independent variables at baseline

The distribution of the baseline independent variables is presented in Table 4.5 (Aim 3) for the overall sample and according to gender. Most means were around half of the maximum possible score or count; however, some biases were present. Girls reported significantly higher scores than boys for physical activity goal setting and neighbourhood safety. Conversely, girls reported lower scores than boys for eleven individual and social variables. These were physical activity competence, physical activity self-efficacy, family co-participation in electronic games, sedentary behaviour discouragement from family, co-participation in electronic games and physical activity with friends or colleagues, social support for physical activity from friends or colleagues, and social network count.

The baseline distribution of most of the environmental independent variables and few of the individual and social variables differed by remoteness and area-level SEP (Appendix 4.5). Of the variables that differed significantly, the trend was that those who lived rurally or in the highest tertile of socio-economic area generally reported a higher proportion of favourable scores or counts.

Table 4.5 Baseline distribution (mean±SD) for independent variables

	n	Max. score	Overall	Gender	
				Girls	Boys
Individual variables (scores)					
PA enjoyment	1 019	15	11.7±2.6	11.7±2.6	11.9±2.7
PA goal setting	1 022	18	8.6±3.9	**8.7±3.7****	8.6±4.3
PA competence	1 020	5	3.5±1.2	**3.4±1.2*****	3.8±1.2
PA self-efficacy	1 022	25	14.4±5.0	**13.8±4.8*****	15.9±5.2
TV avoidance self-efficacy	1 009	25	16.1±4.7	16.1±4.7	16.1±4.7
Social variable					
Family (scores):					
E-games co-participation	995	5	1.7±1.0	**1.6±1.0*****	1.9±1.2
PA co-participation	1 012	5	2.7±1.3	2.6±1.3	2.7±1.3
TV/DVDs co-participation	1 016	5	3.4±1.2	3.4±1.2	3.4±1.1
PA social support	1 012	15	9.5±3.3	9.4±3.2	9.8±3.3
SB discouragement	1 015	5	3.1±1.3	**3.0±1.3***	3.2±1.3
Friends/colleagues (scores):					
E-games co-participation	1 020	5	2.1±1.3	**1.8±1.1*****	2.8±1.4
PA co-participation	1 020	5	2.9±1.4	**2.7±1.3*****	3.3±1.4
TV/DVDs co-participation	1 020	5	2.8±1.2	2.8±1.2	2.7±1.2
PA social support	1 020	15	7.5±3.2	**7.2±3.1*****	8.5±3.4
SB discouragement	1 020	5	1.7±1.0	1.7±0.9	1.9±1.1
Social network count	1 017	∞	11.8±10.1	**11.4±9.4***	12.9±11.6
Gym membership (yes)	1 021	1	28.4%	28.1%	29.2%
Environmental variables:					
Home environment:					
E-devices, no. of	1 018	6	4.5±1.1	4.6±1.1	4.5±1.1
PA equipment, no. of	1 019	5	2.0±1.2	2.1±1.2	2.0±1.2
TVs, no. of	1 016	∞	2.7±2.3	2.6±2.5	2.7±1.4
Neighbourhood environment (scores):					
Noise	1 017	5	2.5±1.0	2.6±1.0	2.5±1.0
Walking environment	1 015	20	15.8±3.0	15.9±2.8	15.7±3.1
Safety	1 016	10	7.3±1.9	**7.9±1.8*****	7.1±1.9
Social cohesion	1 016	10	7.4±1.7	7.5±1.7	7.3±1.6
Land use mix diversity	1 017	8	3.0±2.3	3.0±2.3	2.8±2.2
Recreation facilities	1 016	5	2.4±1.5	2.4±1.5	2.4±1.5

**p<0.05, **p<0.01, ***p<0.001: Continuous variables used independent t-test and categorical variables used Pearson's χ^2 test of significance.*

4.5 Discussion

This chapter described the methodology of ProjectADAPT and participant socio-demographic characteristics at baseline. The test-retest reliability of key survey items and the distribution of the independent variables at baseline were examined. The sample was diverse (Aim 1). Some participants were born overseas (15%) and a higher proportion of parents or carers were born overseas (39%), highlighting that about a quarter of the participants are first-generation Australians. Variations between demographic characteristics by subgroups were found. A higher proportion of rural participants than urban were recruited via schools than social media, which may reflect less internet use in rural 16-17-year-olds than urban counterparts. This contrasts with a study of 16-25-year-old women that noted success recruiting rural or regional participants via social media[199]. A higher proportion of those who lived in the highest tertile of socio-economic area reported income <$150/wk compared to those who lived in lowest and mid tertiles, potentially due to more parental financial support, different social norms and varied expectations in that subgroup. A study reported that young adults expect continued parental support; however, parents of young adult boys expect more independence[249]. This may be important, as reduced parental financial assistance has been linked to lower self-esteem and higher depressive symptoms in young adults[250].

Importantly, the test-retest reliability of the survey items ranged from substantial-to-high; therefore, all were acceptable and appropriate to use in the remaining chapters of this thesis (Aim 2). Findings were consistent with previous research for watching television, DVDs and videos (high[221]). Findings were higher than previously reported for physical activity variables (substantial-to-high vs fair-to-moderate[54]); computer use (high vs substantial[221]); and sedentary behaviour (excluding transport; high vs substantial[221]). Inconsistencies with previous studies may be partially attributed to shorter follow-ups and adaptations to wording and response options[54, 221]. Further, previous studies had older[54, 221], larger[221] samples and represented gender more equally[54].

The initial cluster sampling via school recruitment resulted in a very low response proportion. Although this was a stratified random sampling approach, the sample disproportionately included girls who lived in urban neighbourhoods with the least disadvantage. The subsequent social media recruitment was more successful than school recruitment, although there are differences in demographic and personality

characteristics between social media users and non-users[251] or the general population[252] (described more subsequently). The combination of sampling approaches in this study formed a cohort that was, overall, a convenience sample.

Recruitment strategies aiming at blanket coverage were also successful for a randomised controlled trial of 6-11-year-olds in the UK[253]. The trial found that passive recruitment strategies including flyers and media were more successful than active recruitment strategies, such as directly contacting eligible participants. The authors attributed the success of passive methods to the larger reach and multiple views. Further, passive methods may attract participants who are interested in the study topic and, therefore, more motivated to complete the study[253]. Due to the low response from boys, an additional sampling strategy was employed. Targeted social media advertisements were delivered to boys and resulted in a further *n*=103 consents (*n*=99 completed surveys). Recruiting boys was challenging and may have been due to girls using social media more[252, 254]. Large studies of adolescents that partially or solely recruited via secondary schools achieved more equal gender representation[255-258]. This is inconsistent with this study and may be due to a larger number of additional recruitment strategies (cartoons, brochure, poster, slogan, food, website, television and local paper advertisement)[255], larger recruitment budget[255], less participant burden from a single data collection (cross-sectional survey)[256] or more convenience from administering surveys during class time[257, 258].

The current study provides some insight for future research into difficulties recruiting older adolescents. Maximise participation is critical for studies to be adequately powered. Offering vouchers as compensation may have assisted in recruiting more participants and may be important for retaining participants in cohort studies. In this study, recruitment via social media appeared more successful than recruitment via schools for the age group and boosted the sample considerably. While the advertisements were paid (total cost >$3 700AUD), recruitment via advertising on Facebook involved considerably less staff time than recruiting through schools, which involved extensive time contacting and liaising with schools, scheduling, travel and school visits, sometimes with two staff.

The independent variables that participants reported >50% of the maximum score or count at baseline were physical activity enjoyment, physical activity competence, social support for physical activity from family, the amount of physical activity

equipment at home, and neighbourhood walking environment (Aim 3). Future research is needed that tests whether this reflects a sample bias for higher physical activity. The five variables differed by remoteness, area-level SEP and gender. Gender differences were consistent with other studies of older adolescents[259, 260], with boys reporting >30% higher than girls of the independent variables including physical activity competence, physical activity self-efficacy and social network count. However, gender differences were inconsistent with a small 10-year follow-up study of 12-year-olds (*n*=39) from Sweden[261]. This study found no difference by gender in self-worth or physical self-esteem[261]. The inconsistencies in findings compared to this study may be due to a wider age range, smaller sample size and different source country[261].

Strengths and limitations

Study design and recruitment

A strength of this study was an adequate sample size of >1 000 participants. Despite the non-probability sample, participants were from a range of remoteness, area-level SEP, income profiles and countries of birth. Another strength of this study is that the data collection instrument was a cost-effective, quick and efficient method of assessing domain-specific information about physical activity and sedentary behaviour that, importantly, does not alter the behaviour assessed[262]. The survey was designed to be a short length (30 mins), limiting participant burden. An advantage of the online survey was that it appeared in manageable sections.

A further strength is the study design. Year 11 (second last year of secondary school) was chosen as baseline due to schools often limiting access to Year 12 (final year) students who are focusing on exam preparation. An advantage of this sampling restriction was that the annual assessments captured data on early school leavers who are an understudied minority group. The study design included three annual data collection points that allowed examination of yearly and small behavioural changes which studies with long follow-ups may have masked[163, 164]. The prospective cohort study design captured numerous post-school pathway and situational transitions that students took, not only university.

A strength of the study was the focus on late adolescence and the transition of leaving secondary school. Even though that transition is normative and most people

experience it, it is understudied compared to other normative transitions, such as completeing primary school and commencing secondary school. Although adolescence is crucial in the development of behaviour that tracks throughout the lifespan, it is understudied compared to other life stages of adulthood and childhood. Overall, the data from this study will progress these underresearched and important areas within the field of behavioural epidemiology.

A key limitation of this study is that generalisability and external validity are reduced for two main reasons. Firstly, the sample had inflated proportions of girls (74%) compared to population average of 49% of 17-year-old Victorians[263]. Also, those living in a rural area (29%) in this sample was higher than the Victorian population average of 8%[264]. This overrepresentation may mean that unique findings may be masked, especially for boys. Secondly, the convenience sample lived in only one state within one country (Victoria, Australia). To increase generalisability, future research with these biases could consider weighting the sample or should ensure more equal gender representation and employ random sampling of multiple states or countries.

Social media recruitment, compared to school recruitment, contributed proportionally more participants who were living in the highest tertile of socio-economic area, girls (consistent with studies about social media users[252, 254]), living in an urban area, or unemployed. There are likely differences between social media users who respond to advertisements and users who do not; however, the demographic characteristics of non-responders are unavailable to studies using the platform to recruit. A general limitation of social media recruitment is that, although social media use is prevalent, not all segments of populations have social media accounts. Compared to the general population, social media users are younger, female and are more educated[252]. More social media users than non-users have low conscientiousness, are shy, and have high scores for extraversion, family and social loneliness, narcissism, exhibitionism and leadership[251]. Participants recruited from social media may have addictions to social media, mobile phones and/or the internet[265]. The subsequent issues common to high technology use may also be associated with the primary outcomes variables of this study (high sedentary behaviour and low physical activity), such as high narcissism and low self-esteem[266], or anxiety and insomnia[267].

A study limitation may be the varied survey delivery. When comparing survey delivery mode between telephone and online, a study reported that telephone-delivery elicited higher social desirability, anxiety and stress, and that participants gave different responses depending on the delivery mode[268]. This suggests that multi-modal responses may have impaired comparability[268]. However, a cross-sectional study of 24-year-olds from the USA found that completing online surveys on smartphones was comparable to computers[269]. This was dependent on survey characteristics (wide/long format), smartphone features (screen brightness, text size) and age of participants (adolescents are adept at reading smartphones due to high use)[269]. Modes of sampling and delivery including online surveys on a smartphone or computer[269] should be tested for interactions in future research and accounted for accordingly.

Dependent variables

A strength of this study is the inclusion of sedentary behaviour which is historically understudied compared to physical activity. This is because physical activity is well-established as beneficial for health (see Chapter 2) while the evidence base for sedentary behaviour's negative association with health is more recent but growing, especially for adolescents[74, 270-272]. Another strength of this study is the assessment of sedentary behaviour at work and during school breaks and total sedentary behaviour, as most previous research has focusessed only on watching television (as a proxy for total sedentary behaviour) and screen time[273]. An additional strength is that the measurement of sedentary behaviour in the survey only asked for time while sitting, which addressed how technology is changing and some devices can be used while standing or moving. This clarification was prior to each of the questions about total time sitting and engagement with television, DVDs, videos, computer, laptop, tablet and electronic games.

A limitation of the way sedentary behaviour was assessed was that motorised transport was included in total sedentary behaviour even though that may including standing (LPA) while on a tram or train. Another limitation was that the survey did not adequately address a common way sedentary behaviour is accumulated which often includes concurrent use, for example, watching a movie or series on a television or tablet while browsing social media on a mobile phone, or sitting to have a conversation while listening to music. Further, prolonged sedentary behaviour

(bouts ≥30 mins) was not assessed by this survey even though it is detrimentally associated with several cardio-metabolic biomarkers (BMI, waist circumference, HDL-C and triglycerides)[274] regardless of the amount of total sedentary behaviour. Future research should reduce chances of double-reporting types of sedentary behaviour and should assess prolonged sedentary behaviour and its influences to translate findings into preventative measures and guidelines.

In general, self-report tools have poorer reliability and validity than device-based measurement of movement[61]. Disadvantages of self-report assessment tools include the inaccuracies due to human recall error[262], bias and application of social norms that fit social desirability. This is speculated to result in under-reporting sedentary behaviour and over-reporting physical activity[61, 275]. However, a methodological study that administered a similar self-report survey found that Belgian adolescents (mean 15-years-old; *n*=20) over-estimated average daily total sedentary behaviour by 53%. This may be partially attributed to simultaneous behaviour such as watching television while using a mobile phone resulting in double-reporting[276].

In addition to the test-retest reliability testing presented in this chapter, future research should employ validity testing in this age group of the dependent variables using devices such as an ActiGraph accelerometer (Pensacola, Florida, USA) for physical activity and the *activ*PAL™ inclinometer (PAL Technologies Limited, Glasgow, UK) for sedentary behaviour to support interpretation of the findings. Future research should also use the most reliable and valid measures for physical activity and sedentary behaviour. This is currently concurrent use of an accelerometer for physical activity, inclinometer for sedentary behaviour and log book to record context, wear time, sleep time and non-ambulatory activity[61]. Despite this combination approach being more expensive than self-report alone, the resulting data is of a higher quality (more sensitive) for monitoring behaviour change[61, 275].

Another possible limitation is that sedentary behaviour survey items had multiple sources (IPAQ (www.ipaq.ki.se) and the occupational physical activity questionnaire[218]) and units that varied from time per weekday and weekend day, to total time spent on weekdays (Monday-Friday summed) and weekend days (Saturday-Sunday summed). This may result in mis-reporting, due to it being harder and more time consuming to reflect then estimate the sum of time spent across multiple days, rather than recalling time spent on one day. Completing an

interviewer-administered telephone survey may have amplified the pressure for participants to respond quickly, rather than taking the necessary time to work out the answer. In contrast, the physical activity survey items were phrased simplistically, such as per weekday and weekend day. This discrepancy may have resulted in over-reporting sedentary behaviour and may explain why the sedentary behaviour variables generally had lower test-retest reliability scores than physical activity. Future research should use assessment items with consistent phrasing of wording and response options. This may increase participant comprehension of the survey items, particularly for the sedentary behaviour items used, and potentially improve the test-retest reliability scores.

The main outcome variable for physical activity represented non-utilitarian and discretionary behaviour, because LPA and the time spent active in school and work domains was not assessed by the survey. Not assessing LPA, school or work physical activity time may not have affected the compliance of meeting guidelines since that is are based on MVPA. However, LPA is beneficial for health[277, 278] and most of adolescent's daily time is spent at school[279]; therefore, future research should assess LPA and physical activity in these domains, as well as leisure-time and transport.

Independent variables

A strength of the study was in applying the ecological model[20, 21]. This model is a useful framework to organise correlates according to levels of individual, social and environmental. Applying this model aids understanding of health behaviours by suggesting multiple influences in numerous categories to consider[143]. The findings can inform a multi-setting efficacious intervention with tailored strategies[20, 21]. Further, the study assessed a large range of independent variables from three levels of the ecological model[20, 21] as correlates, determinants and moderators of physical activity and sedentary behaviour. Previous similar studies[149-155, 166, 280] have failed to assess variables from three different levels of the ecological model[20, 21]. The comprehensive collection of variables assessed may reveal novel information about underlying influences on physical activity and sedentary behaviour during the transition out of secondary school. The large range of independent variables measured was informed by the qualitative work presented in the previous chapter, including social support, internal attributes (enjoyment, competence and self-

efficacy), priorities and habits (goal setting), technology access (electronic devices and televisions) and facilities.

Given the breadth of independent variables included, there may be a high probability of finding results by chance due to a high number (26) assessed. Furthermore, 11 of the independent variables were comprised of single survey items. This increases measurement error and, thus, decreases the reliability of the survey item, because a single item only captures one source of variance[281]. It is recommended that the use of single-item variables be minimised, with multiple-item variables preferred when available[281]. Single-item independent variables should be cautiously interpreted if they are physical activity or sedentary behaviour cross-sectional correlates or longitudinal determinants, or moderators of associations between situational transitions and physical activity or sedentary behaviour.

A potential limitation of the independent variables was that the individual variables were limited to psychological and cognitive attributes, rather than also including demographic and biological characteristics. This limits the comparability of findings with previous literature. However, as demographic and biological characteristics are the most studied correlates and determinants of physical activity and sedentary behaviour, further studying these may not be informative[147]. Compared to static demographic and biological variables, psychological and cognitive features are likely to be modifiable and, therefore, relevant for informing design of future health behaviour change interventions[147].

A probable limitation of the environmental independent variables is that all were self-reported and not measured objectively, such as via Geographic Information System (GIS) software. Future research should include objective assessment tools such as GIS to increase data reliability and validity. Supporting this is a large study of 42-year-old Australian women (*n*=1 540) found poor agreement between self-report and GIS for neighbourhood physical activity facilities[282]. The neighbourhood environment survey items asked about the local area but did not define it. The definition of local area and neighbourhood may differ for each participant, based on individual perceptions; therefore, findings may differ if a consistent definition and distance from home is used. Future research of neighbourhood environment could define the neighbourhood scale using consistent units such as postal boundaries or 800m or 2km pedestrian catchment areas from home, as seen in other studies[283, 284].

A further limitation of the environmental independent variables was that no built environment variables were measured, such as school or work. Future research should assess built environment characteristics, mass media advertisements, policies related to parks, and government investment in public recreation[20]. The built environment at school may be particularly important to older adolescents. Examples of characteristics to assess are building and stair design, policies for being active or sedentary during breaks and physical education classes, availability of sit-to-stand workstations, access policies for gymnasium facilities, support for active transport programs, pedestrian and bicycle facilities, and public transport access and investments[20, 21].

Because of its ease of use, Cronbach's alpha coefficient was used to identify the internal consistency of the multi-component independent variables[236]. However, it has well-documented limitations including not being recommended for skewed or asymmetrical data[285] and some multi-component independent variables were skewed. Physical activity enjoyment and neighbourhood walking environment were negatively skewed. Therefore, the internal reliability scores for these should be interpreted with due consideration (0.74 and 0.73, respectively).

Conclusion

ProjectADAPT was a longitudinal study that followed a cohort of students during the transition out of secondary school. The sample was in the second last year of secondary school and there was a higher proportion of girls from urban and the highest tertile of socio-economic area. The self-reported measures assessed physical activity, sedentary behaviour and numerous independent variables. The test-retest reliability of the measures was found to be acceptable. The following chapters of this thesis (Chapters 5-8) will use ProjectADAPT data to develop findings from the qualitative interviews presented in Chapter 3 on how and why physical activity and sedentary behaviour change during the transition out of secondary school. Specifically, the following chapters will cross-sectionally examine physical activity and sedentary behaviour in late adolescence, and will identify individual, social and environmental correlates.

Chapter 5

Physical activity in late adolescence

5.1 Introduction

Chapter 2 highlighted that physical activity is important for health because it is a modifiable risk factor for a range of health outcomes[71-73]. During adolescence, physical activity is positively associated with cardiorespiratory fitness and skeletal and muscular health, and negatively associated with cardiovascular disease risk factors[74, 286] and depressive symptoms[80]. Additionally, inadequate physical activity in childhood has negative health implications that track into adulthood, such as the future development of cardiovascular disease and comorbidities[81-84, 157]. Chapter 2 summarised the previous studies that have described physical activity in late adolescence. Only 6% of Australian 15-17-year-olds complied with National Physical Activity Guidelines[15]. Previous literature has not described different domains of physical activity in this age group. This chapter aims to address these gaps and develop understanding of physical activity in late adolescence.

Cross-sectional research has identified SEP[151], parental support[147] and high-quality neighbourhood sport facilities[155] as being positively correlated with physical activity in adolescence. However, most previous studies sampled a wide age range that included 10-18-year-olds[147, 151] and some[147] assessed only one or two levels of the ecological model[20, 21]. In Chapter 3, perceived influences on physical activity were explored in one-on-one interviews with recent school leavers. Major influences on perceived physical activity were time use and social support. This chapter aims to highlight consistent and new findings by identifying individual, social and environmental correlates of discretionary physical activity.

5.2 Chapter aims

The specific aims of this chapter are to:

1. Present the descriptive epidemiology of physical activity patterns in late adolescence; and
2. Identify individual, social and environmental correlates of discretionary physical activity in late adolescence.

5.3 Methods

This chapter used cross-sectional baseline data from ProjectADAPT. The types of physical activity described in this chapter include total duration of physical activity (mins/day), time spent in active transport, LTPA, school-related physical activity, occupational physical activity and adherence to National Guidelines[109]. A total of 26 independent variables were tested as correlates of physical activity. Chapter 4 described the data cleaning and management of the dependent and independent variables (section 4.3.4). The following section outlines aspects of data analysis relevant to this chapter.

5.3.1 Data analysis

The continuous variables of discretionary physical activity, active transport and LTPA were described as means and SD (Aim 1). These were compared by subgroups using t-tests for binary variables (gender and remoteness) and one-way ANOVA for area-level SEP. Some t-test assumptions were violated since the cohort was not a simple random sample and one group (gender) had a size comparison ratio >1.5. Despite this, the outcome variables were not transformed because independent t-tests are valid for non-normally distributed data using large samples[287]. Categorical variables of school-related physical activity, occupational physical activity and adherence to National Guidelines[109] were described using tabulation and compared by subgroups using two-way tables of frequencies reporting Pearson's chi-squared statistics.

Linear regression analyses were used to address Aim 2. Discretionary physical activity was checked for normality using a histogram and data were positively skewed. However, it was not transformed because the residuals of the discretionary physical activity regression analyses were checked and normality assumptions were met[288, 289]. As some participants were recruited from secondary schools, clustering at the school level was accounted for a priori for all participants as a design factor in models using the cluster command. Confounders were identified using a method for purposeful selection of variables in regression models[290], specifically, a change in estimates[291]. Potential confounders tested were age, gender (woman, man or other), maternal and paternal education (tertiary, technical or trade school certificate, high school, some high school, primary school, never attended school), English as the primary language spoken at home, birth country (Australia or other), remoteness and

area-level SEP. Firstly, a simple linear regression model was used that included the dependent variable (discretionary physical activity) and each independent variable, accounting for clustering by school. These models were then repeated, adding in each of the potential confounders in separate models, seeking a ±10% change in the correlation coefficient from the simple linear regression models. Gender, maternal education, English as the primary language spoken at home and area-level SEP were determined to be confounders, and all subsequent regression models adjusted for these socio-demographic characteristics.

After identification of confounders, 26 separate linear regression models were run, one for each independent variable, adjusting for the four confounders. Significant correlates were added into a 'fully-adjusted' multivariable model to identify the key correlates. Multicollinearity of the fully-adjusted model was checked by reviewing the variance inflation factors. If high variance inflation factors were identified (>5.0)[292], correlation matrices were constructed to determine which variable/s to exclude and the fully-adjusted model was repeated excluding these variables.

5.4 Results

5.4.1 Descriptive epidemiology of physical activity patterns in late adolescence

This section presents and describes various aspects of physical activity patterns in late adolescence (Aim 1). Table 5.1 presents the average duration of LTPA, active transport and discretionary physical activity. Participants reported just over 1.25 h/day of discretionary physical activity. Girls reported 15 mins/day less discretionary physical activity than did boys ($p<0.01$). Almost half of the participants (45%) met the National Guidelines[109].

On average, participants reported spending 51 mins/day in LTPA (Table 5.1), comprised of walking for 12 mins/day, other MPA for 16 mins/day, and VPA for 22 mins/day. Girls reported 3 mins/day less MPA, 10 mins/day less VPA and 13 mins/day less total LTPA than did boys ($p<0.05$). Those who lived in the mid tertile of socio-economic area reported 4 mins/day more leisure-time walking than those who lived in the highest tertile (14.3±23.9 mins/day vs 10.6±17.1; $p=0.042$).

Mean duration of active transport was 26 mins/day, comprised of 3 mins/day of cycling and 23 mins/day of walking for transport (Table 5.1). Girls reported 3 mins/day less cycling for transport than did boys ($p<0.001$). Those who lived in the mid tertile of socio-economic area reported more time in active transport (29.2±36.7 mins/day vs 23.5±25.6, $p=0.031$) and cycling for transport (4.0±15.6 mins/day vs 1.9±7.1, $p=0.020$) than those who lived in the highest tertile.

Table 5.1 Duration of discretionary physical activity, LTPA and active transport (mean mins/day±SD) in late adolescence

			Gender		
	n	**Overall**	**Girls**	**Boys**	***p***
Discretionary PA	1 005	76.6±72.3	72.6±68.5	88.1±81.1	**0.003**
LTPA	1 009	50.8±55.9	47.3±51.9	60.8±65.0	**0.001**
Walking	1 013	12.4±20.8	12.4±20.5	12.3±21.7	0.945
Other MPA	1 017	16.4±23.7	15.5±21.5	19.0±29.1	**0.043**
VPA	1 017	21.8±31.1	19.2±28.7	29.4±36.1	**0.000**
Active transport	1 016	25.7±30.4	25.2±30.3	27.3±30.7	0.331
Cycling for transport	1 019	2.7±10.7	1.8±8.1	5.3±15.6	**0.000**
Walking for transport	1 018	23.0±27.9	23.4±29.0	21.9±24.9	0.469

Independent t-test by gender.

Participation in school-based physical activity in late adolescence is presented in Table 5.2. The main activity during recess and lunch breaks for girls was sitting. Boys reported almost even proportions of sitting, standing, walking and MPA during recess and lunch breaks. The gender differences were statistically significant. Almost three quarters of participants reported no physical education classes each week (these classes are not compulsory during the final two years of schooling in most secondary schools in Victoria, Australia). A greater proportion of girls compared to boys participated in school sport. Most participants were not on a school sport team. Area-level SEP differences were the proportion who participated in school sport (lowest tertile 9.8% vs mid 10.6% vs highest 22.6%; p=0.001) and the main activity during morning recess and lunch break (mostly walk: lowest 21.0% vs mid 23.5% vs highest 13.2%; p=0.010).

Table 5.2 School-related physical activity in late adolescence

		Gender		
	Overall	**Girls**	**Boys**	
	%	%	%	***p***
Main activity level during school breaks, n=1 022				
Mostly sit/stand	72.7	80.9	49.4	
Mostly walk	18.1	17.4	20.2	
Mostly MPA	7.1	1.3	23.2	
Mostly VPA	2.2	0.4	7.1	
				0.000
PE classes/wk, n=1 022				
0	73.2	72.7	74.5	
1	11.6	12.3	9.4	
2-3	10.5	10.2	11.2	
≥4	4.8	4.8	4.9	
				0.762
Participate in school sport, n=1 022				
Yes		40.3	49.4	
	42.8			**0.010**
School sport teams count, n=439				
0	59.5	61.9	52.4	
1	19.3	19.0	20.2	
2-3	17.4	14.9	24.0	
≥4	3.8	4.1	3.0	
				0.348

Pearson's χ^2 test of significance by gender between school activity levels.

Participation in occupational physical activity in late adolescence is presented in Table 5.3. Just over a third of participants reported mainly sitting or standing at work, while just under a fifth mainly walked at work. Few participants performed heavy labour at work and there was a much higher proportion of boys reporting physically demanding work than girls.

Table 5.3 Occupational physical activity in late adolescence

		Gender		
	Overall	**Girls**	**Boys**	
	%	%	%	***p***
Main activity level at work, n=1 012				
Not working	42.0	40.8	45.5	
Mostly sit/stand	35.5	37.5	29.5	
Mostly walk	17.1	18.9	12.1	
Mostly heavy labour or physically demanding	5.4	2.8	12.9	
				0.000

Pearson's χ^2 test of significance by gender between employment activity levels.

5.4.2 Correlates of discretionary physical activity in late adolescence

In the partially-adjusted linear regression models, most variables (15) were associated with discretionary physical activity (Table 5.4). Multicollinearity of the fully-adjusted model was checked and social support for physical activity from friends/colleagues was excluded due to a high variance inflation factor (>5[292]). The final model explained 34% of variance in discretionary physical activity (Table 5.4). Of the 14 variables included in the final model, five remained significant. These were physical activity enjoyment, goal setting and self-efficacy, sedentary behaviour discouragement from friends or colleagues, and social network (Aim 2). The directions of the associations were all positive.

Discretionary physical activity was 2.6 mins/day, 5.2 mins/day or 2.5 mins/day higher with each additional unit increase in physical activity enjoyment, physical activity goal setting or physical activity self-efficacy, respectively. Discretionary physical activity was 5.7 mins/day higher with each additional unit increase in friends or colleagues discouraging sedentary behaviour and 0.7 mins/day higher for each additional person in the social network count.

Table 5.4 Partially- and fully-adjusted[1] associations between independent variables and discretionary physical activity (mins/day) in late adolescence

	Partially-adjusted model B (95%CI)	**Fully-adjusted model[1]** B (95%CI), *n*=907
Individual variables (scores)		
PA enjoyment	**10.6 (8.6, 12.6)*** **	**2.6 (0.5, 4.8)***
PA goal setting	**8.5 (7.0, 10.0)*** **	**5.2 (3.6, 6.8)*** **
PA competence	**20.6 (16.0, 25.3)*** **	3.5 (-1.1, 8.1)
PA self-efficacy	**6.0 (4.9, 7.2)*** **	**2.5 (1.3, 3.8)*** **
TV avoidance self-efficacy	**1.7 (0.7, 2.7)****	-0.5 (-1.6, 0.7)
Social variables		
Family (scores):		
E-games co-participation	-1.4 (-7.0, 7.3)	-
PA co-participation	**8.0 (3.9, 12.1)*** **	0.7 (-3.7, 5.2)
TV/DVDs co-participation	-2.4 (-6.9, 2.2)	-
PA social support	**5.1 (3.4, 6.8)*** **	-0.7 (-3.0, 1.6)
SB discouragement	1.8 (-2.5, 6.1)	-
Friends/colleagues (scores):		
E-games co-participation	-2.1 (-7.1, 2.8)	-
PA co-participation	**13.4 (9.2, 17.7)*** **	-0.7 (-4.1, 2.7)
TV/DVDs co-participation	0.2 (-4.6, 4.9)	-
PA social support	**6.8 (4.8, 8.7)*** **	-
SB discouragement	**11.2 (5.2, 17.1)*** **	**5.7 (0.9, 10.4)***
Social network count	**0.9 (0.2, 1.5)****	**0.7 (0.1, 1.3)***
Gym membership	**30.8 (20.2, 41.3)*** **	7.7 (-0.2, 15.6)
Environmental variables		
Home environment:		
E-devices, no. of	-0.3 (-4.3, 3.7)	-
PA equipment, no. of	**9.8 (4.4, 15.2)*** **	2.0 (-1.7, 5.7)
TV, no. of	1.2 (-0.2, 2.6)	-
Neighbourhood environment (scores):		
Noise	1.7 (-3.5, 7.0)	-
Walking environment	**3.9 (2.4, 5.5)*** **	-0.2 (-1.3, 1.6)
Safety	2.2 (-0.4, 4.9)	-
Social cohesion	3.1 (-0.0, 6.2)	-
Land use mix diversity	2.0 (-0.4, 4.5)	-
Recreation facilities	**6.9 (3.7, 10.2)*** **	2.0 (-0.9, 5.0)
R^2=0.34		

[1] Adjusted for gender, maternal education, English as the primary language spoken at home and area-level SEP. Accounted for clustering by school.

**p<0.05, **p<0.01, ***p<0.001: Linear regression models.*

5.5 Discussion

This chapter described physical activity in late adolescence, and identified individual, social and environmental correlates of discretionary physical activity. On average, participants reported engaging in 77 mins/day of discretionary physical activity and 45% complied with guidelines[109]. Although most discretionary physical activity was comprised of LTPA, participants reported spending on average 26 mins walking or cycling for travel purposes. The key correlates of discretionary physical activity were physical activity enjoyment, goal setting and self-efficacy, friends or colleagues discouraging sedentary behaviour and social network count, each positively associated.

There appears to be much scope in this age group to increase physical activity during leisure-time and for transport, as more than half of the sample did not comply with guidelines. This is a concern as it is recommended to accumulate ≥60 mins/day of MVPA for optimal health benefits[109]. There also appears to be a need to increase physical activity at schools, given that only two-fifths of participants engaged in school sport and few were mostly active during school breaks. This appears to be a missed opportunity, especially considering adolescents sit 70% of school hours and 75% of class time[279]. Further, a longitudinal study found that Australian 14-year-olds (50% males) who were active during school recess had more device-assessed total physical activity over time[293], suggesting that school breaks are critical.

Given variability in assessment tools between studies, it is important to compare findings of those using similar measures. Physical activity in this study was generally higher compared to other studies that used the IPAQ or IPAQ-A. What this study found was similar to those of a large study of Brazilian 14-18-year-olds (*n*=2 545; 51.5% active; 46.1% girls vs 58.6% boys; defined as ≥300 mins/wk)[294]. However, this study's findings were higher for girls and similar for boys compared to Spanish 15-16-year-olds (40% girls active; 47.2% boys active; 'active' computed based on any LTPA)[295]. Lastly, this study's findings were higher than 15-17-year-old Czech boys and girls and Polish girls, and similar to Polish boys (Czech: 20.1% girls, 32.3% boys; Polish: 25.2% girls, 40.5% boys; based on 60 mins/day MVPA)[296]. Numerous studies of adolescents that use IPAQ have reported average duration in metabolic equivalent (MET)/mins/wk[296-299] as per the IPAQ protocol, impairing comparisons with this study.

Sufficient activity and meeting guidelines have been operationalised differently in studies which makes it difficult to compare. Both the average duration and compliance with guidelines was higher in this study than what has been reported for 15-17-year-olds in the Australian Health Survey[15, 300]. Key study differences include a measure that assessed activity on each of the previous seven days, whereas this survey measured activity in a usual week. Secondly, this study measured time spent walking during leisure-time and other MPA which may have contributed to more total MVPA being reported compared to the Australian Health Survey[15, 300]. Lastly, in the Australian Health Survey, some MVPA was mis-categorised to LPA due to participant confusion and excluded from total MVPA (which is used to generate guideline compliance)[15, 300]. When reviewing studies that used accelerometry, this study's findings were higher than adolescents in Australia (<6%)[301] and the USA (8%)[302]. This may reflect over-reporting in this self-report survey, especially since accelerometry measures most types and domains of physical activity, including LPA and time in physical activity at school and work, whereas this study only measured active transport and leisure-time MVPA. Regardless of how physical activity is measured, it remains clear that older adolescents are not engaging in enough physical activity.

Some differences by sub-groups were found for gender. Girls reported less time than did boys in all physical activity except for walking for transport and leisure, and also reported lower engagement in school sport and active school breaks. The finding that girls were less active than boys is consistent with recent studies of older adolescents using IPAQ-A or IPAQ[294-296, 299], as well as across all ages internationally[303]. Numerous reasons have been proposed for these gender differences. Firstly, gender bias in sport and socialised gender roles contributes to the stereotypes that VPA is masculine and girls should maintain aesthetic appearance (including not sweating), resulting in adolescent girls feeling self-conscious, embarrassed and anxious to avoid being shamed and objectified while being active[304, 305]. Secondly, girls have lower proficiency in fundamental movement and object-control skills[306, 307], and less interest (in sport), spectatorship, competitiveness and risk-taking[308], and alternate time-use preferences at this age (more studying, socialising and chores) than boys[309]. In Chapter 3, some participants reflected on why they were not active during secondary school and some women proposed the reasons were the pressures and demands of a large study load and how physical education classes were no longer

compulsory. Although this current study combined boys and girls due to the lower proportion of boys in the sample, future studies could assess correlates of girls and boys separately.

When reviewing findings by sub-groups, adolescent girls are clearly an important target group for physical activity intervention. Although it is encouraging to see no disparity across geographic areas, findings for the components of discretionary physical activity were mixed. This highlights that older adolescents living in various socio-economic areas accumulate physical activity differently, with the clearest example being more school sport in highest tertile of socio-economic area than the lowest or mid. This may reflect better facilities and higher financial resources among these families, consistent with a study from the USA[310]. Other examples were more active transport in mid than highest tertile of socio-economic area, more leisure-time walking in mid than highest tertile of socio-economic area, and more walking during recess and lunch breaks (as opposed to sitting, standing, MPA or VPA) in lowest and mid than highest tertile of socio-economic area. One narrative review[311] of systematic and narrative reviews argued there is no clear pattern across early, mid and late adolescence that physical activity is associated with SEP. Meanwhile, recent studies from Australia and Lithuania have suggested there is a relationship between physical activity and SEP during late adolescence[312, 313]. Future research should explore variance in outcomes by additional groups, such as individual SEP based on maternal/paternal income, education and employment.

A strength of this current study is a wide range of individual, social and environmental correlates assessed. In general, most of the correlates of physical activity in the partially-adjusted models have been reported previously[311], although, the age range in the previous studies was broader than this current study. In this study, five variables remained significant; physical activity enjoyment, goal setting and self-efficacy, friends or colleagues discouraging sedentary behaviour, and social network count. However, the fully-adjusted model did not find that the home or neighbourhood environments were associated with physical activity in late adolescence, despite the ecological model[20, 21] positing that individual, social and environmental levels are important. This is unsurprising, given that the individual-level is proximal and reflects what adolescents control.

The score for physical activity goal setting reflected planning ahead for physical activity, including amount of physical activity, and scheduling in general and with other people. Those with high goal setting scores are likely to prioritise physical activity, valuing it highly and regard it as important enough to make time for, and they might have people within their social networks who are highly active who they meet with often. Goal orientation is consistently identified as a correlate of physical activity during adolescence[311]. Similarly, self-efficacy has been consistently reported as positively correlated with physical activity during adolescence in five reviews since 2005[311]. High physical activity self-efficacy may represent being capable at overcoming challenges and continuing to pursue a goal despite setbacks, which has been linked to having high success markers including self control and grit[314]. There are other types of self-efficacy that should be explored in future studies.

One review found that enjoyment was not always identified as a correlate of physical activity among adolescents[311]; however, one review found a positive association for adolescent girls[315]. Therefore, gender proportion of this current study may have driven this finding. Future studies could examine the efficacy of tailoring strategies that boost enjoyment to older adolescents within physical activity interventions. Testing social network count as a correlate is novel and the finding may imply that those who are active are extraverted, as suggested by a meta-analysis and systematic review in adults[316]. Although the direction of association cannot be ascertained from correlation, another meta analysis and systematic review of adults argued the impact of personality traits on physical activity is not bidirectional[317]. Further research is needed as to whether physical activity interventions may benefit from tailoring to target groups at high-risk of low physical activity with personality-traits like introversion.

In adolescence, social support has been identified as an important correlate of physical activity partly due to relying on families for resources, transport and decision-making. Findings from this study suggest that responsibility for own time, becoming independent and some decision-making are emerging in late adolescence. Friends or colleagues discouraging excessive sedentary behaviour is a specific aspect of social support, with previous studies showing mixed findings as a correlate of physical activity during adolescence[311]. This suggests that seeking approval within peer relationships may be a particularly strong motivation and future research could

examine incorporating a buddy system to boost peer support into physical activity interventions of older adolescents.

The findings in this chapter are consistent with the qualitative research results presented in Chapter 3. When participants in the interviews reflected on what facilitated or inhibited physical activity and sedentary behaviour, poor time management was considered a major barrier. Furthermore, the recent school leavers also described self-efficacy, and spoke of strategies to overcome a range of challenges that were related to demands on time. Although enjoyment and having enough social support were similarly described as influential, so was having enough sleep which was not assessed in this current study. This suggests that while sleep is important, older adolescents are unlikely to be active without a supportive social environment and ability to manage time. Current findings imply that physical activity interventions for this age group need to include strategies to increase enjoyment, goal setting, supportive peer relationships and overcoming barriers such as poor time management.

Most of the five key correlates were related to physical activity (enjoyment, goal setting and self-efficacy), consistent with behavioural-specificity literature[318]. Future research needs to examine whether the five key correlates are also longitudinal determinants (Chapter 8) of physical activity or whether different influences impact behaviour over time. Furthermore, future research is needed to identify whether some of the distal independent variables assessed by this current study are moderators (Chapter 8) or mediators of physical activity in late adolescence.

Strengths and limitations

Strengths of this study include the description of a range of types of physical activity in an infrequently studied age group. Furthermore, school, sport and occupational physical activity are not commonly examined during late adolescence. Applying the ecological model[20, 21] meant a broad range of individual, social and environmental correlates were tested and highlighted that individual and social correlates seem to be more important to discretionary physical activity in late adolescence than environmental correlates. Future studies of late adolescence should also assess the school and work environments, including attributes such as pedestrian and bicycle facilities, support for active transport programs such as safe routes to school, public transport access and investments, and building and stair design[21]. Lastly, examining

sedentary behaviour-related individual, social and environmental correlates (such as television avoidance self-efficacy; number of electronic devices; number of televisions; family, friends or colleagues co-participating in electronic games or television, or discouraging sedentary behaviour) of physical activity was novel and resulted in a unique correlate finding (friends or colleagues discouraging sedentary behaviour).

Physical activity in late adolescence may be underestimated as time in LPA in any domain and time in physical activity at school and work were not included in the physical activity measure. Also not examined in this study were correlates of LTPA and active transport separately, even though other studies of older adolescents have[193, 319-322] and this may clarify what is driving the associations found. Active transport and LTPA were combined because the former made a substantial contribution to discretionary physical activity in this study. This suggests that discretionary physical activity would substantially increase due to more active transport, hence more promotion of the National Guidelines is needed due to its recommendations to walk, cycle or skateboard safely for short trips instead of travelling by car[109].

Environmental variables were not found to be the most important correlates of discretionary physical activity in this study and not testing them as correlates of active transport may partially explain why[318]. This stems from the suggestion that behavioural-specificity may be important for environmental variables[318]. For example, neighbourhood perceptions (land use mix diversity, parks, pedestrian footpaths, shops nearby and traffic speed) were associated with walking or cycling to school in a large cross-sectional study of Irish 15-17-year-olds (n=2 159)[319]. Findings from different aged samples (adults[323] and older adults[324, 325]) also suggest that the neighbourhood environment may have stronger associations with walking for transport rather than discretionary physical activity. Future surveys need to be designed specifically for domain-specific physical activity correlate analyses, for example, assessing independent variables specific to active transport. That new knowledge may inform the design of behaviour-relevant interventions and domain-specific guidelines for active transport in late adolescence. Additionally, future research is needed that examines the correlates of meeting guidelines, acknowledging the limitation of a loss of power from dichotimising the continuous outcome variable[326].

The cross-sectional nature of this study means that it cannot infer causality or directionality. It may be that more physical activity leads to more enjoyment of being active, goal setting, the number of friends, and self-efficacy, for example. The study relied on self-reported measures and correlates, however the test-retest reliability of these were established and were acceptable (Chapter 4). Further, all participants were from Year 11 which, in the Victorian context, is a more studious time compared previous years since scores impact university-entrance. As described in Chapter 4, the sample comprised mostly girls which may have biased findings. Future research using a sample with more equal gender proportions may have different findings. Although an established measure of physical activity was used (IPAQ), a different measure may elicit alternate findings.

Conclusion

This study found 45% of 17-year-olds met National Guidelines which suggests that there is room for improvement. At-risk target groups and behaviours were identified for further interventions. Girls are a particularly important target group for intervention as they reported engaging in less than boys across most types of physical activity. Key correlates appear to be physical activity enjoyment, goal setting and self-efficacy, social network count, and friends or colleagues discouraging sedentary behaviour. The next chapter builds on what this study found by examining patterns and correlates of sedentary behaviour in late adolescence.

Chapter 6

Sedentary behaviour in late adolescence

6.1 Introduction

Sedentary behaviour is defined as an activity that involves sitting, reclining, or limited movement, and low energy expenditure during waking hours[50], and is distinct from physical activity. As described in Chapter 2, different types of sedentary behaviour have associations with health in adolescence that are distinct from physical activity[99, 101-104]. Notably, cardiovascular disease risk factors were reported in some studies[99], the presence of which during adolescence is a serious concern as it tracks into adulthood[84, 105, 106]. Recent compositional analyses consider the interdependence of sedentary behaviour and physical activity; for example, an international meta-analysis found that the threshold for a dose-response relationship with all-cause mortality risk from sitting starts at 7MET h/day or watching television starts at 3MET h/day without physical activity compensation[14]. That study argued that decreasing sitting time and increasing physical activity are equally important to offset all-cause mortality risk[14].

There is a plethora of mobile electronic entertainment options[272]. This has resulted in an appealing and comfortable sedentary environment that also includes convenient labour-saving devices[21]. The accompanying increase in screen addiction, in the form of gaming, social media and texting[327], has harmful effects on the still-developing adolescent brain, including poor academic achievement[328], social and emotional impairment, sleep interference[329] and attention problems[330-332]. Subsequently, as Chapter 2 described, it is common internationally for few adolescents to meet recreational screen-time guidelines[15, 116, 124]. This age represents an important time for intervening as it may be a 'teachable moment' during the life course when individuals may implement health-promoting or negative habits that track into adulthood.

The qualitative findings from Chapter 3 suggest that sedentary behaviour during late secondary school is common. Recent school leavers described using mobile phones, studying and using a computer were popular types of sedentary behaviour, consistent with previous research[15]. This chapter aims to progress those findings by describing total and types of sedentary behaviour, including sedentary transport, sedentary behaviour (excluding transport), recreational screen time, school-related sedentary behaviour and occupational sedentary behaviour. As described in Chapter 2, few studies have examined correlates of total sedentary behaviour in late adolescence from three levels of the ecological model[20, 21]. As argued in Chapter 5, it is possible

to engage in both sedentary behaviour and MVPA during the day[333]. However, sedentary behaviour and LPA are strongly negatively associated (displace each other)[223, 224]. Therefore, correlates traditionally associated with physical activity may affect total sedentary behaviour and warrant testing.

6.2 Chapter aims

The specific aims of this chapter are to:

1. Present the descriptive epidemiology of sedentary behaviour patterns in late adolescence; and
2. Identify individual, social and environmental correlates of total sedentary behaviour in late adolescence.

6.3 Methods

Cross-sectional sedentary behaviour baseline data forms the basis of this chapter. Mean total sedentary behaviour (h/day) is described and types of sedentary behaviour including time spent sedentary at school, work, home, when traveling and during leisure-time. Also examined is recreational screen time (h/day), meeting the National Guidelines[109], sedentary behaviour during breaks at school and occupational sedentary behaviour. The same independent variables examined in Chapter 5 were tested in this current chapter. Chapter 4 described the data cleaning and management of each of these variables (section 4.3.4). The following section details aspects of data analysis relevant to this chapter.

6.3.1 Data analysis

To address Aim 1, continuous variables were described using means and SD. Prior to t-tests, normality of total sedentary behaviour was checked using a histogram and data were normally distributed. Continuous variables were compared by subgroups using t-tests for binary subgroups (gender and remoteness) or one-way ANOVA for area-level SEP. Categorical variables (school-related sedentary behaviour, occupational sedentary behaviour, adherence to National Guidelines[109] and non-active games use) were described using tabulation and compared by subgroups using Pearson's chi-squared statistics.

Linear regression was used to address Aim 2. Firstly, partially-adjusted models were initially run with total sedentary behaviour as the dependent variable and each separate independent variable (totalling 26 models). The residuals of the regression models were checked and were normally distributed, meeting an assumption of regression models[289]. Confounders were identified using the same process described in Chapter 5 (the purposeful selection of variables in regressions method, specifically, a change in estimates[291]). Clustering by school was accounted for a priori, as a design factor. Gender, paternal education, English as the primary language spoken at home, birth country and remoteness were determined to be confounders and partially- and fully-adjusted regression models adjusted for these.

Secondly, a corresponding fully-adjusted model was run, that included only the significant independent variables from the partially-adjusted linear regression models. Multicollinearity of the fully-adjusted model was checked by reviewing the variance inflation factors. If high variance inflation factors were identified (>5.0[292]), correlation matrices were constructed to determine variable/s to exclude. Lastly, the fully-adjusted model was repeated without the identified variables.

6.4 Results

6.4.1 Descriptive epidemiology of sedentary behaviour in late adolescence

In this section, sedentary behaviour patterns in late adolescence are presented and described (Aim 1). Table 6.1 presents information on sedentary behaviour at school and work. Just over half of participants reported mainly sitting during school breaks (recess and lunchtime), although that was driven by girls because a much lower proportion of boys than girls mainly sat during breaks. The proportion of participants who reported mainly sitting during school recess and lunch breaks differed by tertiles of area-level SEP (54% lowest vs 48% mid vs 57% highest; p=0.010). Very few of those employed reported mainly sitting at work. The proportion of boys who reported mainly sitting at work this was double that of girls.

Table 6.1 Proportion of participants reporting 'mainly sitting' during school breaks and at work in late adolescence

		Gender		
	Overall	**Girls**	**Boys**	
	%	%	%	***p***
School breaks, *n=1 022*	53.3	63.9	23.2	**0.000**
Main activity level at work, *n=1 012*				
Did not work	42.0	40.8	45.5	
Mostly sit	3.1	2.4	4.9	
Mostly stand/walk/heavy labour	54.9	56.8	49.6	
				0.000

Pearson's χ^2 test of significance by gender.

Table 6.2 details the mean total sedentary behaviour, sedentary behaviour (excluding transport), sedentary transport, and recreational screen time in late adolescence. Overall, participants reported spending just under 9 h/day engaged in total sedentary behaviour, comprised of 8h at school, work, home, and during free time, and a little under 1h traveling in a motor vehicle. Total recreational screen time was around 3.5 h/day. This was comprised of 1.5h of watching television, DVDs or videos, almost 2h of using a computer, laptop or tablet, and 14 mins of playing electronic games. Correspondingly, a third (35%) of the overall sample complied with the National

Guidelines[10], with more girls complying than boys ($p<0.01$). Non-active electronic games use was reported by 26% of the cohort (15% girls vs 57% boys; $p<0.001$).

Sedentary behaviour differed according to gender, remoteness and area-level SEP. Firstly, girls reported significantly more total sedentary behaviour, and more sitting at school, work, home and during free time than did boys (Table 6.2). Furthermore, girls reported significantly less total recreational screen time and electronic games than did boys. Sedentary transport or watching television did not differ by gender. Secondly, those who lived in an urban area reported significantly more total sedentary behaviour (9.0±2.9 h/day vs 8.4±2.7; $p=0.003$) and sedentary behaviour (excluding transport; 8.1±2.8 h/day vs 7.5±2.6; $p=0.001$) than those who lived rurally. Lastly, those who lived in the lowest tertile of socio-economic area watched significantly more television, DVDs or videos than those who lived in the highest tertile (1.7±1.8 h/day vs 1.3±1.2; $p<0.001$).

Table 6.2 Duration of total sedentary behaviour and recreational screen time (mean h/day±SD) in late adolescence

			Gender		
	n	**Overall**	**Girls**	**Boys**	***p***
Total SB	1 003	8.8±2.9	9.0±2.8	8.3±3.0	**0.001**
SB (excluding transport)	1 005	8.0±2.7	8.1±2.7	7.4±2.8	**0.001**
Sedentary transport	1 020	0.9±0.8	0.9±0.8	0.9±0.7	0.478
Total recreational screen time	956	3.5±2.6	3.3±2.5	3.8±2.7	**0.007**
Watching TV, DVDs or videos	986	1.5±1.4	1.5±1.4	1.4±1.4	0.681
Computer, laptop or tablet	983	1.8±1.6	1.8±1.5	2.0±1.7	0.115
E-games	1 012	0.2±0.7	0.1±0.4	0.6±1.2	**0.000**

Independent t-test by gender.

6.4.2 Correlates of total sedentary behaviour in late adolescence

Results of the linear regression models examining associations between the independent variables and total sedentary behaviour in late adolescence are presented in Table 6.3. Most (17) of the 26 independent variables were significantly negatively associated with total sedentary behaviour in the partially-adjusted models. Multicollinearity of the fully-adjusted model was checked and social support for physical activity from friends/colleagues was excluded due to a high variance inflation factor (>5[292]). The fully-adjusted model explained 13% of the variance in total sedentary behaviour. Of the 16 variables included in the final model, one remained significantly associated with total sedentary behaviour, physical activity goal setting (Aim 2). This finding suggests that for each additional unit increase for physical activity goal setting, Year 11 students engaged in 5 mins/day less total sedentary behaviour.

Table 6.3 Partially- and fully-adjusted associations[1] between independent variables and total sedentary behaviour (mins/day) in late adolescence

	Partially-adjusted model B (95%CI)	**Fully-adjusted model** B (95%CI), *n*=901
Individual variables (scores)		
PA enjoyment	**-13.5 (-18.2, -8.8)*****	-3.1 (-9.5, 3.4)
PA goal setting	**-11.0 (-14.3, -7.7)*****	**-5.1 (-8.6, -1.7)****
PA competence	**-32.1 (-42.7, -21.6)*****	-9.9 (-24.7, 4.8)
PA self-efficacy	**-6.9 (-9.2, -4.6)*****	-0.9 (-3.7, 1.9)
TV avoidance self-efficacy	**-2.8 (-5.4, -0.3)***	-0.2 (-2.4, 2.1)
Social variables		
Family (scores):		
E-games co-participation	10.2 (-3.6, 23.9)	-
PA co-participation	**-24.0 (-32.4, -15.6)*****	-8.0 (-21.3, 5.3)
TV/DVDs co-participation	2.6 (-9.2, 14.3)	-
PA social support	**-10.5 (-14.1, -6.9)*****	0.2 (-6.9, 7.4)
SB discouragement	**-12.9 (-21.6, -4.2)****	-2.4 (-10.9, 6.1)
Friends/colleagues (scores):		
E-games co-participation	6.8 (-4.6, 18.1)	-
PA co-participation	**-21.5 (-31.1, -11.8)*****	-2.1 (-13.0, 8.8)
TV/DVDs co-participation	-2.0 (-8.8, 12.9)	-
PA social support	**-10.2 (-13.7, -6.8)*****	-
SB discouragement	**-23.5 (-34.7, -12.4)*****	-8.7 (-20.8, 3.4)
Social network count	**-1.2 (-2.1, -0.3)***	-0.2 (-1.0, 0.6)
Gym membership	**-47.3 (-69.9, -24.7)*****	-15.5 (-39.2, 8.1)
Environmental variables		
Home environment (counts):		
E-devices, no. of	1.4 (-9.3, 12.1)	-
PA equipment, no. of	**-16.6 (-28.1, -5.2)****	-3.2 (-14.4, 7.9)
TVs, no. of	-2.6 (-6.5, 1.2)	-
Neighbourhood environment (scores):		
Noise	-1.8 (-13.6, 9.9)	-
Walking environment	**-8.3 (-12.2, -4.3)*****	-2.8 (-7.1, 1.4)
Safety	**-9.3 (-15.9, -2.8)****	-7.2 (-15.1, 0.7)
Social cohesion	**-9.1 (-16.4, -1.8)***	5.8 (-3.8, 15.5)
Land use mix diversity	-3.9 (-9.4, 1.6)	-
Recreation facilities	-4.0 (-12.5, 4.6)	-
R^2=0.13		

[1] *Adjusted for gender, paternal education, English as the primary language spoken at home, birth country and remoteness. Accounted for clustering by school.*

**p<0.05, **p<0.01, ***p<0.001: Linear regression models.*

6.5 Discussion

The aims of this chapter were twofold. Firstly, to describe sedentary behaviour of a cohort of older adolescents. Secondly, to identify individual, social and environmental correlates of total sedentary behaviour. It is novel to examine a range of correlates of sedentary behaviour in late adolescence. This cohort reported accumulating approximately 9 h/day of total sedentary behaviour. Only 35% complied with National Guidelines[109]. Fully-adjusted linear regression models identified that physical activity goal setting was negatively correlated with total sedentary behaviour in late adolescence.

In this sample, adolescents near the end of secondary school spent a considerable amount of the day engaging in sedentary behaviour (almost 9h). An observational study of Australian 15-year-olds argued that most of this occurs during school time and class time[279]. Of this current cohort, >50% reported mainly sitting during recess and lunch breaks at school and particularly girls. This appears to signal a lot of scope for improvement. Notably, the proportion employed in sedentary occupations was only 4%.

Previous studies that also administered IPAQ reported less sedentary behaviour compared to this current study. In a study of 16-20-year-olds, high school students engaged in 7 h/day of sedentary behaviour in Spain or 4 h/day in Portugal[334]. Another study of Portuguese adolescents reported 13-18-year-olds' median sedentary behaviour was 7 h/day[335]. A large cluster randomised trial of French 14-18-year-olds (*n*=1 445) reported daily mean sedentary behaviour was 7h and 33% sat for ≥7 h/day[336]. A reason for these differences may include region-specific time-use profiles from a lower proportion of sedentary lifestyles in Europe.

Previous studies that did not use IPAQ observed similar findings to this current study. A large cross-sectional study reported 13-18-year-olds from Europe (*n*=2 200) engaged in 9 h/day of device-assessed total sedentary behaviour which is very consistent with this current study[124]. That study also reported gender differences in total sedentary behaviour, consistent with this study[124]. Qualitative findings from Chapter 3 support what this chapter found and reflected that sedentary behaviour levels during secondary school were high, with common types being watching television, studying, and using a computer. This is consistent with previous research[15, 337]. In another Australian cross-sectional study of 15-17-year-olds, the

authors reported 3 h/day of screen-based leisure activity[15]. A large cross-sectional study found that Australian older adolescents (*n*=2 620) self-reported spending more time than younger children using computers recreationally than watching television, which is a typical finding from the research in this field[337]. The substitution of watching television in childhood to using computers in adolescence may be due to changing interests with age, increased school and study demands, and daily use of social media.

A third of this current study sample complied with guidelines. This was higher than compliance in other studies[15, 116]. A cross-sectional self-report study reported 19% of Australian 15-17-year-olds complied with guidelines[15] and a large cross-sectional study of 10-16-year-old Canadians (*n*=6 942) reported 14% of boys and 18% of girls met guidelines[116]. Explanations for differences in findings are that the other Australian study surveyed a national sample rather than a single state[15] and the sample in the Canadian study had a broader age range[116]. Regardless, intervening is warranted as older adolescents are engaging in excessive total sedentary behaviour and recreational screen time. Future research should focus efforts on decreasing recreational screen time, as it is modifiable and was a considerable portion of total sedentary behaviour in this current study. Further, recreational screen time should be targeted since it is more discretionary than sedentary transport, which may be the only or best option for commuting between school, work and home.

A few target groups emerged when reviewing sub-group variance in sedentary behaviour. Firstly, girls reported more total sedentary behaviour than boys, and boys reported more recreational screen time. Girls sit more to socialize at school, while boys spent more time using screens and electronic games. Strategies to reduce this may be more generic for girls such as ‘Sit Less, Move More’, while for boys a type-specific message could be ‘Less Gaming’. Secondly, there were few differences by remoteness. Those living in urban areas consistently reported more of total and specific types of sedentary behaviour than the rural counterparts. Lastly, those who lived in the lowest tertile of socio-economic area reported watching television, DVDs or videos more. Future research is needed to explain mechanisms behind the remoteness and SEP differences. A cross-sectional study of Nepalese 17-year-olds (44% girls) that also administered the IPAQ similarly found girls engaged in more total sedentary behaviour than boys but found that those who lived rurally were more likely to sit for >6 h/day than urban students, and that boys at private schools,

arguably a proxy for SEP, were more likely to sit for >6 h/day than boys at public schools[338]. The discrepancies may be due to country-specific differences in time-use between Australia and Nepal.

When reviewing studies that did not administer the IPAQ, the differences by gender, remoteness and SEP are similar. Firstly, a large cross-sectional study (*n*=2 071) found Australian 12-16-year-olds boys, particularly from urban areas, self-reported more screen time than girls and boys from inner regional, outer regional and remote areas[339]. Similarly, a study of Australian 10-18-year-olds[340] and an international study of 11-15-year-olds[341] both concluded adolescent boys engaged in more recreational screen time than did girls. Secondly, the differences according to SEP are consistent with a systematic review of studies of 13-18-year-olds[149] and a narrative review[148]. Specifically, a cross-sectional study of European 13-18-year-old girls found self-reported television watching was associated with SEP and may reflect low maternal education and parent occupation status[342]. In summary, this study's findings imply that the key target groups during late adolescence are girls and those living in urban and the lowest tertile of socio-economic area. These groups need support, perhaps in the form of tailored strategies designed within sedentary behaviour reduction interventions and guidelines. Future research during late adolescence that uses device-based measurement of movement such as inclinometers would strengthen support for this implication.

A strength of this study is that a wide range of correlates were tested from three levels of the ecological model[20, 21]. The key correlate of sedentary behaviour in late adolescence was physical activity goal setting. Similar to Chapter 5, most independent variables were associated in the partially-adjusted models but less remained significant in the fully-adjusted model. Safety and social cohesion were significant in partially-adjusted models for sedentary behaviour but not for physical activity. This may be explained by better social conditions in a neighbourhood resulting in a lower likelihood of being sedentary inside the home and vice versa. Future research needs to examine mechanisms to explain why physical activity goal setting may be important to sedentary behaviour in late adolescence, perhaps using moderation or mediation analyses[5].

The findings of previous studies that administered the IPAQ to adolescents provided mixed support to what this study found. Firstly, students in the final two years of secondary school in Portugal and Spain reported physical self-concept (competence and body-image) was negatively associated with sedentary behaviour during high school[334]. Body-image was not assessed in this current study. Secondly, Nepalese students reported individual correlates of sitting >6 h/day were sedentary transport to school (although arguably on the causal pathway and should be excluded), cycling to school (in girls only), no school playgrounds and no extra-curricular activities provided at school[338]. The latter environmental correlates are similar to this current study which found physical activity equipment at home is associated with total sedentary behaviour in a partially-adjusted model, albeit applied to a different domain. Thirdly, social correlates of sedentary behaviour include the amount of sitting that the best friend engaged in (Portuguese 13-18-year-olds)[335] and the number of children and having a partner (European 15-25-year-old women; *n*=1 218)[343]. The current study did not test these but found eight family and peer environment characteristics were social correlates of sedentary behaviour in partially-adjusted models.

Some of the findings of this current study are supported by the findings of reviews of studies that administered measures other than IPAQ-A or IPAQ. Firstly, a narrative and systematic review reported key individual correlates of sedentary behaviour in adolescence were age (positive)[148], ethnicity (positive; non-white)[148, 149] and parental education (negative)[149]. Secondly, the social correlates from the partially-adjusted models in this current study were consistent with a narrative review which reported parental modelling (positive), avoidance of risk (positive; outdoor safety concerns), restriction (negative; enforcement of rules and limits), and discouragement (negative) are key social correlates of sedentary behaviour in childhood and adolescence[148]. However, narrative reviews reported the number of televisions and computers per household (positive)[148] and having a television in the bedroom (positive)[154] were environmental correlates of sedentary behaviour. Differences may be due to a broader age range (2-18-year-olds)[148, 154] and this current study not assessing demographic characteristics as correlates, instead focussing on modifiable attributes to inform interventions. These previous studies have not tested physical activity goal setting as a correlate of total sedentary behaviour in adolescence, suggesting future research needs to.

Only one of the variables from the partially-adjusted models remained associated with total sedentary behaviour in late adolescence in the fully-adjusted model and future research is needed to clarify why. An individual correlate may have been found to be most important in this study because the current outcome variable of total sedentary behaviour captured other behaviours in various domains and at numerous times of day. As sedentary behaviour is pervasive throughout the day, there may be another explanation regarding the other types of sedentary behaviour that the outcome variable included. Future research needs to study correlates of specific types of sedentary behaviour.

Individuals with higher scores may be people who are likely to be highly active, health conscious and mindful of time use. Chapter 3 provided some insights into why physical activity goal setting may be important for sedentary behaviour in late adolescence, as recent school leavers described routines and regimented/structured days were influences on sedentary behaviour, as was personal preference. An observational study of Australia 15-year-olds identified the typologies of physical activity and sedentary behaviour and found a distinct cluster of MPA and high screen-time[313]. Included in the cluster was device-assessed MVPA, active travel, leisure-time sport or physical activity, watching television, electronic games and media, and sedentary homework[313]. Future studies need to study the correlates of these typologies in late adolescence to identify explaining mechanisms of these interdependent behaviours and test if physical activity goal setting may be important for certain clusters.

Notably, although television avoidance self-efficacy and sedentary behaviour discouragement from family, friends or colleagues were associated in partially-adjusted models, this study suggests these are less important to total sedentary behaviour than physical activity goal setting. Another unexpected finding was that sedentary behaviour was not associated with co-participation in electronic games, television or DVDs with family, friends or colleagues or the number of electronic devices or televisions at home. An explanation might be that some of these correlates tested are domain-specific, whereas the outcome variable was across the whole day. Further, none of the social or environmental associations were retained in the final model, perhaps signifying that sedentary behaviour may be driven by intrinsic attributes in the later years of secondary school. Qualitative methods explore responses to gain understanding of this knowledge-gap and Chapter 3 reported that

recent school leavers described social support as a major influence on sedentary behaviour during the transition out of secondary school. Further, interviewees described other influences on sedentary behaviour were school (size and quality of grounds, play equipment and facilities, and exams and homework), transport (car ownership, commute duration and distance), time use (holidays and free time), internal (maturity, embarrassed feelings and mental health) and occupation type. Occupation type was also found to be an influential factor linked to sedentary behaviour for European 15-25-year-olds[343]. Future studies are needed to confirm what this study found using device-based measurement of sedentary behaviour such as a wearable inclinometer without the biases of self-report[61].

The key correlate this current study found is characterised as traditionally behaviourally-specific to physical activity, similar to a 2016 systematic review[344]. That review reported proximity and density of green space, neighbourhood walkability, workplace showers, lockers and bicycle storage were environmental correlates of adult sedentary behaviour. The mix of behavioural specificity between correlates and outcomes in that review and in the current findings support the interdependency of sedentary behaviour and physical activity. Further, the findings advocate for the importance of testing variables that have been traditionally behaviourally-specific to physical activity as correlates of sedentary behaviour to better understand the complex relationship and inform sedentary behaviour recommendations and interventions.

Strengths and limitations

Some strengths of the study have been previously outlined in Chapter 4, such as assessing sedentary behaviour as distinct from physical activity and not simply a lack of physical activity. Also, assessing total sedentary behaviour, since previous research primarily assessed screen-based sedentary behaviour[273] and behaviour in the work and school domains. Further, this study acknowledged the interdependence of sedentary behaviour and physical activity by testing physical activity enjoyment, goal setting, competence, self-efficacy, co-participation, and equipment at home as correlates of sedentary behaviour. This unique approach revealed a novel key correlate of sedentary behaviour in late adolescence, adding to the sparse knowledge base of correlates of sedentary behaviour in late adolescence. Physical activity goal setting is known to be important for physical activity in adulthood but its role in

sedentary behaviour and late adolescence overall is less clear[345]. Future research is needed that similarly tests a wide variety of potentially influential attributes to continue to explore the interdependency of sedentary behaviour and physical activity.

Applying the ecological model[20, 21] emphasized that an individual-level correlate seemed to be most important for total sedentary behaviour in late adolescence, as opposed to social or environmental attributes. Qualitative research may be needed to explore the reasons for this and if there are social and environmental influences on sedentary behaviour important to this age group that were not assessed by this current study. The ecological model suggests some social and environmental chacteristics that may be important and should be tested in future research, including prompts to sit, awkwardness of standing, modelling, mass media, relevant government policies and investments, and schools and workplaces that have sitting requirements and only provide furniture designed for sitting[21]. Future research with alternate analyses is needed to identify the correlates and odds ratios for the likelihood of complying guidelines if older adolescents have high or low levels of individual, social and environmental attributes.

A limitation of this current study is that only correlates of total sedentary behaviour and not recreational screen time or sedentary transport were analysed. The main reason for this was that the survey did not ask in what domain the dependent variable took place in, such as recreational screen time at a friend's home, school, neighbourhood library or during transit. Correspondingly, some of the independent variables were domain-specific (the number of electronic devices and televisions at home) while others were not (television avoidance self-efficacy, electronic games co-participation and sedentary behaviour discouragement). This may have led to underestimated associations[318, 346]. Meanwhile, the independent variables did not include the school environment, despite total sedentary behaviour including sitting at school and it is known by previous literature that most sitting of older adolescents occurs at school and during class time[279]. Future research is needed to identify correlates of multiple types of sedentary behaviour, and to test school environment correlates of sedentary behaviour in late adolescence, as findings may inform domain-specific strategies to use in interventions and guidelines.

As mentioned in Chapter 5, a limitation of cross-sectional research is that it cannot confirm causality or directionality; consequently, it may be that more sedentary behaviour leads to less physical activity goal setting and longitudinal research is needed to clarify. Further, prospective studies are needed to examine whether physical activity goal setting is also a determinant of sedentary behaviour during the transition out of secondary school or whether different mechanisms partially explain behaviour over time. Other study-specific limitations were previously described in Chapter 4 such as sample bias due to the very high proportion of girls, or how the survey did not adequately address a common way of accumulating sedentary behaviour via concurrent use of multiple types, for example, watching movies or series while using a mobile phone, or measure prolonged sedentary behaviour which has the strongest associations with negative health outcomes.

Conclusion

Only 35% of 17-year-olds met guidelines, indicating more needs to be done to decrease the amount of recreational screen time during late adolescence. Compared to girls, less boys met the guidelines and more boys had sedentary occupations. Those living in an urban area reported higher total sedentary behaviour and those living in the lowest or mid tertiles of socio-economic area reported higher recreational screen time. The key correlate of sedentary behaviour in late adolescence appears to be physical activity goal setting. As this was also a correlate of physical activity and is modifiable, it warrants further research attention in behaviour change interventions. The next chapter builds on what this chapter found by examining changes in physical activity and sedentary behaviour during the transition out of secondary school and whether those differences are unique to situational transitions experienced post-school.

Chapter 7

Changes in physical activity and sedentary behaviour during the transition out of secondary school

7.1 Introduction

Chapter 2 summarised how most cross-sectional and longitudinal studies during late adolescence report that as age increases, physical activity is lower[130]; however, evidence is mixed for changes in sedentary behaviour[15, 130, 139]. These studies also have various limitations including heterogeneous data collection instruments that lacked validation and assessed only one component of physical activity and sedentary behaviour such as LTPA or television-viewing. Further, longitudinal studies with large follow-up intervals may mask the effects of transitioning out of secondary school and include a range of additional life changes, such as marital status or becoming a parent, that typically occur later in adulthood. In the qualitative study described in Chapter 3, most recent school leavers described changing physical activity and sedentary behaviour after leaving secondary school. The direction of the changes had no clear pattern (physical activity: *n*=13 increased and *n*=11 decreased; sedentary behaviour: *n*=13 increased and *n*=12 decreased) and few recent school leavers described maintaining physical activity (*n*=5) or sedentary behaviour (*n*=4). This current chapter aims to progress the understanding of those results by highlighting consistent or new findings about the changes in the descriptive epidemiology of physical activity and sedentary behaviour patterns during the transition out of secondary school.

Prospective studies have not adequately examined whether changes in physical activity and sedentary behaviour during the transition out of secondary school differ by gender, remoteness or area-level SEP or are impacted by a broad range of situational transitions. Situational transitions may require life adjustments that disrupt routines and habits around physical activity and sedentary behaviour[8]. Further, Chapter 3 reported a range of situational transitions were experienced immediately post-school by interviewees, including commencing full-time work or tertiary education at a university or vocational training, and moving out of the family home. Notably, most recent school leavers believed tertiary education was a major reason for changes in physical activity and sedentary behaviour.

Previous literature reported physical activity after leaving secondary school differed according to work status[9, 10] and tertiary student status[118, 125, 170-173]; however, physical activity was not assessed while still attending secondary school, leaving the impact of the transition unknown. Further, there are mixed findings according to living with parents or independently for changes in physical activity after leaving

secondary school[10, 347] and for changes in sedentary behaviour according to tertiary student status[170, 171]. Therefore, the impact of tertiary student status, work status and living independently/with parents on changes in physical activity and sedentary behaviour immediately post-school have not been quantitatively investigated in a prospective cohort recruited while still attending secondary school. This knowledge is crucial for understanding changes in physical activity and sedentary behaviour during this normative transition, so adolescents are equipped with resilience skills to avoid decreases in physical activity or increases in sedentary behaviour during early adulthood and beyond.

7.2 Chapter aims

The specific aims of this chapter are to:

1. Describe the changes in the descriptive epidemiology of physical activity and sedentary behaviour patterns during the transition out of secondary school;
2. Describe situational transitions experienced after leaving secondary school; and
3. Examine associations between situational transitions and changes in discretionary physical activity and total sedentary behaviour during the transition out of secondary school.

7.3 Methods

Chapter 4 described the full methodology of ProjectADAPT. To recapitulate, this study was a prospective cohort study of secondary school students in Victoria, Australia and took place between August, 2013 and June, 2017. Data collection occurred on three annual occasions at the same time of year as baseline for each participant (Figure 7.1). Participants recruited in 2013 completed all surveys by telephone (interviewer-administered). Those recruited in 2014-2015 opted at the time of consent to complete the survey via telephone or online (self-administered) and continued to be administered the survey via that mode for the two follow-up surveys. Survey items included at baseline were repeated at the one- and two-year follow-ups (Appendix 4.1), except for some school-based items in the final survey.

Figure 7.1 Study design and timeline

7.3.1 Data management

Cleaning and management of the socio-demographic, physical activity and sedentary behaviour data was explained within Chapter 4.

Physical activity and sedentary behaviour

How the physical activity and sedentary behaviour variables were generated is described in Chapter 4. The outcome variables include discretionary physical activity (leisure and transport domains), total sedentary behaviour (all domains), physical activity and sedentary behaviour during school breaks, occupational physical activity and sedentary behaviour, and recreational screen time (watching television, DVDs or videos, using a computer, laptop or tablet, and playing electronic games) (Aim 1).

Situational transitions experienced

Situational transition variables related to study, employment and household composition were generated using responses from relevant single or multiple survey items at the two-year follow-up (Aims 2 and 3). To summarise, the first three situational transitions were: 1) tertiary student (yes, no); 2) substantial weekly work hours (≥20, <20, none); and 3) living with parents (yes, no). The next three situational transitions were more complex: 4) combinations of study and work (concurrently studied and worked, exclusively studied, exclusively worked, neither studied nor worked); 5) combinations of study and living with parents (studying while living with/without parents, not studying); and 6) combinations of work and living with parents (working while living with/without parents, not working).

The situational transitions were identified from literature or by Chapter 3. Firstly, there has been some literature on associations between changes in physical activity and tertiary student status[125, 170-173] or living with parents status[10, 347]. Secondly, Chapter 3 reported that interviewees perceived combinations of work/study and household composition were important influences on physical activity and sedentary

behaviour. Lastly, weekly work hours were the main employment-related situational transition variable, since hours of casual or part-time work varied greatly in the cohort from a few hours to full-time equivalent (>35 h/wk). Further, the cut-point applied of 20 h/wk of work is consistent with the average part-time weekly paid hours amongst Australian 18-21-year-olds[348]. When generating the variable for living with parents status, one participant consistently lived with a cousin, Aunt and Uncle at each time-point, hence was categorised as living with parents due to maintaining household composition.

7.3.2 Data analysis

Baseline participant characteristics were compared between the study non-completers (completed one or two of the surveys) and completers (completed all three surveys) using Pearson's chi-square analyses (categorical data) or a two-sample t-test using groups (continuous data). Further analyses used a restricted sample that only included study completers and those not attending secondary school at the two-year follow-up to examine a cohort who have experienced the normative situational transition of leaving secondary school. The outcome variables of discretionary physical activity and total sedentary behaviour were checked for normality using a histogram. Discretionary physical activity data were positively skewed at all time-points, while total sedentary behaviour data were normally distributed at all time-points. The residuals for the discretionary physical activity and total sedentary behaviour regression analyses were checked and were normally distributed, in accordance with relevant assumptions[288, 289].

To address Aim 1, changes in discretionary physical activity and total sedentary behaviour were identified using multilevel mixed-effects linear regression models. Marginal means were extracted for each model. Data was used from all time-points (long-form), adjusting for age and mode of survey administration a priori, and for confounders. The same confounders were used for consistency across the thesis, and because it is arguably more important to include potentially important confounders than to exclude weak or non-confounders[291]. Confounders in the physical activity models were gender, maternal education, English as the primary language at home and area-level SEP. Confounders in the sedentary behaviour models were gender, paternal education, English as the primary language at home, birth country and remoteness. As some participants were clustered within secondary schools due to the

sampling methods, multilevel modelling was required, and a two-level model was used that accounted for individuals nested within schools.

Additional models were run with an interaction term added between time and gender, remoteness or area-level SEP. If significant, marginal means of the within-group changes were extracted. Changes in secondary outcome variables from baseline were examined using the same procedures as above. Secondary outcome variables included LTPA, active transport, sedentary behaviour (excluding transport), sedentary transport and recreational screen time. Lastly, changes in guideline compliance were examined over time using a multilevel mixed effects logistic regression accounting for individuals nested within schools.

To address Aim 2, characteristics of the cohort at the two-year follow-up were described using tabulation or means and standard deviations. Firstly, study-related variables included secondary school status (early school leaver, early school leaver but returned the following year, still at secondary school, finished secondary school), tertiary student status (yes - higher education or vocational training, no - including deferred), tertiary study mode (full-time, part-time, deferred, no study), duration studying (h/wk), and contact hours since secondary school (increased, decreased, no change, no study). Secondly, employment-related variables included employment status (yes, no), employment type (volunteering, paid, did not work), employment mode (full-time, part-time, casual, did not work), number of jobs, hours worked/wk and changed work hours since secondary school (increased, decreased, no change). Thirdly, living situation variables were parent's home, rental or share house, residence hall, other relative's home or other, and many variables were created for the combinations of situations based on studying and working, studying and living with parents, and working and living with parents. Lastly, predominant time-use variables were vocational training, university, part-time work, full-time work, job seeking, apprenticeship, volunteering, traineeship, defence forces or other (participants were asked to specify). Categorical data were compared by subgroups using Pearson's chi-square analyses and continuous data were compared by subgroups using two-sample t-tests (binary groups; gender and remoteness) or one-way ANOVAs (area-level SEP).

To address Aim 3, time by transition interactions were examined to determine whether there were interactions between the main situational transitions experienced

at the two-year follow-up and time-point for discretionary physical activity and total sedentary behaviour. The main situational transitions were each added as an interaction term with time-point into separate multilevel mixed-effects linear regression models for both outcome variables (totalling 12 models) and *p*-values were reviewed. To determine if interactions were meaningful, Akaike's information criteria (AIC) was compared between main effect models that included each situational transition as an independent variable and the models that included each situational transition as an interaction term (totalling 24 models) with time-point. If a significant interaction was confirmed based on an AIC improvement (i.e., decrease) of ≥2 points[349, 350], within-group change for the situational transition categories at the three time-points were examined, and marginal means were extracted.

7.4 Results

7.4.1 Participant characteristics

Figure 7.2 presents retention proportions. Of the 1 022 participants at baseline, 7% did not respond to correspondence to participate in the one-year follow-up survey, and an additional 9% did not respond to correspondence or declined to complete the survey at the two-year follow-up, resulting in an 84% retention proportion.

Figure 7.2 Retention proportions (RP) among participants

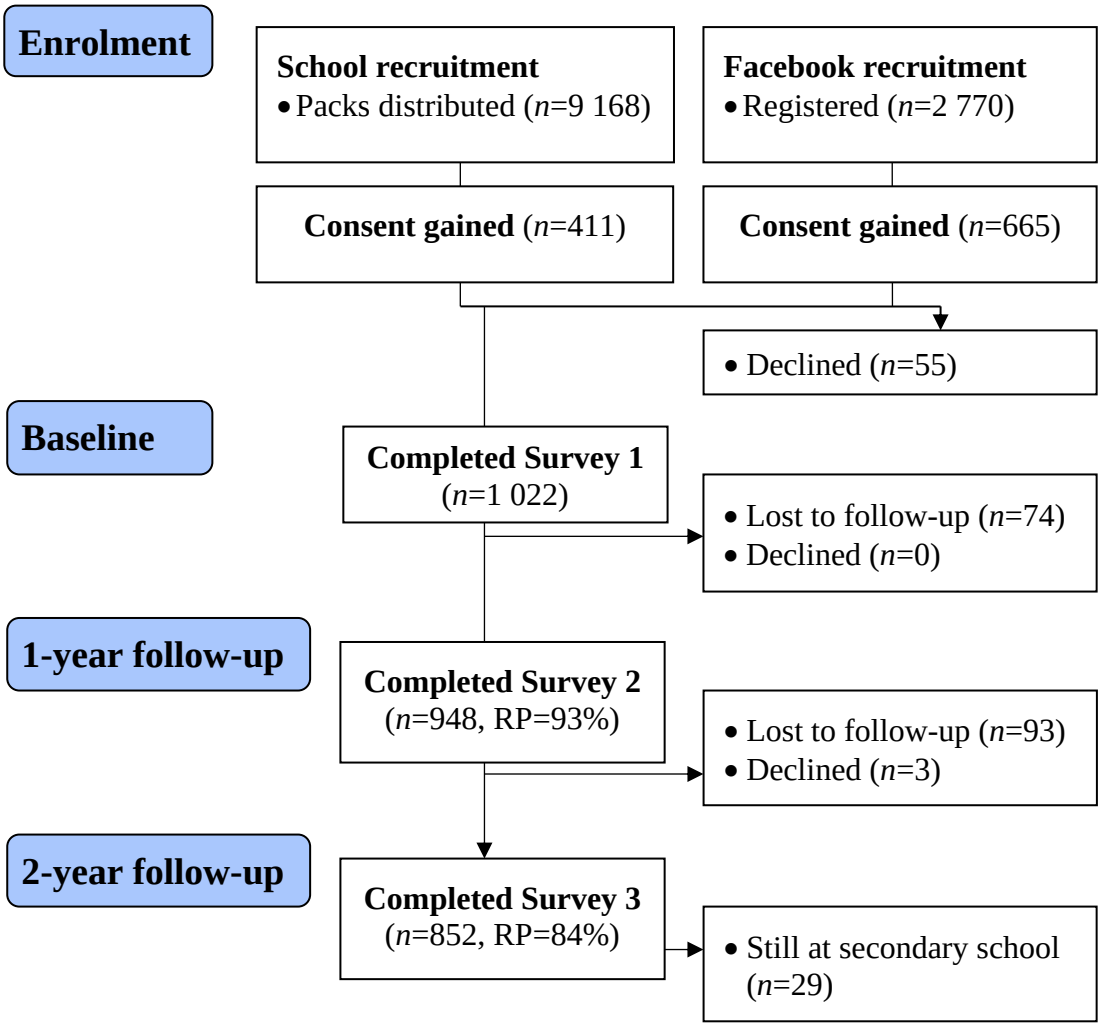


Table 7.1 presents the baseline characteristics of study completers and non-completers. A higher proportion of completers were recruited via social media, took the survey online and identified as a woman than non-completers. Completers reported lower discretionary physical activity and higher total sedentary behaviour at baseline than non-completers.

Table 7.1 Baseline characteristics of study completers and non-completers

	Participants		
	Non-completers (%)	**Completers** (%)	***p***
(n)	(170)	(852)	
Recruitment method[1]			**0.004**
Secondary schools	47.1	35.5	
Social media	52.9	64.6	
Survey mode[1]			**0.000**
Online	78.2	95.4	
Telephone	21.8	4.6	
Demographic characteristics[2]			
Age (mean years±SD)[3]	16.8±0.4	16.9±0.4	0.073
Gender[1]			**0.038**
Girl	67.5	75.1	
Boy	32.5	24.9	
Remoteness[1]			0.363
Urban	67.7	71.1	
Rural	32.4	28.9	
SEP[1]			0.214
Lowest tertile (area-level)	26.5	23.3	
Mid tertile (area-level)	33.5	29.4	
Highest tertile (area-level)	40.0	47.4	
Mother tertiary-educated	51.8	55.2	0.427
Father tertiary-educated	42.2	44.4	0.593
Birth country[1]			
Participant - Australia	81.2	85.1	0.455
Mother - Australia	62.9	61.4	0.533
Father - Australia	58.2	61.7	0.663
English as the primary language spoken at home[1]	85.3	85.2	0.473
Employment (types not mutually exclusive)[1]			
Not employed	44.1	41.1	0.269
Paid employment	50.6	56.2	0.372
Casual employment	37.1	43.4	0.527
Part-time employment	18.2	21.4	0.777
>1 job	8.2	8.3	0.747
Income >$150/wk	8.2	10.8	0.403
Discretionary PA (mean h/day±SD)[3]	1.6±1.5	1.2±1.1	**0.000**
Total SB (mean h/day±SD)[3]	8.4±2.7	8.9±2.9	**0.047**

[1] *Pearson's χ^2 test of significance by completion status.*

[2] *Most demographic characteristics had a small amount missing (n=1-9; age, gender, remoteness, area-level SEP, maternal education, paternal education, birth country and employment variables). Outcomes variables also had a small amount missing (PA: n=17; SB: n=19).*

[3] *Two-sample t-test using completion status.*

7.4.2 Changes in physical activity and sedentary behaviour

Changes in physical activity

Table 7.2 presents the changes in physical activity over time (Aim 1). Discretionary physical activity decreased from baseline to the two-year follow-up by an average of almost 10 mins/day. The proportion who met the National Physical Activity Guidelines[109] declined from baseline to the one-year follow-up (45% vs 37% (p<0.001) vs 41%). Total LTPA, MPA and VPA decreased over time, and total active transport and walking for transport decreased between baseline and the one-year follow-up (Table 7.2). There were no significant interactions between time and gender or remoteness and one significant interaction between time and area-level SEP (Appendix 7.1). Within-group change in discretionary physical activity (B:-7.1; 95%CI:-11.8, -2.3; p<0.01) between baseline and the one-year follow-up for those living in the highest tertile of socio-economic area differed significantly to the within-group changes for those living in the lowest tertile.

For community sport, the mean number of non-school sport teams decreased over time (1.0±1.3 vs 0.8±1.1 vs 0.7±1.2; p<0.001). Of those who reported working, occupational physical activity decreased from baseline to two-year follow-up (p<0.001). Firstly, the proportion who reported mostly standing at work decreased (56% vs 55% vs 53%). Secondly, the proportion who reported mostly walking at work decreased over the transition (29% vs 31% vs 26%). Lastly, the proportion who reported mostly heavy labour or physically demanding work was maintained (9% vs 10% vs 9%).

Table 7.2 Changes in physical activity during the transition out of secondary school

	Baseline		**1-year follow-up**			**2-year follow-up**		
	n	**Marginal mean** mins/day (95% CI)	***n***	**Marginal mean** mins/day (95% CI)	**Change from baseline** mins/day (95% CI)	***n***	**Marginal mean** mins/day (95% CI)	**Change from baseline** mins/day (95% CI)
Discretionary PA	809	77.1 (72.3, 81.9)	819	66.1 (61.2, 71.0)	**-11.0 (-15.7, -6.3)*****	809	67.8 (62.7, 72.8)	**-9.3 (-14.2, -4.5)*****
LTPA	811	51.3 (47.8, 54.9)	820	43.3 (39.7, 46.9)	**-8.0 (-11.5, -4.5)*****	811	42.4 (38.7, 46.2)	**-8.9 (-12.5, -5.2)*****
Walking	815	12.5 (11.2, 13.9)	821	11.9 (10.5, 13.2)	-0.7 (-2.3, 0.9)	811	11.0 (9.5, 12.5)	-1.5 (-3.2, 0.1)
Other MPA	819	16.5 (15.1, 17.9)	820	12.6 (11.2, 14.1)	**-3.9 (-5.5, -2.3)*****	812	12.9 (11.4, 14.4)	**-3.6 (-5.2, -2.0)*****
VPA	819	22.0 (20.1, 23.9)	821	18.6 (16.7, 20.6)	**-3.4 (-5.2, -1.5)*****	811	18.2 (16.2, 20.2)	**-3.8 (-5.7, -1.9)*****
Active transport	820	25.6 (23.4, 27.8)	821	23.0 (20.8, 25.3)	**-2.6 (-4.9, -0.2)***	812	25.4 (23.0, 27.7)	-0.2 (-2.7, 2.2)
Cycling for transport	822	2.6 (1.9, 3.3)	821	2.8 (2.1, 3.5)	0.2 (-0.6, 1.0)	814	3.0 (2.2, 3.7)	0.3 (-0.5, 1.2)
Walking for transport	820	22.9 (21.0, 24.9)	821	20.2 (18.2, 22.2)	**-2.7 (-4.9, -0.5)***	812	22.3 (20.3, 24.4)	-0.6 (-2.8, 1.7)

**p<0.05, ***p<0.001: multilevel mixed-effects linear regression models between 1- or 2-year follow-up and baseline. Adjusted for age, survey mode and confounders (gender, maternal education, English as the primary language spoken at home, and area-level SEP), with repeated measurements for individuals nested within schools.*

Changes in sedentary behaviour

Table 7.3 presents the changes in types of sedentary behaviour over time (Aim 1). Total sedentary behaviour increased from baseline to the one-year follow-up by 16 mins/day ($p<0.05$). The increase was not sustained, and total sedentary behaviour declined at the two-year follow-up compared to baseline by 44 mins/day ($p<0.001$). Sedentary behaviour (excluding transport) decreased from baseline to the two-year follow-up, sedentary transport increased from baseline to the two-year follow-up, and total recreational screen time increased from baseline to the two-year follow-up. The proportion who met the National Sedentary Behaviour Guidelines[109] over time was 35% vs 38% vs 30%, with a decline from the one- to two-year follow-up ($p<0.01$).

There were four interactions between time and remoteness for sedentary behaviour (Appendix 7.1). Firstly, those who lived in a rural area had a larger within-group change in total sedentary behaviour of 0.7 h/day (95%CI:-0.9, -0.5; $p<0.001$) over time compared to those living in an urban area. Secondly, those who lived in an urban area had a larger within-group change in sedentary transport of -0.3 h/day (95%CI:0.2, 0.3; $p<0.001$), in total recreational screen time of 0.2 h/day (95%CI:0.1, 0.3; $p<0.01$) and in electronic games of -0.0 h/day (95%CI:-0.1, -0.0; $p<0.01$) over time compared to those living in a rural area. There were three interactions between time and area-level SEP (Appendix 7.1). Those who lived in the highest tertile of socio-economic area had a larger within-group change in 1) total recreational screen time of 0.6 h/day (95%CI:0.1, 1.2; $p<0.05$) over time compared to those living in the lowest tertile, and 2) watching televisions, DVDs or videos of 0.5 h/day (95%CI:0.2, 0.8; $p<0.01$) over time compared to those living in the lowest tertile. Lastly, those who lived in the mid tertile of socio-economic area had a larger within-group change in watching televisions, DVDs or videos of 0.3 hours/day (95%CI:0.0, 0.7; $p<0.05$) over time compared to those living in the lowest tertile. There were no interactions between time and gender for any sedentary behaviour variable (Appendix 7.1).

Table 7.3 Changes in sedentary behaviour during the transition out of secondary school

	Baseline		**1-year follow-up**			**2-year follow-up**		
	n	**Marginal mean** h/day (95% CI)	***n***	**Marginal mean** h/day (95% CI)	**Change from baseline** h/day (95% CI)	***n***	**Marginal mean** h/day (95% CI)	**Change from baseline** h/day (95% CI)
Total SB	808	8.8 (8.6, 9.0)	803	9.1 (8.8, 9.3)	**0.3 (0.0, 0.6)***	805	8.1 (7.8, 8.3)	**-0.8 (-1.0, -0.5)*****
SB (excluding transport)	810	7.9 (7.7, 8.1)	805	8.1 (7.9, 8.4)	**0.2 (0.0, 0.5)***	805	6.8 (6.6, 7.1)	**-1.1 (-1.4, -0.9)*****
Sedentary transport	821	0.9 (0.8, 0.9)	820	0.9 (0.9, 1.0)	0.0 (-0.0, 0.1)	814	1.2 (1.1, 1.3)	**0.3 (0.3, 0.4)*****
Total recreational screen time	774	3.4 (3.2, 3.6)	778	3.3 (3.1, 3.5)	-0.1 (-0.3, 0.1)	724	3.7 (3.4, 3.9)	**0.2 (0.0, 0.5)***
Watching TV, DVDs or videos	798	1.5 (1.4, 1.6)	798	1.4 (1.3, 1.5)	-0.1 (-0.2, 0.0)	798	1.6 (1.5, 1.7)	0.1 (-0.0, 0.2)
Computer, laptop or tablet	796	1.7 (1.6, 1.9)	796	1.8 (1.6, 1.9)	-0.0 (-0.1, 0.1)	784	1.9 (1.7, 2.0)	0.1 (-0.0, 0.2)
E-games	816	0.2 (0.2, 0.2)	816	0.2 (0.1, 0.2)	-0.0 (-0.1, 0.0)	764	0.2 (0.1, 0.2)	-0.0 (-0.1, 0.0)

**p<0.05, **p<0.01, ***p<0.001: multilevel mixed-effects linear regression models between 1- or 2-year follow-up and baseline. Adjusted for age, survey mode and confounders (gender, paternal education, English as the primary language at home, birth country and remoteness), with repeated measurements for individuals nested within schools.*

7.4.3 Are situational transitions associated with changes in physical activity and sedentary behaviour?

Describing the situational transitions experienced

Few (*n*=29; 3.5%) of the cohort reported that they were still attending secondary school at the two-year follow-up. Very few (*n*=7; 0.8%) were early school leavers, i.e., reported not attending secondary school at the one- and two-year follow-ups. Also, very few (*n*=3; 0.4%) were early school leavers who returned, i.e., were attending school at baseline and the two-year follow-up but not at the one-year follow-up. Only those who reported not attending secondary school at the two-year follow-up were included in further analyses.

Tables 7.4 presents the study-related characteristics of the cohort at the two-year follow-up (Aim 2). Most of the cohort studied at a tertiary institute, studied full-time, reported 11-15 h/wk contact hours and had fewer contact hours compared to secondary school. A greater proportion of men reported not studying compared to women, while women studied off-campus more than men.

Table 7.4 Study characteristics of participants at the two-year follow-up

	Overall (%)	Gender		
		Women (%)	Men (%)	*p*
Tertiary student status, n=796				
Not studying (including deferred)	20.7	20.1	22.5	
Studying	79.3	79.9	77.5	
				0.475
Study mode, n=796				
Not studying	9.2	7.9	13.0	
Full-time	75.1	75.0	75.5	
Part-time	4.2	4.9	2.0	
Deferred study	11.6	12.2	9.5	
				0.042
In those who study, changed contact hours at place of study since baseline, n=796				
Not studying	20.7	20.1	22.5	
Increased	10.3	10.7	9.0	
Decreased	57.2	58.4	53.5	
No change	11.8	10.7	15.0	
				0.287
H/wk in class and studying on campus, n=782				
0 or off-campus student	20.6	20.4	21.4	
1-5	3.3	3.7	2.0	
6-10	12.4	12.7	11.2	
11-15	22.7	23.9	18.9	
16-20	18.3	17.1	21.9	
21-25	12.2	11.2	15.3	
26-30	6.9	7.1	6.1	
>30	3.6	3.7	3.1	
				0.374
	(mean h/wk ±SD)	*(mean h/wk ±SD)*	*(mean h/wk ±SD)*	
Study time at home if enrolled on-campus, n=618	10.0±8.4	10.2±8.5	9.6±8.2	0.226
Study time if enrolled off-campus, n=153	1.3±5.3	1.7±6.2	0.1±0.8	**0.049**

Pearson's χ^2 test of significance or two-sample t-test by gender.

Table 7.5 presents the employment-related characteristics of the cohort at the two-year follow-up (Aim 2). A higher proportion of participants reported working, mainly on a casual basis, for <20 h/wk, and had increased weekly work hours since baseline. Most of the employment characteristics changed over time. For employment status, the proportion of those not employed (paid or voluntary) decreased (40% vs 40% vs 23%; $p<0.001$). Of those employed, part-time employment was lower at the one-year follow-up coinciding with the final year of school (36% vs 30% vs 35%; $p<0.001$), whereas casual employment decreased overtime (74% vs 76% vs 60%; $p<0.001$). Work hours increased for those with one job (8±5 h/wk vs 8±5 vs 16±12; $p<0.001$). The proportion with >1 job was higher over time (14% vs 15% vs 23%; $p<0.05$) and hours worked increased over time (11±7 h/wk vs 11±8 vs 23±15; $p<0.001$). Consequently, reported earnings >$150/wk increased over time (14% vs 21% vs 60%; $p<0.01$).

Table 7.6 presents other characteristics of the cohort at the two-year follow-up (Aim 2). A higher proportion of participants concurrently studied and worked, were living with parents, simultaneously studied while living with parents, and reported that time was mostly occupied by university study. A higher proportion of women compared to men reported time was mostly occupied by part-time work. Meanwhile, a higher proportion of men compared to women reported time was mostly occupied by an apprenticeship.

Table 7.5 Employment characteristics of participants at the two-year follow-up

	Overall (%)	Gender		
		Women (%)	Men (%)	*p*
Employment status[1], n=804				
Not working	22.9	22.0	25.6	
Working	77.1	78.0	74.4	
				0.288
Employment type, n=804				
Not working	22.6	21.8	25.1	
Volunteering	8.2	7.9	9.0	
Paid work	69.2	70.2	65.8	
				0.504
Employment mode[1], n=799				
Not working	23.0	22.2	25.5	
Casual	46.3	46.3	46.0	
Part-time	22.8	18.9	19.0	
Full-time	7.9	7.3	9.5	
				0.352
Number of jobs, n=804				
0	22.9	22.0	25.5	
1	59.2	59.8	57.5	
≥2	17.9	18.2	17.0	
				0.592
Substantial work hours[1], n=804				
Not working	22.9	22.0	25.5	
Working <20h/wk	49.9	50.2	49.0	
Working ≥20h/wk	27.2	27.8	25.5	
(Working ≥35h/wk)	(14.2)	(12.8)	(18.4)	
				0.568[2]
Changed work[1] hours since baseline, n=681				
Not working	18.4	16.8	23.2	
Increased	61.2	62.6	57.1	
Decreased	17.0	17.9	14.3	
No change	3.4	2.7	5.4	
				0.070

[1] Paid and/or voluntary work.

[2] Does not include 'Working ≥35h/wk'

Pearson's χ^2 test of significance by gender.

Table 7.6 Other characteristics of the participants at the two-year follow-up

	Overall (%)	Gender		
		Women (%)	Men (%)	*p*
Combinations of study and work[1], n=795				
Concurrently studied and worked	58.9	60.7	53.3	
Exclusively studied	20.5	19.1	24.6	
Exclusively worked	18.2	17.3	21.1	
Neither studied nor worked	2.4	2.9	1.0	
				0.074
Household type, n=805				
Parent's home	79.3	78.8	80.5	
Rental or share house	8.1	7.8	9.0	
Residence hall	9.3	9.8	8.0	
Another relative's home	1.7	1.5	2.5	
Other	1.6	2.1	0.0	
				0.198
Combinations of study and household composition, n=785				
Studied and lived with parents	62.8	63.5	60.7	
Studied and lived independently	16.2	16.1	16.3	
Did not study	21.0	20.4	23.0	
				0.722
Combinations of work[1] and household composition, n=795				
Worked and lived with parents	64.8	65.4	62.9	
Worked and lived independently	12.1	12.4	11.2	
Did not work	23.1	22.2	25.9	
				0.558
'Time mostly occupied by…', n=805				
University	72.8	73.6	70.5	0.400
Part-time work	35.0	37.0	29.0	**0.039**
Job seeking	12.8	13.1	12.0	0.698
Full-time work	9.1	8.8	10.0	0.597
Vocational training	6.7	6.9	6.0	0.644
Volunteering	6.5	7.3	4.0	0.103
Traineeship	1.7	2.0	1.0	0.356
Apprenticeship	0.9	0.3	2.5	**0.004**
Defence	0.4	0.5	0.0	0.318
Other[2]	6.0	5.6	7.0	0.475

[1] *Paid and/or voluntary work.*

[2] *Time was mostly occupied by (in order of most common) casual work, travelling/worked aboard for the gap year, gap year, sport, musician, blogging, or undergoing cancer treatment.*

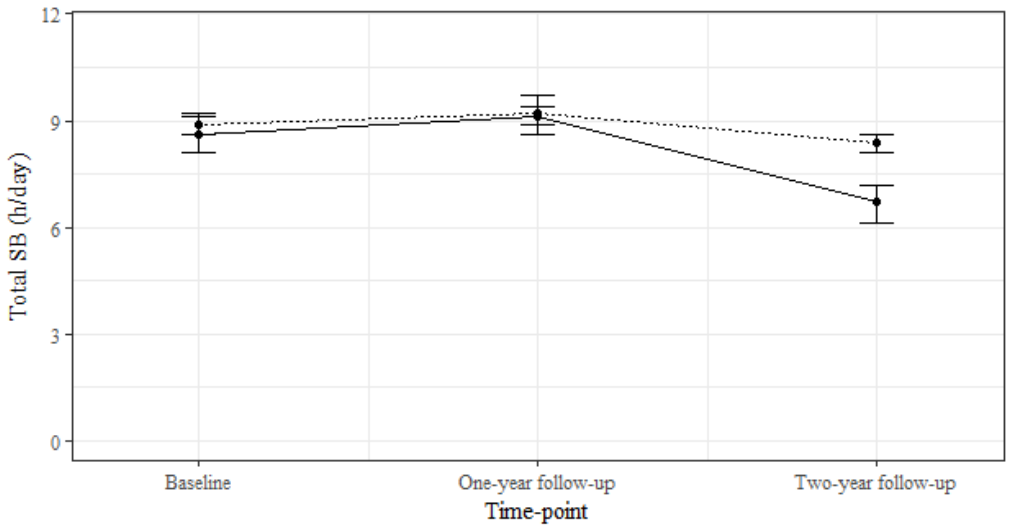
Pearson's χ^2 test of significance by gender.

Changes in behaviour according to situational transitions

The interactions between the main situational transitions experienced and changes in discretionary physical activity and total sedentary behaviour during the transition out of secondary school are presented in Appendix 7.2 (Aim 3). There were significant interactions between time and the situational transitions for total sedentary behaviour but not for discretionary physical activity. Overall, interactions were found for tertiary student status, substantial weekly work hours status, living with parents status, study and work combinations, studying while living with or without parents, and working while living with or without parents. These interactions are explored graphically below.

Those not studying at a tertiary institute at the two-year follow-up decreased total sedentary behaviour more over time compared to tertiary students (Figure 7.3).

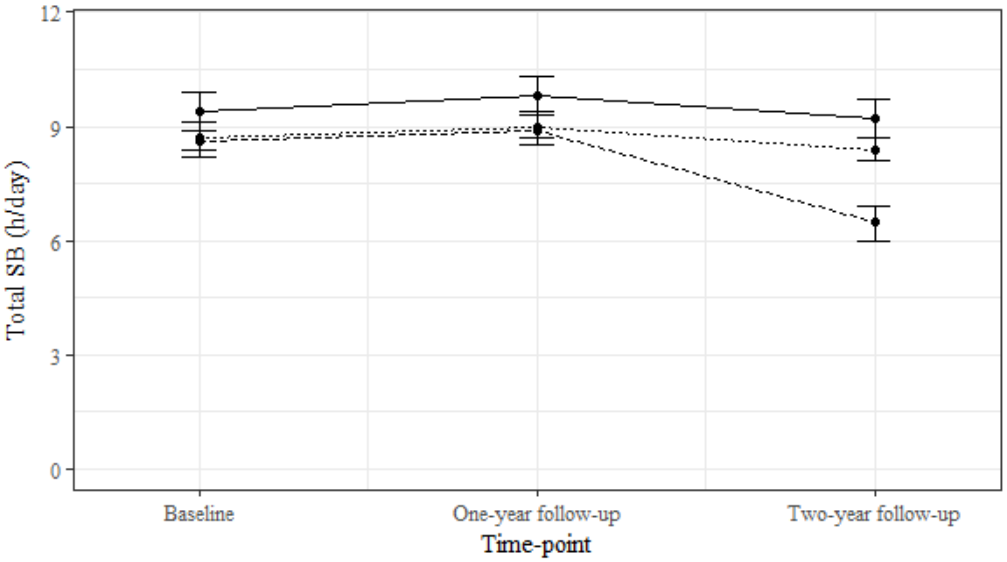
Figure 7.3 Change in marginal means (95% confidence intervals) for total sedentary behaviour according to tertiary student status at two-year follow-up (*n*=796)



····· *tertiary student;* — *not a tertiary student.*

Those working ≥20 h/wk at the two-year follow-up had a greater decrease in sedentary behaviour over time, compared to those not working (Figure 7.4).

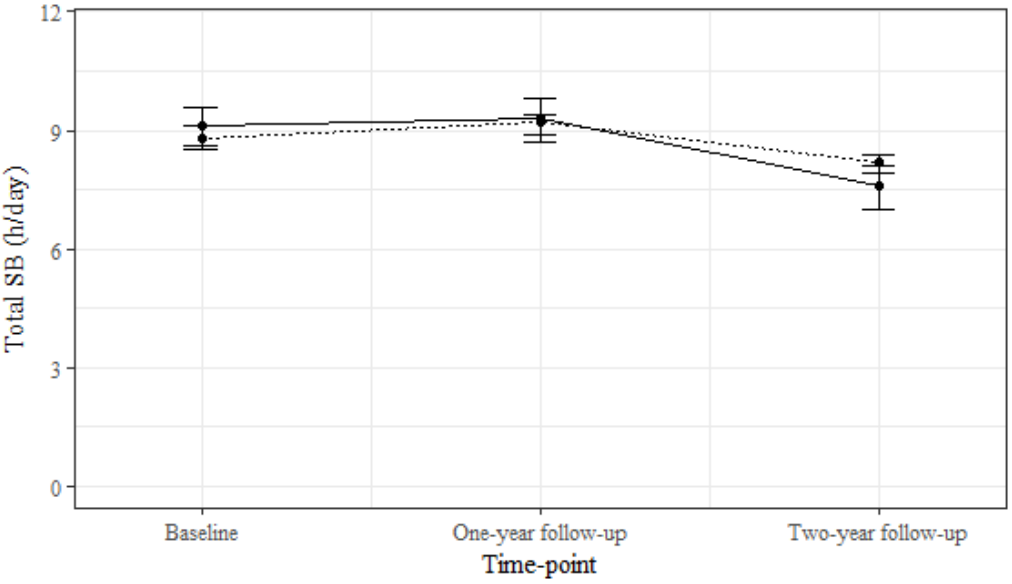
Figure 7.4 Change in marginal means (95% confidence intervals) for total sedentary behaviour according to substantial weekly work hours at two-year follow-up (*n*=804)



- - - - - working ≥20 h/wk; ····· working <20 h/wk; —·not working.

After leaving secondary school, those living independently decreased sedentary behaviour significantly more over time than those living with parents (Figure 7.5).

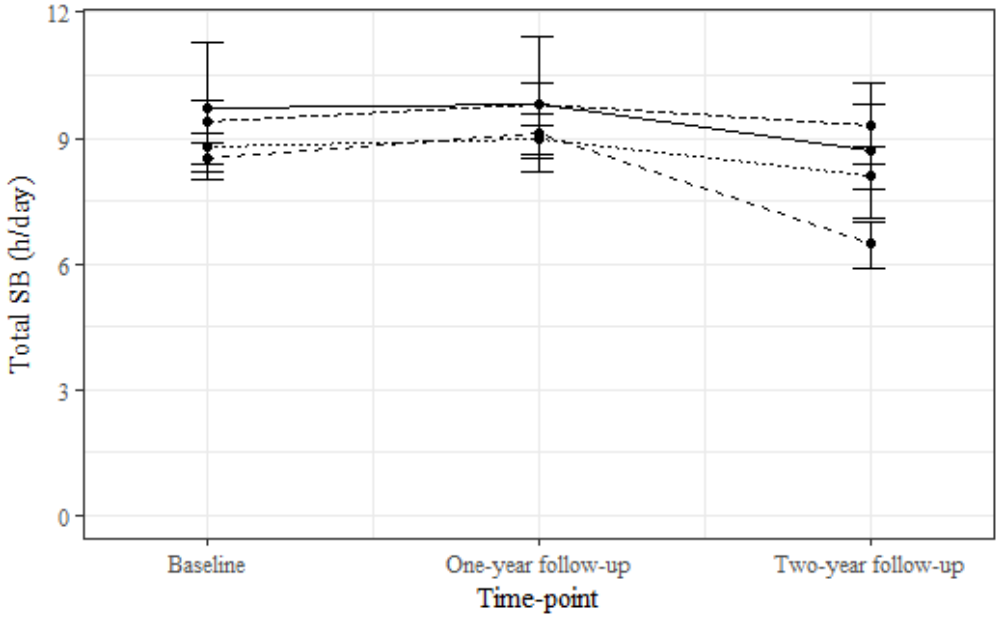
Figure 7.5 Change in marginal means (95% confidence intervals) for total sedentary behaviour according to living with parents at the two-year follow-up (*n*=805)



···· living with parents; —·living independently.

After leaving school, those exclusively working reported engaging in the least sedentary behaviour, while those exclusively studying reported the most. Further, those exclusively studying after leaving secondary school changed sedentary behaviour the least amount over time, compared to those exclusively working, studying while working, and neither studying nor working (Figure 7.6).

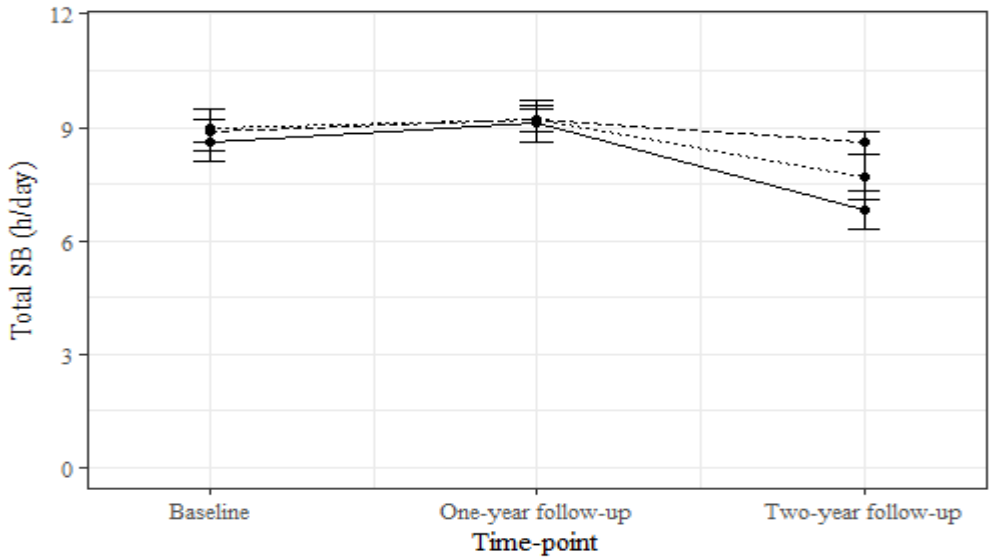
Figure 7.6 Change in marginal means (95% confidence intervals) for total sedentary behaviour according to study and work combinations at the two-year follow-up (*n*=795)



- - - - - exclusively working; ----- exclusively studying; ···· concurrently studying while working; —·neither working nor studying.

Those not studying at a tertiary institute after leaving secondary school decreased total sedentary behaviour significantly more over time compared to those studying while living with parents (Figure 7.7).

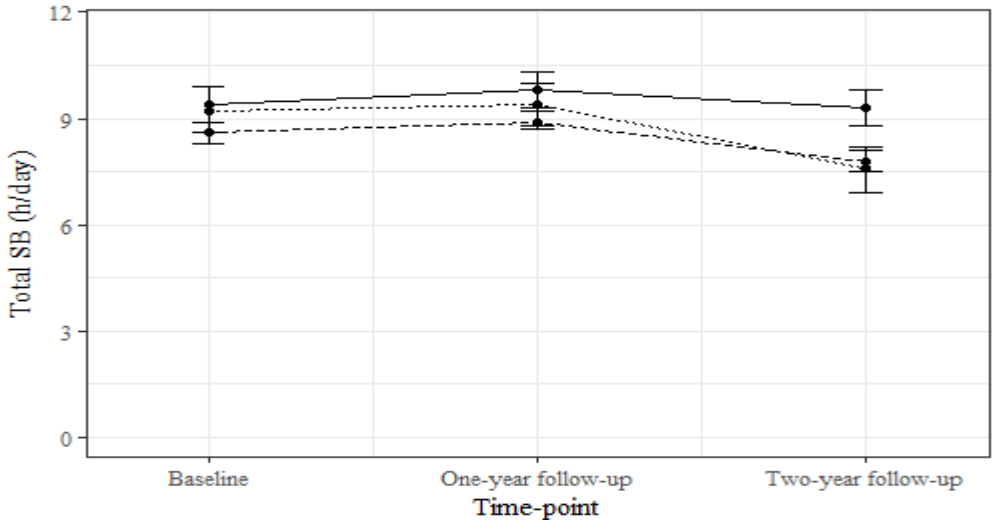
Figure 7.7 Change in marginal means (95% confidence intervals) for total sedentary behaviour according to whether participants were studying while living with or without parents at the two-year follow-up (*n*=785)



---- living with parents while studying; ··· living independently while study; —· not studying.

Irrespective of living with or without parents, those working after leaving secondary school decreased total sedentary behaviour significantly more over time compared to those not working (Figure 7.8).

Figure 7.8 Change in marginal means (95% confidence intervals) for total sedentary behaviour according to whether participants were working while living with or without parents at the two-year follow-up (*n*=795)



------ living with parents and worked; ····· living independently and worked; —· not working.

7.5 Discussion

In summary, this study aimed to describe changes in physical activity and sedentary behaviour during the transition out of secondary school, describe situational transitions post-school, and examine interactions between these. This study found that both discretionary physical activity and total sedentary behaviour declined, consistent with previous studies of older adolescents[15, 85, 118, 122, 123, 134, 135, 139]. After leaving secondary school, most of the cohort lived with parents and concurrently studied and worked. The three most common activities that occupied time were university studies, part-time work or job-seeking. Situational transitions associated with a decrease in sedentary behaviour were not studying, working substantial hours, exclusively working, living independently, and studying while living independently.

This study found the magnitude of the discretionary physical activity changes were small with an average decline of almost 10 mins/day over time and an 8% reduction in compliance with guidelines in Year 12. This is a concern due to the associated health outcomes outlined in Chapter 2. The physical activity declines may be partially attributed to less structure and routine on weekdays compared to secondary school classes but future research is needed to confirm determinants. Regarding changes in types of physical activity, school leavers decreased MPA other than walking and VPA over time. The physical activity declines observed in this study signal that preventative initiatives are needed that prepare adolescents for leaving secondary school. Active transport comprised almost a third of discretionary physical activity and was therefore important. However, at the one-year follow-up, it declined. Future interventions need to encourage older adolescents to use active transport by promoting walking and cycling for short trips and tailor messages to the pro-environmental interest and awareness in this age group by highlighting the sustainability benefits such as climate crisis mitigation and reducing traffic congestion[351, 352].

While national statistics suggested sedentary behaviour was higher as age increased (3 h/day in 15-17-year-olds and 5.5 h/day in 18-24-year-olds)[15], this current study found that total sedentary behaviour decreased by 44 mins/day over time, which is promising. Differences may be due to different measures and samples, as the current study included proportionally more women, tertiary students and those living in the highest tertile of socio-economic area. Sedentary behaviour may have declined post-school due to less pressure and demand to study compared to the final years of

secondary school, but future research is needed that identifies determinants. The sedentary behaviour declines could imply that the secondary school environment may be conducive to an extra 44 mins/day of sedentary behaviour that interventions could target with strategies to reduce prolonged sitting in secondary school students such as encouraging active breaks during classes and when studying at home. Regarding changes in specific types of sedentary behaviour, school leavers increased their recreational screen time which caused an 8% decline in compliance with National Sedentary Behaviour Guidelines. Sedentary transport also increased, while sedentary behaviour in domestic and leisure-time domains decreased. Future research is needed to clarify whether the sedentary transport increase was based on private car use, which is negative, or public transport use, which is positive since it may include standing, walking or cycling as part of the journey. Older adolescents living in an urban area or the highest or mid tertiles of socio-economic area were identified as target groups for intervention because they increased recreational screen time over time more than those living in an urban area or in the lowest tertile, respectively.

This current study found that participants experienced a range of disruptive changes during late adolescence that included major life adjustments, such as living independently, substantial weekly work hours, commencing tertiary education, and, importantly, simultaneous combinations of these. This implies that adolescents are not a homogenous group but instead experience a range of situational transitions. Following a cohort from secondary school meant that it was possible to explore a range of situational transitions after leaving school and addressed a literature gap as similar studies mainly assessed tertiary students who had moved away from home onto student residences on campus[118, 125, 170-173]. The proportions who experienced specific situational transitions in this study were mostly inconsistent with national data among 15-20-year-olds[353]. Compared to this current study, national data showed that a lower proportion of Australian recent (<1-year) school leavers were studying at university or further education (63% vs 79%), or concurrently studied and worked (39% vs 59%); a higher proportion exclusively worked (24 % vs 18%), or neither studied nor worked (14% vs 2%); and a similar proportion exclusively studied (24% vs 21%)[353]. The dissimilar findings may be partially explained by the wide age range included in the national data, which was representative of 15-20-year-olds.

Although many previous studies found associations between changes in physical activity and situational transitions experienced after leaving secondary school[9, 118, 125,

[170, 171, 173, 347, 354, 355], this study did not. The inconsistent findings may be due to methodological differences, in particular, this current study had a short, two-year timeframe. Future research needs to continue examining annual changes in physical activity by situational transition over a longer period of time, assess physical activity using devices and large random samples to capture a broader range of situational transitions and combinations of these. Further, future research needs to examine whether there is an accumulative impact of multiple simultaneous situational transitions on changes in behaviour.

In contrast, changes in sedentary behaviour were associated with situational transitions in this current study. This is a novel finding, as no other studies have been found that focus on the role of situational transitions on explaining sedentary behaviour changes post-secondary school. In all of the associations, behaviour was maintained at the one-year follow-up and the declines were observed only after leaving secondary school. The finding supports the life transition model[18] that disruptions and instability can change the trajectory of health behaviour. This study found a cluster of helpful (sedentary behaviour declined) situational transitions including not studying, working ≥20 h/wk, living independently and exclusively working (without concurrent study). Future research needs to examine why these groups are helpful.

More work hours may be a proxy for having stable and consistent employment that leads to a structured lifestyle, being financially independent and more time in a different social environment with work colleagues. Also, occupation type may be an explaining mechanism for declines in sedentary behaviour, since there was a low proportion of sedentary occupations in this age group. As supportive evidence, the most common (n>20) occupation types of the cohort were retail assistant, fast food team member, cashier, waitress and customer service officer, which traditionally involve a lot of standing and/or walking. Chapter 3 supported this finding as recent school leavers perceived that their work influenced changes in sedentary behaviour and the direction of influence was based on their job type. Studies have found sedentary behaviour associated with employment status[280] and, specifically, unemployment associated with more television viewing, non-full-time employment associated with more leisure-time sedentary behaviour and mid-income range associated with more home computer use[356].

The impact of living independently on changes in sedentary behaviour may be partially attributed to improved access to neighbourhood facilities, doing more chores and grocery shopping as part of changes in home-life routines, and being actively involved with new flatmates and a new social support base in a new neighbourhood. An insight from Chapter 3 is that numerous recent school leavers reported a shift in friendship groups away from secondary school peers. Also, the qualitative study participants similarly reported that home life was an influence on changes in sedentary behaviour, as well as independence and pet ownership. A study found living alone was associated with more sedentary behaviour (watching television, using a home computer and leisure-time sedentary behaviour)[356].

This study found a cluster of unhelpful (sedentary behaviour was maintained) situational transitions for intervention including living with parents, not working, working <20 h/wk, exclusively studying and the combinations of studying while living with parents, neither working nor studying, and working while studying. Although it was positive that sedentary behaviour did not increase in these target groups, future research is needed to examine how to decrease sedentary behaviour in these populations. Tertiary students may have maintained sedentary behaviour because of continued studious habits from school; therefore, future research needs to examine how to decrease sedentary behaviour in students, such as introducing strategies that break up prolonged sitting (sit-stand desks and frequent active study breaks). As mentioned earlier, a study found unemployment associated with more television viewing and non-full-time employment associated with more leisure-time sedentary behaviour[356].

Strengths and limitations

Strengths of this study include an adequate sample size and high retention. There were three data collection points and the annual follow-ups were conducted at the same time of year as baseline to reduce intra-individual seasonal variation in behaviour. Future studies could consider collecting data within only one season as Chapter 3 findings suggest that Winter and the school holidays influenced less socialising, more sedentary behaviour, and less physical activity. The annual assessment intervals addressed a literature gap because large intervals, such as four years, had been previously used[9, 354, 355] and may have masked changes in behaviour due to the unique transition out of secondary school that had not been previously

exposed. Another literature gap addressed was assessing physical activity and sedentary behaviour prior to the transition out of secondary school which gave this study robust baseline data, since previous studies on the transition post-school only assessed behaviour after leaving secondary school[9, 125, 170, 172, 354, 355] or relied on recall of secondary school behaviour once the participant had already left school[118, 171, 173]. Identifying an impact of situational transitions on changes in sedentary behaviour during the transition out of secondary school was novel. Future research needs to examine the effect of single and cumulative situational transitions experienced after leaving secondary school on changes in other health behaviours, such as meal patterns and smoking, to identify explaining mechanisms of change that are common across multiple health behaviours.

The findings may largely apply to women who are tertiary students living in the mid or highest tertile of socio-economic area and would benefit from verification in studies that use random sampling methods and sample an even representation of gender to increase generalisability. Further, study completers had lower baseline discretionary physical activity, higher baseline total sedentary behaviour, more identified as girls, were recruited via social media and completed the surveys online than non-completers. The latter two factors possibly reflect being highly active on social media and tech-savvy, which may have contributed to higher total sedentary behaviour in those participants.

Changes in physical activity in late adolescence may be underestimated in the findings as time in LPA in any domain and time in physical activity at school and work were not assessed in the physical activity measure. Although the test-retest reliability of the measure is acceptable, the magnitude difference between declines in physical activity and sedentary behaviour may be due to measurement error and a more robust measure is needed to clarify findings. As mentioned in Chapter 4's discussion, although at a larger cost, device-based measures with concurrent log book use has more sensitivity and would provide a more reliable and valid estimate of health behaviours[61, 275]. The use of a self-reported measure is associated with a number of limitations including human recall error[61, 275] and applying social norms by under-reporting sedentary behaviour. Self-report measures are a cost-effective method, however, for assessing physical activity and sedentary behaviour, are unlikely to alter the behaviour[262] and are one of the only ways to collect domain-specific information. Lastly, relying on mean changes in behaviour at the group-level

can mask the behavioural trajectories of sub-groups. To develop what this study found, future research is needed that uses a different longitudinal analysis approach such as trajectory, path or latent class growth analyses to identify clusters of behaviour patterns and identify the unique influences on behaviour.

Conclusion

This chapter showed that total sedentary behaviour declined during the transition out of secondary school; however, recreational screen time increased and discretionary physical activity and compliance with National Physical Activity and Sedentary Behaviour Guidelines declined. This highlights the need to advocacy for older adolescents and development of preventive initiatives prior to the transition out of school. Various situational transitions occurred post-school, mostly simultaneously. Living independently, not studying, and working were associated with declines in total sedentary behaviour over time. Future research could identify insulating characteristics and coping skills that need to be in place during secondary school associated with higher physical activity and lower sedentary behaviour. This could develop what this study found by revealing recommendations for protective attributes important for the various situational transitions that older adolescents commonly experience after leaving secondary school.

Chapter 8

Determinants and moderators of physical activity and sedentary behaviour during the transition out of secondary school

8.1 Introduction

In Chapter 3, recent school leavers suggested that the main influences on physical activity during the transition out of secondary school were time use and social support, whereas tertiary study and social support were the main influences on sedentary behaviour. Chapters 5-6 found correlates of physical activity in late adolescence were physical activity enjoyment, goal setting and self-efficacy, friends or colleagues discouraging sedentary behaviour and social network count (all positive), and the correlate of sedentary behaviour in late adolescence was physical activity goal setting (negative). Therefore, this current chapter progresses the understanding of those findings by identifying individual, social and environmental longitudinal determinants of physical activity and sedentary behaviour during the transition out of secondary school, highlighting consistent or new findings.

The current study addresses the various limitations of previous studies that reported longitudinal determinants of physical activity and sedentary behaviour during the transition from adolescence into adulthood. Limitations include long follow-up periods[163, 164] and broad age ranges[160, 162, 164, 165]. A study assessed the transition out of secondary school and found that perceptions of peers' physical activity, family support and planning for VPA were determinants of physical activity[159]. Some studies assessed a limited scope of types of sedentary behaviour (only television, videos or video games on the computer on school days[160]) and physical activity (only LTPA frequency)[164]. Few studies assessed both physical activity and sedentary behaviour[160, 163]. Elucidating longitudinal determinants of physical activity and sedentary behaviour during the transition out of secondary school will provide important information on which to base intervention strategies.

Chapter 7 identified that the magnitude of change in sedentary behaviour differed according to which situational transition adolescents experienced after leaving school. School leavers who did not study at a tertiary institute, worked ≥20 h/wk or did not live with parents decreased sedentary behaviour after leaving school significantly more than respective comparison groups. It is possible that individual, social and environmental attributes during secondary school may moderate associations between situational transitions and physical activity and sedentary behaviour during the transition out of secondary school, helping to promote resilience to detrimental changes associated with specific situational transitions. However, to the author's knowledge, only one previous prospective study assessed

moderators of associations between situational transitions and changes in physical activity during the specific transition out of secondary school[22]. That study reported that belonging to a sporting club during school moderated the association between working full-time and decreasing LTPA post-school[22]. That is, belonging to a sports club during school helped ameliorate the decline in physical activity associated with full-time work after school. Sedentary behaviour and potential environmental moderators were not assessed in that study.

8.2 Chapter aims

The specific aims of this chapter are to:

1. Identify individual, social and environmental longitudinal determinants of discretionary physical activity and total sedentary behaviour during the transition out of secondary school; and
2. Identify individual, social and environmental baseline moderators of associations between situational transitions experienced and discretionary physical activity and total sedentary behaviour during the transition out of secondary school.

8.3 Methods

Data from the baseline and two-year follow-up of ProjectADAPT forms the basis of this chapter. The dataset used in this chapter excludes those participants studying at secondary school at the two-year follow-up and those who did not complete all three surveys. The analytical sample, therefore, comprises *n*=823 participants. Situational transitions examined in this chapter are tertiary student (yes, no), substantial weekly work hours (≥20, <20) and living with parents (yes, no) and were selected due to four reasons. The situational transitions chosen were themes that were discussed by interviewees in Chapter 3, are post-school pathways that could be targeted in interventions, represent the main situational changes that occur during the transition out of secondary school presented in Chapter 7, and were associated with changes in sedentary behaviour in Chapter 7.

8.3.1 Data management

Outcome variables of this chapter (discretionary physical activity and total sedentary behaviour) and socio-demographic variables were described in Chapter 4 and are consistent throughout Chapters 4-7. Situational transition variables were mostly consistent with Chapter 7, except for substantial weekly work hours since 'not working' was coded as <20 h/wk.

In preparation for moderation analyses, baseline independent variables (previously described in detail in Table 4.1) were dichotomised to increase the interpretability of the findings. Meaningful cut-points were based on either the response options (if the scale had clear high and low options such as agree or disagree; 20/26 variables) or were determined from examining the mean distribution (6/26 variables; social network count, the number of electronic devices, physical activity equipment and televisions at home, and land use mix diversity and recreation facilities scores). Cut-points applied were "0" to represent a low level of the scores and counts or "1" to represent a high level (Table 8.1). Some (10) variables had fairly even (40-60%) proportions of participants with low and high levels, whereas other variables were skewed. Firstly, >80% of the cohort reported high scores of physical activity enjoyment, electronic devices at home and neighbourhood walking environment at baseline. Lastly, <20% of the cohort reported high scores of electronic games co-participation with family and friends or colleagues, discouragement of sedentary behaviour from friends or colleagues, and neighbourhood noise at baseline.

Table 8.1 Additional treatment of baseline independent variables in preparation for moderation analyses and the proportion of the cohort who had high baseline levels

	Score cut-points (low vs high)	***n***	**High level** (%)
Individual variables (scores)			
PA enjoyment (3 items summed)	≤9; >9	822	80.1
PA goal setting (3 items summed)		823	38.8
PA competence (1 item)	≤3; >3	823	54.3
PA self-efficacy (5 items summed)	≤15; >15	823	40.7
TV avoidance self-efficacy (5 items summed)		814	54.7
Social variables			
Family (scores):			
E-games co-participation (1 item)	≤3; >3	801	7.0
PA co-participation (1 item)		817	25.7
TV/DVDs co-participation (1 item)		819	50.2
PA social support (3 items summed)	≤9; >9	817	51.2
SB discouragement (1 item)	≤3; >3	819	39.9
Friends/colleagues (scores):			
E-games co-participation (1 item)	≤3; >3	823	16.0
PA co-participation (1 item)		823	34.9
TV/DVDs co-participation (1 item)		823	30.0
PA social support (3 items summed)	≤9; >9	823	25.5
SB discouragement (1 item)	≤3; >3	823	5.8
Social network count (3 items summed)	≤9; >9 people	822	51.7
Gym membership (1 item)	=0; =1	821	28.5
Environmental variables			
Home environment (counts):			
E-devices, no. of (count of 6 items)	≤3; >3 items	821	82.2
PA equipment, no. of (count of 5 items)	≤2; >2 items	822	33.5
TVs, no. of (1 item)		819	44.1
Neighbourhood environment (scores):			
Noise (1 item)	≤3; >3	822	19.5
Walking environment (4 items summed)	≤12; >12	820	86.5
Safety (2 items summed)	≤6; >6	821	68.1
Social cohesion (2 items summed)		821	70.8
Land use mix diversity (count of 8 destinations within 10 mins)	≤2; >2	822	49.0
Recreation facilities (count of 5 destinations within 10 mins)		821	47.6

8.3.2 Data analysis

T-tests were used to compare the distribution of independent variables at baseline between the cohort who completed all three surveys and were no longer at secondary school at the two-year follow-up (*n*=823), and non-completers or those at secondary school at the two-year follow-up (*n*=199). Baseline independent variables that were previously described in Chapter 4 (Table 4.1) and used in Chapters 5-6, were examined as potential determinants (Aim 1) and moderators (Aim 2). Physical activity and sedentary behaviour data from baseline and two-year follow-up were used. Excluding the one-year follow-up physical activity and sedentary behaviour data (Year 12, for most participants) did not limit the ability to address this chapter's aims which focussed on behaviour after leaving secondary school.

To address Aim 1, mixed-effects linear regression models were used. Discretionary physical activity or total sedentary behaviour at the two-year follow-up was the dependent variable. Each potential determinant (baseline value) was the independent variable in separate mixed-effects linear regression models (partially-adjusted models; 26 potential determinants resulted in 52 models). Two fully-adjusted models were then run to confirm determinants that included the significant independent variables from the partially-adjusted models (one each for physical activity and sedentary behaviour). Multicollinearity of the fully-adjusted models was checked but no variable had a high variance inflation factor (>5.0)[292].

To address Aim 2, generalised estimating equation models were used. This was chosen because generalised estimating equation models fit a marginal distribution and a population average effect is sought, whereas linear mixed effects models often are interested in a conditional approach and the individual specific effect[357]. Within the models, the dependent variable was discretionary physical activity or total sedentary behaviour at the two-year follow-up and the independent variable was the situational transition. A series of models were used, adding an interaction term for each potential moderator (baseline value; three situational transitions and 26 potential moderators resulted in 78 models for discretionary physical activity and total sedentary behaviour, totalling 156 models; Appendices 8.1-8.2). If there was a significant interaction, the models were stratified by the moderator to show the strength and direction of the associations of the low and high levels of the moderator with discretionary physical activity or total sedentary behaviour (Appendix 8.3).

Graphing the adjusted means (margins) from models in a series of figures provided a visual representation of the moderation effect.

Mixed-effects linear regression models (Aim 1) and generalised estimating equations (Aim 2) were chosen to account for clustering within schools, as the data had non-independence rising from its hierarchical structure[358]. The data was used in wide-form over long-form for two main reasons. Firstly, this avoided a three-level model needed to analyse long-form data such as time-points nested within individuals nested within schools. Lastly, this avoided a three-way interaction between changes in behaviour over time, changes in the determinants over time, and, for Aim 2 only, whether situational transition were experienced.

For both aims, models adjusted for baseline discretionary physical activity or total sedentary behaviour, age, survey mode of administration and confounders. Confounders were consistent with Chapter 5-7. Confounders for the physical activity models were gender, maternal education, English as the primary language spoken at home and area-level SEP, and confounders in the sedentary behaviour models were gender, paternal education, English as the primary language at home, birth country (Australian, other) and remoteness (urban, rural). Further, as some participants were recruited from secondary schools, multilevel modelling was required so models had two-levels that included individuals nested within schools.

8.4 Results

8.4.1 Impact of study attrition on distribution of independent variables

Table 8.2 describes the baseline distribution of the independent variables among those included in the analytical sample (*n*=823), compared to those excluded from further analyses (*n*=199). Study completers who had left secondary school by the two-year follow-up reported lower scores for five variables compared to non-completers, specifically, co-participation in electronic games with family, friends or colleagues, social support for physical activity from friends or colleagues, discouragement of sedentary behaviour from friends or colleagues, and neighbourhood land use mix diversity.

Table 8.2 Comparison of the distribution of independent variables at baseline between study completers and non-completers

		Participants				
		Completers		Non-completers		
	Max. score	*n*	mean±SD	*n*	mean±SD	***p***
Individual variables (scores)						
PA enjoyment	15	822	11.7±2.6	197	11.8±2.7	0.807
PA goal setting	18	823	8.6±3.8	199	8.8±3.9	0.504
PA competence	5	823	3.5±1.2	197	3.6±1.2	0.142
PA self-efficacy	25	823	14.3±4.9	199	14.9±5.2	0.127
TV avoidance self-efficacy	25	814	16.1±4.7	195	16.0±4.9	0.768
Social variables						
Family (scores):						
E-games co-participation	5	801	1.6±1.0	194	1.9±1.3	**0.006**
PA co-participation	5	817	2.7±1.3	195	2.7±1.4	0.812
TV/DVDs co-participation	5	819	3.4±1.2	197	3.4±1.2	0.582
PA social support	15	817	9.5±3.2	195	9.6±3.5	0.716
SB discouragement	5	819	3.0±1.3	196	3.1±1.4	0.858
Friends/colleagues (scores):						
E-games co-participation	5	823	2.0±1.2	197	2.3±1.3	**0.007**
PA co-participation	5	823	2.9±1.4	197	2.9±1.4	0.624
TV/DVDs co-participation	5	823	2.8±1.2	197	2.8±1.3	0.787
PA social support	15	823	7.4±3.2	197	7.9±3.4	**0.041**
SB discouragement	5	823	1.7±0.9	197	1.9±1.2	**0.017**
Social network count	∞	822	11.6±10.1	195	12.6±10.0	0.229
Gym membership (yes)	1	822	28.5%	199	28.1%	0.927
Environmental variables						
Home environment:						
E-devices, no. of	6	821	4.6±1.1	197	4.5±1.3	0.470
PA equipment, no. of	5	822	2.0±1.2	197	2.1±1.2	0.331
TVs, no. of	∞	819	2.7±2.4	197	2.5±1.5	0.340
Neighbourhood environment (scores):						
Noise	5	822	2.5±1.0	195	2.5±1.0	0.938
Walking environment	20	820	15.7±3.1	195	15.9±2.7	0.400
Safety	10	821	7.3±1.9	195	7.5±2.0	0.068
Social cohesion	10	821	7.3±1.7	195	7.5±1.7	0.115
Land use mix diversity	8	822	2.9±2.2	195	3.3±2.4	**0.023**
Recreation facilities	5	821	2.4±1.4	195	2.4±1.6	0.535

T-test or Pearson's χ2 test of significance by completed study status.

8.4.2 Longitudinal determinants of physical activity and sedentary behaviour during the transition out of secondary school

Table 8.3 presents the longitudinal determinants of discretionary physical activity and total sedentary behaviour during the transition out of secondary school. In the partially-adjusted models, discretionary physical activity after leaving secondary school was associated with eight baseline independent variables. In the fully-adjusted model, two variables remained significant. Every unit increase in physical activity enjoyment and goal setting scores in Year 11 was associated with 2.6 mins/day (95%CI:0.3, 5.0) or 1.6 mins/day (95%CI:0.1, 3.1) higher discretionary physical activity after leaving secondary school, respectively, independent of baseline physical activity. For sedentary behaviour, one of the seven associations from the partially-adjusted models remained significant in the fully-adjusted model. Every unit increase in television avoidance self-efficacy score (25 units maximum) in Year 11 was associated with 3.9 mins/day (95%CI:-7.1, -0.7; p=0.016) lower total sedentary behaviour after leaving secondary school, respectively, independent of baseline sedentary behaviour.

Table 8.3 Baseline determinants of discretionary physical activity and total sedentary behaviour after leaving secondary school[1]

	Discretionary PA mins/day at 2-year f/up B (95%CI)		**Total SB mins/day at 2-year f/up** B (95%CI)	
	Partially-adjusted model	**Fully-adjusted model, *n*=733**	**Partially-adjusted model**	**Fully-adjusted model, *n*=719**
Individual variables (scores)				
PA enjoyment	**3.7 (2.0, 5.5)*** **	**2.6 (0.3, 5.0)***	**-11.3 (-16.9, -5.6)*** **	-4.2 (-13.3, 4.8)
PA goal setting	**2.8 (1.4, 4.2)*** **	**1.6 (0.1, 3.1)***	**-6.4 (-10.5, -2.2)** **	-1.3 (-6.6, 4.0)
PA competence	**4.6 (0.9, 8.3)***	-3.1 (-8.1, 1.9)	**-23.1 (-34.8, -11.3)*** **	-6.9 (-25.0, 11.3)
PA self-efficacy	**1.5 (0.6, 2.5)** **	0.4 (-0.6, 1.5)	**-5.5 (-8.9, -2.1)** **	-1.5 (-6.1, 3.1)
TV avoidance self-efficacy	0.7 (-0.1, 1.6)	-	**-4.9 (-8.0, -1.9)** **	**-3.6 (-6.9, -0.3)***
Social variables				
Family (scores):				
E-games co-participation	-1.3 (-5.7, 3.1)	-	13.8 (-2.2, 29.7)	-
PA co-participation	**6.7 (3.2, 10.2)*** **	3.6 (-1.7, 9.0)	-7.9 (-18.5, 2.7)	-
TV/DVDs co-participation	-1.9 (-6.0, 2.1)	-	8.5 (-3.6, 20.7)	-
PA social support	**2.8 (1.5, 4.2)*** **	0.4 (-1.8, 2.6)	-4.3 (-9.0, 0.3)	-
SB discouragement	2.0 (-1.6, 5.6)	-	5.2 (-6.1, 16.4)	-
Friends/colleagues (scores):				
E-games co-participation	3.4 (-1.5, 8.3)	-	7.5 (-5.4, 20.5)	-
PA co-participation	2.8 (-0.3, 6.0)	-	-8.4 (-19.2, 2.3)	-
TV/DVDs co-participation	0.2 (-3.8, 4.1)	-	2.1 (-11.6, 15.8)	-
PA social support	**1.6 (0.1, 3.1)***	-0.2 (-2.1, 1.7)	-2.7 (-7.2, 1.8)	-
SB discouragement	5.4 (-0.3, 11.1)	-	-3.3 (-20.6, 14.0)	-
Social network count	0.5 (-0.0, 1.0)	-	-0.8 (-1.7, 0.2)	-
Gym membership	9.9 (-0.3, 20.0)	-	**-40.9 (-75.3, -6.5)***	-29.7 (-64.8, 5.5)

Table 8.3 Continued

	Discretionary PA mins/day at 2-year f/up B (95%CI)		**Total SB mins/day at 2-year f/up** B (95%CI)	
	Partially-adjusted model	**Fully-adjusted model, *n*=733**	**Partially-adjusted model**	**Fully-adjusted model, *n*=719**
Environmental variables				
Home environment:				
E-devices, no. of	2.4 (-1.0, 5.8)	-	-0.5 (-13.1, 12.2)	-
PA equipment, no. of	**5.3 (1.6, 9.0)****	3.1 (-0.6, 6.9)	**-13.0 (-25.1, -0.9)***	-6.9 (-19.4, 5.6)
TVs, no. of	-0.5 (-2.5, 1.2)	-	1.7 (-4.3, 7.7)	-
Neighbourhood environment (scores):				
Noise	2.0 (-1.9, 5.8)	-	1.0 (-13.2, 15.3)	-
Walking environment	0.8 (-0.6, 2.3)	-	-0.5 (-5.3, 4.4)	-
Safety	2.1 (-0.5, 4.8)	-	-0.3 (-9.9, 9.4)	-
Social cohesion	2.2 (-0.9, 5.4)	-	-1.6 (-12.2, 9.0)	-
Land use mix diversity	-0.8 (-2.7, 1.0)	-	-2.9 (-10.3, 4.5)	-
Recreation facilities	1.6 (-1.9, 5.1)	-	0.8 (-9.6, 11.3)	-

**p<0.05, **p<0.01, ***p<0.001: Mixed-effects linear regression models.*

[1] Partially-adjusted models adjusted for baseline PA/SB, age, survey mode and confounders (PA: gender, maternal education, English as the primary language spoken at home, and area-level SEP; SB: gender, paternal education, English as the primary language spoken at home, birth country and remoteness), with repeated measurements for individuals nested within schools. Fully-adjusted models additionally adjusted for significant variables from the partially-adjusted models.

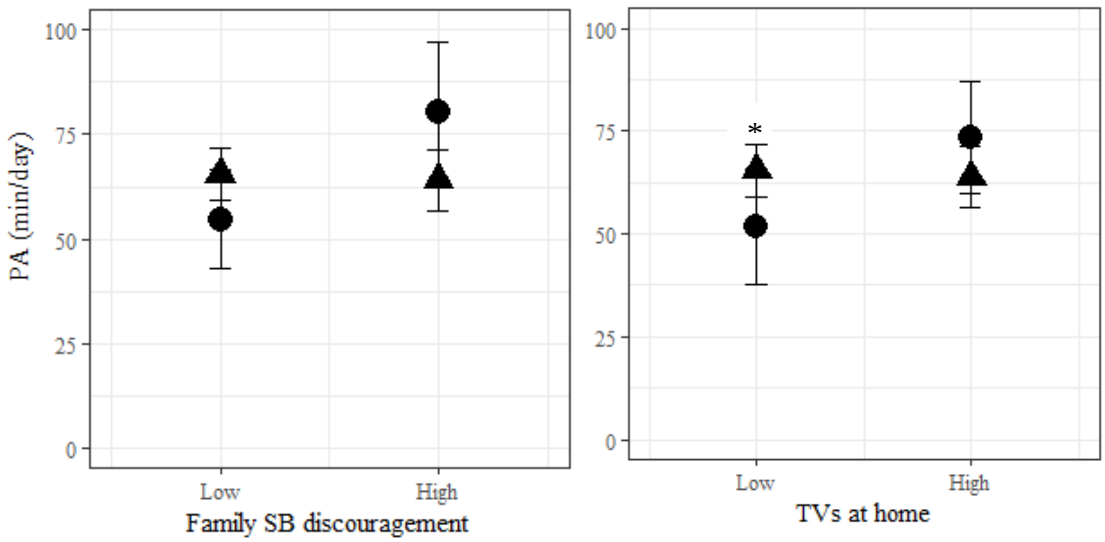
8.4.3 Moderators of associations between situational transitions and physical activity and sedentary behaviour during the transition out of secondary school

Situational transition: Tertiary student status at two-year follow-up

There was no significant association between tertiary student status after leaving school and changes in discretionary physical activity (p=0.087; Akaike's information criteria (AIC) change <2) at the two-year follow-up compared to baseline but there was for changes in total sedentary behaviour (p=0.000; AIC change >2; Appendix 7.2). For sedentary behaviour, there were no significant interactions between tertiary student status and the potential moderators (Appendix 8.2). However, receiving discouragement for sedentary behaviour from family (B:-27.0; 95%CI:-49.6, -4.5; p=0.019) and the number of televisions at the home (B:-23.5; 95%CI:-45.2, -1.8; p=0.034) at baseline moderated the associations between tertiary student status and discretionary physical activity at the two-year follow-up (Appendix 8.1; Figure 8.1). Stratified analyses showed that the low and high levels of the two moderators produced associations that differed in direction (Appendix 8.3).

In summary, those not studying at a tertiary institute reported higher discretionary physical activity compared to those studying, only among those who reported higher sedentary behaviour discouragement from family and televisions at home in Year 11.

Figure 8.1 Moderation of associations between tertiary student status and discretionary physical activity (adjusted marginal means) at the two-year follow-up, *n=796*



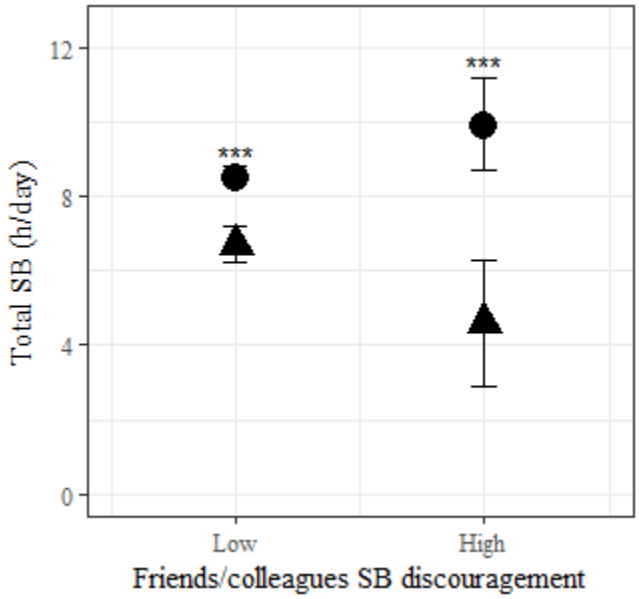
●: not studying; ▲: studying;
*p<0.05; e*rror bars: 95% confidence intervals.*

Situational transition: Working hours at two-year follow-up

There was a significant association between working hours after leaving school and changes in total sedentary behaviour at the two-year follow-up compared to baseline (p=0.000; AIC change >2; Appendix 7.2). Baseline sedentary behaviour discouragement from friends or colleagues (B:-3.5; 95%CI:-5.6, -1.3; p=0.002) moderated the associations between working hours and total sedentary behaviour at the two-year follow-up (Appendix 8.2; Figure 8.2). Stratified analyses showed that the low and high levels of the moderator produced an association that differed in strength (Appendix 8.3).

To summarise, those who worked ≥20 h/wk post-school reported lower total sedentary behaviour compared to those who worked less, and this was regardless of how much discouragement of sedentary behaviour from family in Year 11. However, the difference in total sedentary behaviour was more marked among those with high discouragement of sedentary behaviour from family in Year 11.

Figure 8.2 Moderation of associations between substantial weekly work hours and total sedentary behaviour at the two-year follow-up, adjusted marginal means, *n=804*

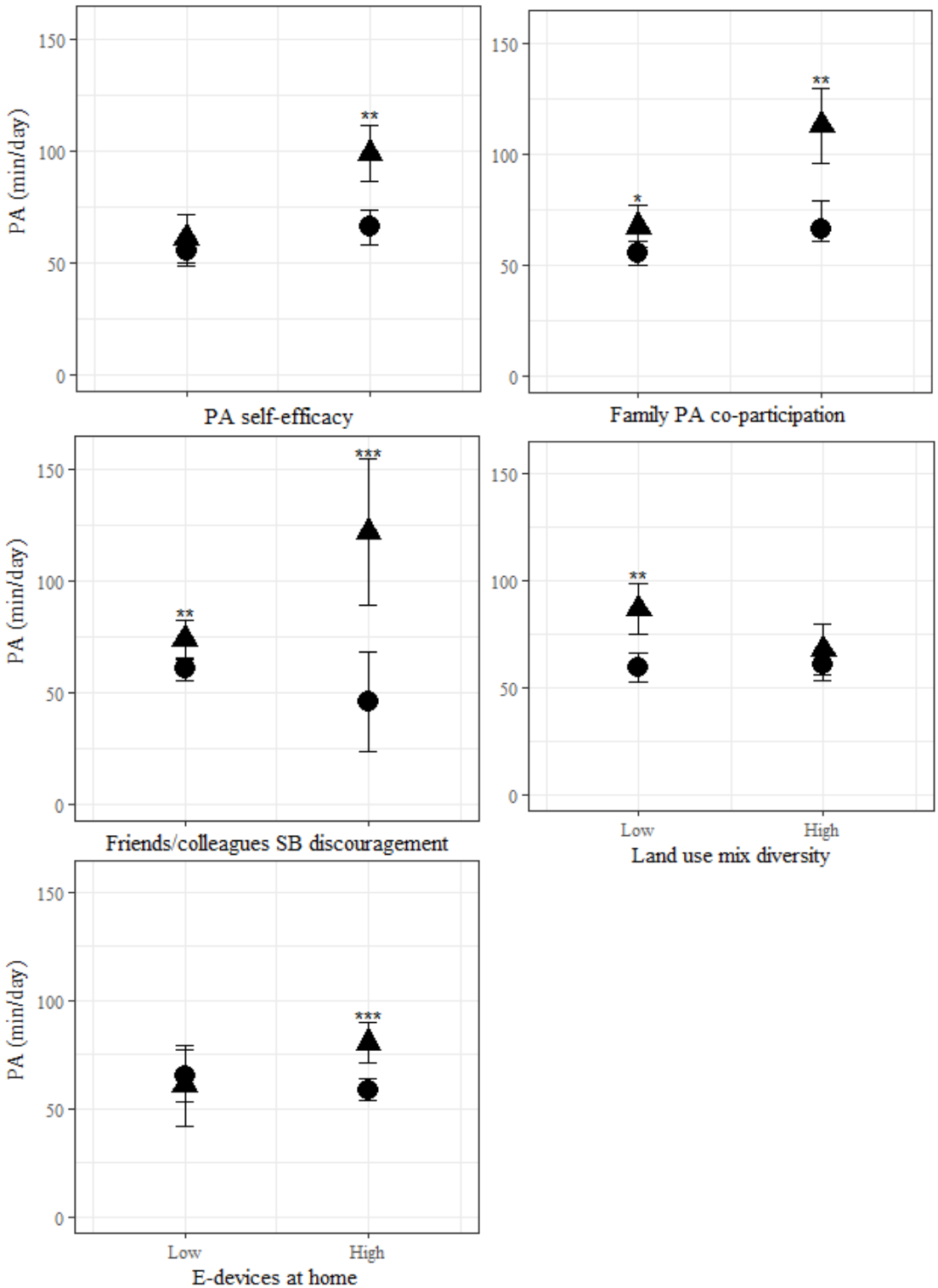


●: worked <20 h/wk; ▲: worked ≥20 h/wk;
***p<0.001; *error bars: 95% confidence intervals.*

There was no significant association between working hours after leaving school and changes in discretionary physical activity at the two-year follow-up compared to baseline (p=0.584; AIC change <2). Despite this, there were five baseline moderators of the association between working hours and discretionary physical activity at the two-year follow-up (Appendix 8.1; Figure 8.3). Firstly, the individual moderator was physical activity self-efficacy (B:27.4; 95%CI:8.1, 46.6; p=0.005). Secondly, social moderators were co-participation with family in physical activity (B:31.3; 95%CI:9.3, 53.4; p=0.005) and sedentary behaviour discouragement from friends or colleagues (B:62.6; 95%CI:21.8, 103.4; p=0.003). Lastly, environmental moderators were electronic devices at home (B:26.2; 95%CI:1.7, 50.8; p=0.036) and neighbourhood land use mix diversity (B:-20.1; 95%CI:-39.4, -0.8; p=0.041). Stratified analyses showed that the low and high levels of the moderators produced associations that differed mainly in strength, except for electronic devices at home which differed in direction (Appendix 8.3).

In summary, those working ≥20 h/wk reported markedly higher discretionary physical activity compared to those working less, only among those who had high physical activity self-efficacy, co-participation with family in physical activity, sedentary behaviour discouragement from friends or colleagues, and electronic devices at home in Year 11. Whereas the opposite pattern was evident for neighbourhood land use mix diversity (higher physical activity only among those with low scores in Year 11).

Figure 8.3 Moderation of associations between substantial weekly work hours and discretionary physical activity at the two-year follow-up, adjusted marginal means, *n=804*



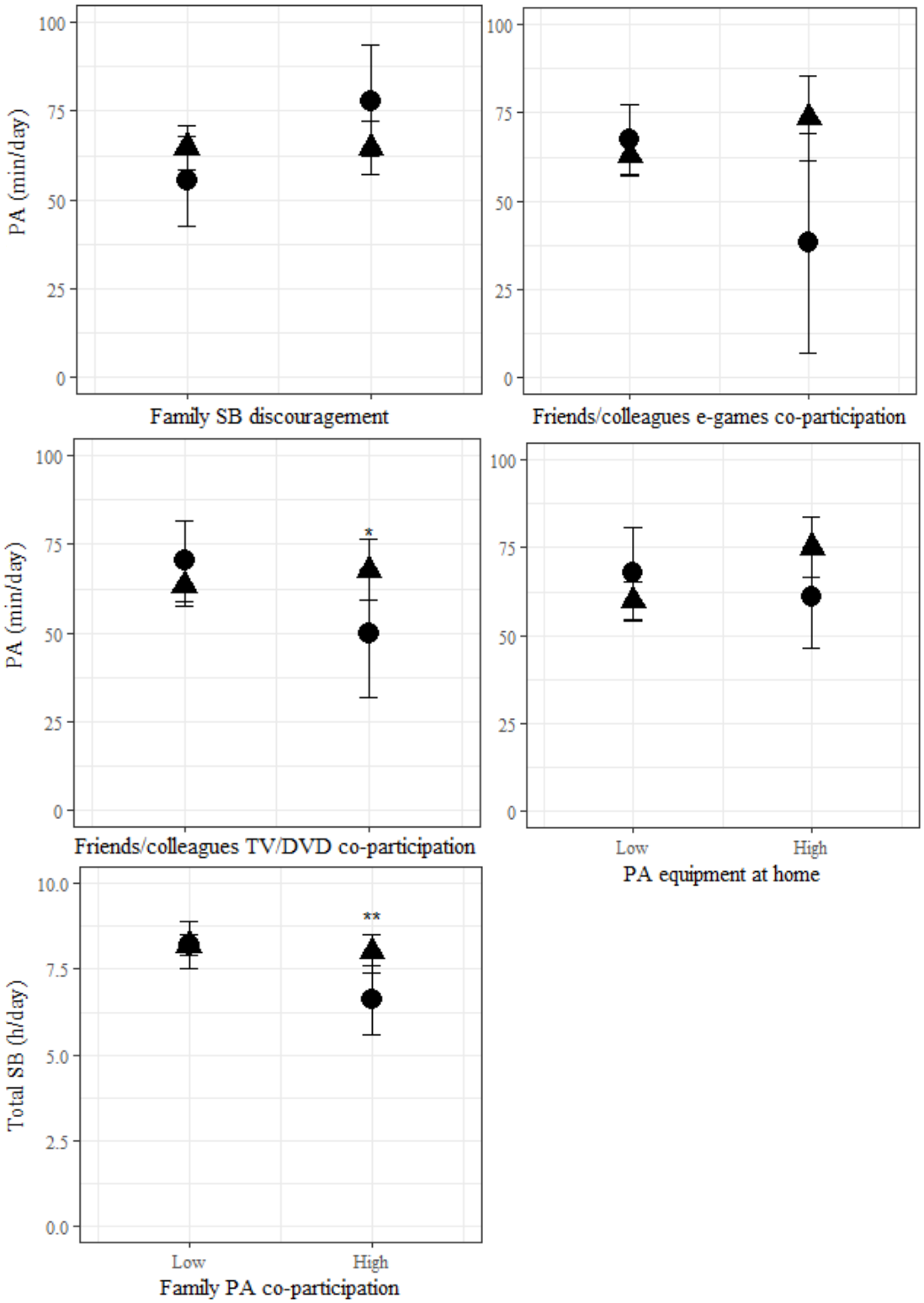
●: worked <20 h/wk; ▲: worked ≥20 h/wk;
*p<0.05, **p<0.01, ***p<0.001; *error bars: 95% confidence intervals*.

Situational transition: Living with parents status at two-year follow-up

Living with parents status after leaving school was not associated with changes in discretionary physical activity (p=0.662; AIC change <2; Appendix 7.2) at the two-year follow-up compared to baseline but was associated with changes in total sedentary behaviour (p=0.009; AIC change >2; Appendix 7.2). Family and peer environments during Year 11 moderated associations between living with parents status and discretionary physical activity and total sedentary behaviour after leaving school (Appendices 8.1-8.2; Figure 8.4). Four moderators of physical activity were discouragement of sedentary behaviour from family (B:-22.7; 95%CI:-45.2, -0.3; p=0.047), co-participation in electronic games with friends or colleagues (B:40.3; 95%CI:5.1, 75.4; p=0.025), co-participation in television or DVDs with friends or colleagues (B:24.8; 95%CI:0.9, 48.7; p=0.042), and physical activity equipment at home (B:22.4; 95%CI:0.2, 44.6; p=0.048). One moderator of sedentary behaviour was co-participation in physical activity with family (B:1.4; 95%CI:0.1, 2.8; p=0.037). Stratified analyses showed that the low and high levels of the five moderators produced associations that differed in direction, not strength (Appendix 8.3).

To summarise, among those living independently post-school, there was a pattern for higher physical activity if they received frequent sedentary behaviour discouragement from family in Year 11, lower physical activity if they had high co-participation in electronic games and in television/DVD viewing with friends or colleagues in Year 11, and lower sedentary behaviour if they had high co-participation in physical activity with family in Year 11. Whereas, those living with parents post-school had higher physical activity if they reported high levels of physical activity equipment at home in Year 11.

Figure 8.4 Moderation of associations between living with parents and discretionary physical activity or sedentary behaviour at the two-year follow-up, adjusted marginal means, *n=805*



●: lived independently; ▲: lived with parents;
*p<0.05, **p<0.01; *error bars: 95% confidence intervals.*

8.5 Discussion

This is one of the first prospective studies to examine individual, social and environmental determinants of physical activity and sedentary behaviour during the transition out of secondary school[159]. Although numerous independent variables were significantly associated in the partially-adjusted models, key determinants of physical activity were physical activity enjoyment and goal setting, while the key determinant of sedentary behaviour was television avoidance self-efficacy. This study is also one of the first to examine individual, social and environmental moderators of physical activity and sedentary behaviour in those who experience multiple situational transitions post-school[22]. Three key situational transitions post-school were tertiary study status, weekly working hours, and household composition. Moderators for the three key situational transition were mostly unique; however, discouragement of sedentary behaviour and co-participation with family, friends or colleagues in recreational screen time emerged as reoccurring moderators.

The determinants are attributes needed as a minimum for higher physical activity and lower sedentary behaviour and were individual and internalised characteristics. In contrast, the moderators found are needed during times of change and instability. Further, the moderators represent support mechanisms, were external and were characteristics that tend to change with age, such as the family or home environment or social attributes. Moderators are important in the presence of a disruptor, such as age or circumstance. Although changes in independent variables were not analysed, since the focus was to elucidate what to have in place during school that is protective, it is likely that some attributes changed over time. Nonetheless, the determinant and moderator findings highlight the high or low baseline levels of attributes that set individuals up for future health behaviours. As an example, for those who go on to live independently post-school to have higher physical activity and lower sedentary behaviour, it is recommended that they maintain physical activity equipment levels and that families co-participate in physical activity and discourage sedentary behaviour, particularly recreational screen time with friends.

The moderators were mostly social and external attributes. In contrast, the key determinants reflected internal attributes such as preferences and prioritising physical activity. These are, therefore, critical to develop during adolescence since they impact later physical activity. Three key points of interest about the moderators and key determinants are, firstly, discouragement of sedentary behaviour appears to be

important regardless of situational transition experience post-school. A pattern emerged suggesting family, friends and colleagues have an important role to play in communicating messages about reducing excessive sedentary behaviour during this transition. Secondly, healthy behaviours in place in Year 11 may help individuals cope with changes during the transition. As an example, whose who have established higher physical activity self-efficacy during school may be able to overcome barriers post-school in order to be active, such as time constraints from working substantial weekly hours. Lastly, a recommendation is that families are encouraged to co-participate in physical activity with adolescents because those who with established high levels and went onto live independently or work substantially post-school had higher physical activity.

There are multiple potential reasons for the importance of sedentary behaviour discouragement as a reoccurring moderator for physical activity and sedentary behaviour. Firstly, it may be a marker of having a social network with high health literacy which mediated the resulting high physical activity and low sedentary behaviour. Secondly, it may reflect the high dependency on peers for cultural influences during adolescence[359]. Appeasing social networks, wanting to fit in and seeking approval of peers are commonly important social goals during adolescence[360]. There is a progression from dependence on parents in childhood to peers in adolescence then self-authority in adulthood[359] which is a reason peer pressure is common during adolescence. The current data does not provide insight into whether individuals have maintained or changed their social networks compared to their friends or colleagues who delivered these messages, and this may help explain this finding. Thirdly, having family members verbalise their expectations by reminding to avoid excessive sedentary behaviour may represent parents who provide good leadership for their children's health by actively engaging with choices. These parents may have an authoritative parenting style[361] which is associated with other health benefits such as mental health, dietary behaviours and weight status, academic success and grit[362-365]. Future research could examine if study parenting styles C and D (permissive, lenient, uninvolved and negligent parenting[361]) are associated with physical activity and sedentary behaviour after leaving school and if they moderate associations between living independently or with parents post-school and health behaviours.

This study had some null findings. Firstly, it is unclear why low land use mix diversity and electronic devices are associated with higher physical activity among those who work substantial weekly hours, since literature says the opposite is helpful for physical activity during adolescence[366, 367]. The role of employment needs to be explored in future research. A potential explanation is that more disposable income allows participants access to more opportunities regardless of distance to home, compared to baseline; whereas, those with high land use mix diversity did not change physical activity as much. This is consistent with a previous study that reported that belonging to a sporting club at baseline moderated the effect size of the association between working full-time and LTPA a year post-baseline[22]. Secondly, it is unexpected that established high levels of recreational screen time with friends or colleagues in Year 11 are associated with lower physical activity after school if the individuals lived independently, as the importance of household composition over employment or study is unclear. Future research is needed to understand why the association was found for physical activity and not sedentary behaviour and whether this supports the interdependence between physical activity and sedentary behaviour. Lastly, some expected associations were not found. Social support for physical activity from family did not moderate physical activity post-school among those living independently, there were no key social and environmental determinants of physical activity and sedentary behaviour, and most of the significant determinants in the partially-adjusted models were not moderators.

Some moderation findings were similar to the perceived influences on physical activity and sedentary behaviour specific to situational transitions experienced post-school suggested in Chapter 3 by interviewees. Firstly, if responders commenced tertiary education, influences were choice of active or sedentary tertiary course, increased free time and increased hours studying; however, this current study did not assess or analyse those characteristics. Secondly, if participants commenced full-time employment, influences were increased working hours and technology access and use. This finding was similar to the number of electronic devices at home moderating the association between working hours and physical activity during the transition out of secondary school. Lastly, if interviewees moved out of the family home, influences were increased independence and less rules and boundaries from parents. This current study similarly found high sedentary behaviour discouragement from family in Year 11, potentially operationalised as a house rule or boundary, was

associated with high physical activity post-school, among those living independently post-school.

Strengths and limitations

A key strength of this chapter is that it assessed determinants and moderators of physical activity and sedentary behaviour in late adolescence during the transition out of secondary school from three levels of the ecological model[20, 21] which have not been previously revealed or adequately described. Sampling Year 11 students annually captured data on the understudied minority group of early school leavers, as well as numerous post-school pathways. However, generalisability of findings is reduced from a cohort not randomly sampled and predominantly women. An ecological model[20, 21] proved to be appropriate and applicable since individual, social and environmental moderators were found for the associations between situational transitions and physical activity or sedentary behaviour after leaving secondary school. Specific to the instrument used, self-reported physical activity and sedentary behaviour data includes bias and the high number (26) of independent variables tested may have increased the probability of finding results by chance. Additionally, two-thirds of the moderators were variables comprised of a single item from the survey, the implications of which are higher measurement error and lower instrument reliability since only one source of variance is captured[281].

Importantly, some moderators were newly discovered and were not determinants or correlates reported in Chapters 5-6. These were sedentary behaviour discouragement, the number of televisions, electronic devices and physical activity equipment at home, and land use mix diversity. However, the moderator findings should be interpreted with consideration of how situational transitions are not mutually exclusive, as evidenced by the large overlap between those who are tertiary students, working and living with parents post-school. Future research needs to assess the cumulative effect of simultaneous situational transitions on changes in physical activity and sedentary behaviour during the transition out of secondary school, and what the key individual, social and environmental attributes are that play a role in those associations.

Positively, most baseline attributes did not vary significantly between study completers and non-completers, signalling that an adjustment method did not need to be applied to weight the data from the analytical sample[368]. However, the final cohort had lower baseline levels of five independent variables and, notably, three of those were moderators (co-participation in electronic games with friends or colleagues, discouragement of sedentary behaviour from friends or colleagues and neighbourhood land use mix diversity). Therefore, those three moderation associations may have been weakened due to attrition bias. Further, while interpretation of moderation analyses was aided by stratifying the cohort by low and high levels of the baseline independent variables, a cost of dichotomising is a loss of power. In some instances, the mean or median of the cohort was the basis for the cut-point of the dichotomised variable rather than an external reference point, which may limit the specificity of the findings to this cohort and decrease the generalisability of the moderation findings to the broader population.

Alternative analytical approaches may help explain this study's findings. Firstly, this chapter analysed baseline attributes to establish what protective attributes need to be in place during secondary school to inform interventions. Future research is needed to analyse changes in independent variables and whether they mediate the association between situational transitions and changes in physical activity and sedentary behaviour during the transition out of secondary school. Secondly, similar to the correlation findings in Chapters 5-6, there were numerous significant determinants in the partially-adjusted models but most dropped out of the fully-adjusted model despite no multi-collinearity. This suggests that physical activity competence, self-efficacy and equipment are still important determinants of physical activity and sedentary behaviour during the transition out of secondary school but are not as much of a driver as physical activity enjoyment, goal setting and television avoidance self-efficacy. Mediation models may help understand these findings. Lastly, an alternative analytical approach to moderation and interaction analyses and instead of relying on means, trajectory/path analysis and latent class growth analysis (LCA)/modelling may provide more insight into the explaining mechanisms of physical activity and sedentary behaviour during the transition out secondary school.

The findings of this study have possible implications in additional areas of study, in particular, other key health behaviours during late adolescence of improving diet quality, decreasing smoking and decreasing excess alcohol consumption. Examining the individual, social and environmental moderators of associations between situational transitions experienced after leaving secondary school and other health behaviours may confirm or elucidate additional population groups to target and protective attributes that inform interventions and curriculums. For example, future research could examine longitudinal changes in meal patterns during the transition out of secondary school, especially as adolescents move out of the family home. Further, any protective attributes that, if in place during the school years, may promote resilience to poor eating behaviours in adulthood could be identified. Identifying tailored strategies to different target groups or an individual risk profile[176] is important for informing interventions and has been implemented in studies aimed at changing health behaviours of diet, smoking, alcohol consumption and breast cancer screening[177, 178].

Conclusion

Physical activity enjoyment, goal setting and television avoidance self-efficacy emerged as key determinants of later physical activity and sedentary behaviour. Further, sedentary behaviour discouragement and recreational screen time co-participation with friends, family and colleagues emerged as reoccurring moderators of physical activity and sedentary behaviour for the situational transitions of weekly work hours, household composition and tertiary study status. The determinant and moderator findings highlight what attributes are protective against inadequate physical activity and excessive sedentary behaviour during the transition out of secondary school. The findings also highlight whether high or low levels of these attributes need to be established during secondary school. Future research needs to identify efficacious and feasible strategies that influence these insulating attributes prior to the transition out of secondary school, followed by a translational approach of embedding scalable strategies into curriculums, interventions and community health promotion initiatives.

Chapter 9

Conclusions

9.1 Introduction

This thesis was designed to contribute to the field of behavioural epidemiology[19]. Specifically, this thesis aimed to:

1. Examine physical activity and sedentary behaviour changes during the transition out of secondary school; and
2. Examine individual, social and environmental influences on physical activity and sedentary behaviour during the transition out of secondary school.

This thesis utilised a mixed methods approach and used data from three research projects to address the thesis aims. Firstly, a qualitative investigation was conducted using semi-structured interviews. The second and third projects were part of a larger observational longitudinal study (ProjectADAPT) and included a test-retest reliability study. This chapter discusses the overall findings of the thesis in relation to the life transition model[18] and the ecological model[20, 21], summarises key strengths and limitations, and proposes implications for future research directions and practice.

9.2 Overview of findings

This section synthesises the main findings around two themes. The first concerns how much physical activity and sedentary behaviour older adolescents engaged in during the transition, the second concerns the common influences underlying these health behaviours.

9.2.1 Behaviour pattern changes

This thesis found that physical activity and sedentary behaviour tend to change as older adolescents transition out of secondary school, with few maintaining these behaviours. This was apparent in both the qualitative and quantitative studies and supports the hypothesis of the life transition model[18] and the findings from two systematic reviews[8, 10] that transitions are times of instability and variability that may disrupt health behaviours. The qualitative study indicated that not all recent school leavers change physical activity and sedentary behaviour in the same way, with ~84% increasing or decreasing. The quantitative study found mean discretionary physical activity and total sedentary behaviour declined. Despite the latter, recreational screen time increased and participants suggested this was due to more

free time post-school and less boundaries after moving out of the family home. The situational transitions post-school of working ≥20 h/wk, exclusively working, not studying, and living independently resulted in declines in total sedentary behaviour over transition out of secondary school (in order of greatest declines), whereas there were no interactions between time and situational transitions for discretionary physical activity.

9.2.2 Interventions leverage points

The influences underlying physical activity and sedentary behaviour had a number of commonalities. In the quantitative study, physical activity goal setting and enjoyment were associated with physical activity during secondary school and during the transition. This suggests that physical activity may be lower and decline if it is not prioritised and liked because of late adolescence being a busy life stage with competing demands on time from socialising, study and work. For both physical activity and sedentary behaviour, physical activity goal setting was a correlate during secondary school, and sedentary behaviour discouragement and co-participation with social networks were moderators for multiple situational transitions. Lastly, in the qualitative study, social support was considered to be a major influence on physical activity and sedentary behaviour changes during the transition out of secondary school. Therefore, physical activity goal setting and enjoyment, sedentary behaviour discouragement, co-participation and social support are key leverage points to focus strategies on within interventions for older adolescents, irrespective of students' demographic characteristics or the situational transitions experienced post-school. Future research needs to examine the practicalities of increasing these influences.

Physical activity and sedentary behaviour were cross-sectionally correlated with more individual attributes than social or environmental. This contrasted the longitudinal findings to an extent, with more social than individual or environmental attributes associated with physical activity and sedentary behaviour post-school. Further, most of the helpful (i.e., associated with higher physical activity or lower sedentary behaviour) moderators in those who were working ≥20 h/wk, not studying or living independently post-school were social attributes. These findings inform the focus of interventions during secondary school, support the sociable natures and social needs of adolescents[23], and support the use of the ecological model[20, 21] to understand the influences on older adolescents' health behaviours.

9.3 Strengths and limitations

9.3.1 Strengths

A key strength of this thesis was its novel focus on the impact of the transition period of leaving secondary school on physical activity and sedentary behaviour, since there has been limited research on this issue. This thesis has contributed to the field of behavioural epidemiology by addressing this gap. Most previous studies have included predominantly retrospective quantitative designs or did not survey students while at secondary school[118, 170, 171, 173], or were based on a limited range of situational transitions[118, 125, 170-173]. This thesis utilised prospective quantitative data during the transition, which few other studies have[159], as well as retrospective qualitative data. Another key strength of this thesis is that it measured physical activity and sedentary behaviour, while previous studies measured physical activity only[118, 173]. Sedentary behaviour is important to assess as it is increasingly being recognised as a threat to health and wellbeing, especially excessive prolonged (uninterrupted) sedentary behaviour[109].

An important strength of this thesis was that it identified moderators, which are under-researched when studying explanations for why older adolescents engage in higher or lower physical activity and sedentary behaviour during the transition out of secondary school. Also, it provides insights into modifiable attributes to inform interventions, in contrast to commonly tested biological and demographic characteristics[369]. Further, the large range of modifiable attributes measured were from across the individual, social and environmental levels of the ecological model[20, 21], whereas many previous studies about influences on physical activity and sedentary behaviour in adolescence assessed attributes from only one level (mainly social)[160, 162-164].

Another key strength of this thesis is that is utilised a mixed methods approach. The inductive qualitative study informed the quantitative study. Although baseline had already commenced for ProjectADAPT, the qualitative findings informed future waves of ProjectADAPT and were critical for interpreting survey findings. The test-retest reliability performed on the ProjectADAPT survey added further rigour to this thesis. This methodological study provided insight into the internal validity of ProjectADAPT and also informed interpretation of findings. This was important since some survey items were amended from original sources and others were newly

developed. The key strengths of the ProjectADAPT study specifically include an adequate cohort of >1 000 older adolescents at baseline, drawn from six areas (lowest, mid and highest tertiles of socio-economic areas from urban or rural remoteness), and high retention.

9.3.2 Limitations

There are two main limitations of this thesis. The first is that this thesis employed self-reported measures to assess physical activity and sedentary behaviour and underlying influences. Self-reported data are limited by human recall errors and social desirability response bias[370], suggesting that physical activity may be overestimated and sedentary behaviour may be underestimated. Although, the ProjectADAPT survey had acceptable test-retest reliability and internal validity, and the associations found were logical and reasonable. However, criterion validity of the behavioural items (physical activity and sedentary behaviour measurement; dependent variables) was not determined, nor was construct and content validity (face validity) of the influence items (independent variables). Previous validity testing may not apply to the newly developed items, amended items or to the population of older adolescents[54, 68, 220, 371]; therefore, a validity study using this age group is needed that addresses these limitations, particularly for the dependent measures. Future research about changes in physical activity and sedentary behaviour should use device-based measurement tools concurrently with a log book to reduce bias, improve reliability and validity, and provide more sensitive data on prolonged sitting, short and long bouts of behaviour, and the timing of these behaviours.

The second main limitation relates to the generalisability of findings to the broader youth population. Due to a range of recruitment difficulties during the ProjectADAPT study, two recruitment strategies were adopted (school recruitment and social media). However, the non-random sample comprised mostly of young women (74% vs 49% of 17-year-old Victorians[263]). Because of the disproportionate gender distribution potentially causing a lack of power for boys, gender was adjusted for in many analyses, as opposed to other studies on physical activity in adolescence stratifying influences by gender[372]. Additionally, there was a higher proportion of the cohort living in a rural area than population averages (29% of the baseline cohort vs 9% of Victorians[264]). Further, study completers differed to non-completers such that their baseline discretionary physical activity was lower, total sedentary behaviour

was higher and more were recruited via social media, completed the surveys online and identified as a woman. Future research would benefit from a random and representative sample.

9.4 Implications

9.4.1 Future research implications

There are two key areas for future research arising from this thesis. The first concerns the need for additional studies to understand, explain and expand some of this thesis' findings, especially null and unexpected findings on how and why physical activity and sedentary behaviour change during the transition out of secondary school. The second area concerns development and testing of strategies based on this thesis' findings to implement within interventions and translational research.

Understanding how and why physical activity and sedentary behaviour change during the transition out of secondary school

This thesis examined influences on physical activity and sedentary behaviour. Future research could also consider influences on complying with National Guidelines and domain-specific behaviours to inform more targeted interventions. In addition, there is emerging literature examining how various types of physical activity and sedentary behaviour cluster in older adolescents[313, 373, 374]. Future research could examine clusters of these behaviours and how these typologies change during the transition out of secondary school, exposing new information on resilient and at-risk older adolescents, which follows a resilience model of health research[174]. A range of modifiable health behaviours, such as meal patterns, alcohol consumption, cigarette smoking and illicit drug use, could also be included in such research to identify health-promoting and health-adverse clusters, or different combinations, and their attributing factors. This is similar to recent studies of tertiary students in Ireland[375, 376].

An analytical method that may further advance understanding of why behaviour changes during the transition out of secondary school is examining mediators of associations between situational transitions and changes in physical activity and sedentary behaviour. Mediation analyses could also be used in future research using larger samples to assess whether physical activity and sedentary behaviour mediate changes in health outcomes over time. Another analytical method for use in future research is examining how changes in influences over time may impact physical activity and sedentary behaviour. For example, the provision of parental support may decline as adolescents transition out of secondary school and progress to becoming fully independent, and this may partially explain changes in physical activity and sedentary behaviour during the transition period. Studying changes associated with relocation may also be helpful. Among those who relocate, the physical environment is likely to change and the environment during secondary school may be less important for changes in physical activity and sedentary behaviour than this shift in real or perceived physical activity supportiveness of the new environment.

The environments that the ProjectADAPT study assessed were neighbourhood, home and family; however, adolescents are also exposed to other environments. To address the lack of environmental influences identified in this thesis, future research should examine time in LPA and physical activity during school and work hours, as well as how school and workplace conditions during secondary school influence physical activity and sedentary behaviour changes during the transition into adulthood. For example, facility access and prompts and cues to sit at school that create social norms may be influential[21]. A future research question could be whether students exposed to activity-permissive classroom environments during school engage in less prolonged sitting over time. Another consideration for future research on environmental influences is using objective measures, although limitations include imposed and minimally relevant buffers. Attributes such as walkability characteristics, walking and cycling infrastructure, and employment density could be assessed via a Geographical Information System (GIS) software package[377] or auditing of streetscapes via desk-top or in-person[377-379]. Objective measures are more specific and sensitive to changes, whereas most self-reported environment measures are usually very general and related to awareness of surroundings. Lastly, to identify environmental influences, particularly on sedentary behaviour, qualitative studies

need to be conducted to uncover important and modifiable characteristics in the built, physical, school, work, home and neighbourhood environments.

Changes in physical activity were not associated with situational transitions in this thesis. Although this may reflect that adolescents tend to similarly change physical activity regardless of post-school pathway, studies with different methodological approaches are needed. Group-based trajectory analyses could explore whether everyone tends to change physical activity in the same way or if there are groups of people who might be more resilient to change than others[380]. Additionally, studies with larger samples would allow a broader range of situational transitions to be analysed, including multiple combinations of simultaneous post-school pathways and their cumulative effects on physical activity and sedentary behaviour.

Future interventions

The findings of this thesis highlight a need for interventions to boost the influences identified so adolescents are resilient to a decrease in physical activity and an increase in sedentary behaviour during the transition out of secondary school. Such preventative interventions would lead to the final stage of the Behavioural Epidemiology Framework of implementing translational research into practise[19]. An important next step would be to identify efficacious, feasible and scalable strategies that target older adolescents and their physical activity goal setting, enjoyment, self-efficacy and equipment at home, television avoidance self-efficacy, sedentary behaviour discouragement from family, friends and colleagues, co-participation in physical activity with family, and co-participation in recreational screen time with friends and colleagues. Further, future research is needed to confirm optimal timing of interventions and whether late adolescence is too late to increase some attributes such as physical activity enjoyment and if interventions are needed that commence in mid or early adolescence, or childhood. This is evidenced by declines in physical activity throughout adolescence; for example, sport participation reduced in Australian children from 66% for 12-14-year-olds to 60% for 9-11-year-olds[381]. Lastly, pinpointing settings to deliver strategies based on this thesis' findings is critically important. For adolescents about to transition out of school, the secondary school and tertiary settings, and families and communities are likely to be the most important settings to intervene. Implications for these settings are outlined in the following section.

9.4.2 Practice implications

Secondary schools

This thesis' findings pointed to the role of student empowerment, voice and engagement which suggests employing school-based positive psychology interventions or evidence-based coaching. These student well-being programs could have a co-design process and be embedded into pastoral care or the curriculum in established subjects such as Arts, Health Development, or Religion. Targeted information delivered could focus on influencing the key correlates, determinants and moderators identified in this thesis, such as each individual's physical activity goal setting, self-efficacy and enjoyment, and promoting the key role students can play in discouraging their friends, family and colleagues from engaging in sedentary behaviour.

This thesis found a low proportion of physical activity and high proportion of sedentary behaviour during school breaks. Therefore, schools should offer more options and modes of physical activity for older adolescents during recess and lunch times and implement policies that discourage sedentary behaviour to create a supportive culture where movement is the norm. Physical activity interventions during school breaks have had some success for adolescents[382-384], despite challenges such as inactive norms, social anxieties and peer judgement[385]. An after-school intervention also had success for adolescents in increasing physical activity and decreasing recreational sedentary behaviour, as well as improving health outcomes of lower waist circumference, waist to height ratio, BMI, BMI-z-score and scores on an unhealthy foods index, and higher self-esteem)[386]. Schools should promote active transport to school, especially to older adolescents living within 4km of school[387], as well as sports to decrease overweight/obesity[78].

Participants' recommendations could be explored, including introducing policies and resources that support active breaks during class and less sedentary lessons (e.g. using sit-stand desks), walking classrooms and linking students to community sport. Early work on the efficacy of these strategies in secondary schools appears promising, such as sit-stand desks and prompts[388], standing classrooms[389], flexible learning spaces[390] and links to community sport[146].

Tertiary institutions

This thesis' findings have broad implications for tertiary institutions. Participants suggested policies and resources are needed in tertiary institutions that support spending time outside in between classes, sit-stand desks in rooms, active breaks during lessons, and outdoor learning. Sit-stand desk interventions in tertiary institutions are efficacious[391, 392] and, broadly, systematic reviews and a meta-analysis found mixed findings for the efficacy of physical activity interventions in tertiary institutions[393, 394]. Students with minimal or nil on-campus contact hours can receive interventions via electronic-mail, mobile phone and web-based platforms, as these delivery methods were efficacious, feasible and acceptable for tertiary students in physical activity interventions[395-398]. Policies for increasing physical activity and decreasing sedentary behaviour at tertiary institutions could be based on the Okanagan international charter for health-promoting universities[399, 400]. Orientation week is an opportune time to provide information that aims to increase physical activity and decrease sedentary behaviour and campuses typically have recreational facilities on-site available to be utilised[401].

Current findings suggest that improved active and public transport around campuses are needed, especially if the increase in sedentary transport during the transition out of secondary school was based on private car use. An active transport intervention delivered to tertiary students via a smartphone application, social media and social marketing was efficacious[402]. At the on-campus student residences, different built environment factors may impact physical activity[403] and all have experienced a change in place of residence and do not live with parents. Therefore, tailored information could be delivered to these students with at-risk levels of moderators for those living independently (high co-participation in electronic games, television and DVD viewing with friends or colleagues) that are associated with lower physical activity and higher sedentary behaviour during the transition out of secondary school. For this target group, there has been an efficacious physical activity intervention consisting of peer-delivered information, structured activities, group challenges, a guidebook and behaviour change techniques[404].

Workplaces

Participants suggested some recommendations for workplaces to increase physical activity and decrease sedentary behaviour. These included employers supporting employees to exercise and participate in fitness classes, creating physical activity challenges between employees, and providing opportunities for employees to stand more during meetings and via sit-stand furniture in offices.

Family and community settings

Families should encourage adolescent children to move more and sit less since there was much scope to increase physical activity and decrease sedentary behaviour in late adolescence, especially considering the 8% decline in compliance with National Physical Activity and Sedentary Behaviour Guidelines observed during this study. This thesis found suggestive evidence on how to do this, including parents participating in physical activity with adolescent children, discouraging sedentary behaviour, especially excessive prolonged sitting, and providing access to physical activity equipment in the home. Participants recommended that families walk their dog together frequently and create limits for television watching. Future research is needed that identifies efficacious, feasible and scalable strategies that promote parents providing consistent supportive messages to adolescent children in relation to increasing physical activity and decreasing sedentary behaviour. This is especially true as the dependency on parents that is prominent during childhood decreases and partially shifts to peers in adolescence[359].

Physical activity enjoyment was associated with higher physical activity cross-sectionally and longitudinally. To target this influence, families should encourage participation in a range of physical activities during childhood and early adolescence to identity preferred physical activities before late adolescence. The moderation findings suggest that families should create a home environment where norms encourage physical activity and discourage sedentary behaviour. This is to equip adolescents with coping and resilience skills prior to leaving secondary school, leaving home, starting tertiary study and commencing employment to resist the impact of these situational transitions. Despite the importance of parental concern, rules and regulation on adolescents' physical activity and sedentary behaviour[405-408], the above recommendations for families should be delivered earlier than adolescence-onset and prior to the common decline in physical activity after late

childhood[17, 381]. This is because parents may be more receptive to messages when their children are younger[409, 410] and may be able to have more impact on preventing inadequate physical activity and excessive sedentary behaviour.

The aforementioned recommendations should be reflected in parenting advice services delivered in settings such as schools and communities. An efficacious example is a transdisciplinary study that increased Icelandic youth engagement and improved health behaviours[411]. This study delivered specific resources and strategies to parents in a school setting, as well as free community sport memberships, ideas for schools, and formed partnerships between community youth organisations and public health policy-makers within local governments. The study was successful in strengthening the evidence that youth engagement is a protective attribute and mechanism, that may also decrease other harmful health behaviours such as inadequate physical activity and excessive sedentary behaviour.

9.5 Conclusion

This thesis contributes to the field of behavioural epidemiology by identifying how physical activity and sedentary behaviour change during the transition out of secondary school and modifiable individual, social and environmental influences underlying these two health behaviours. Physical activity and sedentary behaviour changed in mixed directions in the qualitative study and, in the quantitative study, physical activity declined after Year 11 and sedentary behaviour declined after Year 12; the second last and last year of secondary schooling, respectively. The situational transitions of working ≥20 h/wk and/or exclusively working post-school resulted in the greatest declines in total sedentary behaviour over time. Correlates and determinants of physical activity and sedentary behaviour were mostly individual attributes, including physical activity goal setting, self-efficacy and enjoyment. In contrast, predominantly social attributes such as sedentary behaviour discouragement and co-participation with family, friends or colleagues moderated associations between situational transitions and physical activity and sedentary behaviour. Effective, feasible and scalable strategies are needed to target the influences found in multiple settings, including secondary schools, tertiary institutions, families and communities. This may insulate older adolescents to the impact of the transition out of secondary school and result in the adoption and maintenance of higher physical activity and lower sedentary behaviour over time which are associated with positive health outcomes in adolescence and later adulthood.

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Appendices

Appendix 2.1 Summary of prospective longitudinal studies of tracking of physical activity during the transition from adolescence to adulthood

Study (if applicable) and authors	**Country**	***n***	**Age at baseline** (years)	**Follow-up duration** (years)	**Measures**	**Tracking**	**Mean change**
Norwegian Longitudinal Health Behavior Study. Anderssen, Wold and Torsheim, 2005[132]	Norway	557	13	8 (6 follow-ups at intervals of 1-2y)	Self-reported frequency and duration of PA.	Weak tracking of PA frequency (females: r=0.18, $p<0.01$; males: r=0.22, $p<0.001$) and duration (females: r=0.25, $p<0.001$; males: r=0.27, $p<0.001$).	Proportion active ≥2 times/wk were 72% at 13y, 56%, at 16y, 46% at 19y, and 50% at 21y (females) vs 85%, 66%, 52%, and 53% (males).
Barnekow-Bergkvist et al., 1996[412]	Sweden	373	15-18	18	Self-reported survey on number of leisure-time sports activities and memberships of sports clubs, and attitude to sports activities, sports performances and PE lessons.	No tracking in females (r=0.0) or males (r=0.1).	Proportion of LTPA participation ↑51-63% (females) and ↓69-65% (males).
Young Hearts Project. Boreham et al., 2004[106]	Northern Ireland	476	15	7	Self-reported PA (transport, during school breaks, after school sport).	Poor tracking of PA in females (k=0.021) and low (k=0.202) in males.	Incomparable PA scores were calculated at baseline[413] and follow-up[414].

Appendix 2.1 Continued

Study (if applicable) and authors	**Country**	***n***	**Age at baseline** (years)	**Follow-up duration** (years)	**Measures**	**Tracking**	**Mean change**
Quebec Family study. Campbell et al., 2001[186]	Canada	153	8-18	12	Self-reported 3-day recall survey.	No tracking of MVPA in females (r=0.22; NS) or males (r=0.14; NS).	Not reported.
Childhood Determinants of Adult Health study. Cleland, Dwyer and Venn, 2011[136]	Australia	2 201	9-15	20	Self-reported questionnaire and pedometer.	Weak tracking of PA (r=−0.08–0.14).	Total PA 13-15y ↑333 mins/wk (females) and 241 mins/wk (males). LTPA ↓102 mins/wk (females) and 164 mins/wk (males).
Glenmark et al., 1994[415]	Sweden	105	16	11	Self-reported LTPA.	Baseline duration of PA, frequency of PA, frequency of competitive PA, and PA index (range: 5.5-18) were associated with PA index at follow-up.	Sport club membership ↓52-45% (females) and 79-52% (males).
Childhood Determinants of Adult Health study. Jose et al., 2011[213]	Australia	2 048	7-15	19-21	Self-reported LTPA, PA attitudes, and sport competency.	Not reported.	30.3% remained inactive, 49.8% remained variably active and 19.9% remained active.

Appendix 2.1 Continued

Study (if applicable) and authors	**Country**	***n***	**Age at baseline** (years)	**Follow-up duration** (years)	**Measures**	**Tracking**	**Mean change**
Norwegian Longitudinal Health Behaviour study. Kjønniksen, Torsheim and Wold, 2008[133]	Norway	630	13	10	Self-reported LTPA and recreational PA (sport).	Not reported.	LTPA↓ in females (B=-0.1; SE=0.01) and males (B=-0.17; SE=0.01). Recreational PA↓ in females (B=-0.09; SE=0.01) and males (B=-0.12; SE=0.01). Those active ≥4 days/wk at baseline, reduced this level to 2-2.5 days/wk at follow-up. Types of PA↓ from 5.7±3.49 to 3.5±2.33 (females) and 7.5±5.22 to 4.0±2.83 (males).
Canada's National Population Health Survey. Kwan et al., 2012[135]	Canada	640	12-15	14 (6 follow-ups at 2-year intervals)	Self-reported types of LTPA.	Tracking coefficient = -0.105, SE=0.03, p<0.01)	Duration of LTPA↓ by 17% (females) and 30% (males).
Northern Finland birth cohort. Tammelin et al., 2003[134]	Finland	7 794	14	17	Self-reported participation in leisure-time sport, club membership and PE grade. At follow-up the survey asked about frequency, intensity and duration or LTPA.	Low PE grade associated with adult low PA in males (OR= 1.29; 95%CI=1.07–1.56; adj. for adolescent PA).	LTPA participation ≥4 times/wk↓ 27.5-11.5% (females) and 47.9-13.4% (males).

Appendix 2.1 Continued

Study (if applicable) and authors	**Country**	***n***	**Age at baseline** (years)	**Follow-up duration** (years)	**Measures**	**Tracking**	**Mean change**
Cardiovascular Risk in Young Finns study. Telama et al., 1997[416]	Finland	2 309	9-18	9 and 12	Self-reported school sport participation, school PE, and LTPA type, duration and intensity.	Significant but low tracking. Correlation coefficients after 9y ranged from 0.18-0.47, and 0.00-0.27 after 12y. Strongest associations with later PA were with baseline competitive sport participation and school PE grade.	Not reported.
Cardiovascular Risk in Young Finns study. Telama et al., 2005[131]	Finland	1 563	3-18	18 (5 follow-ups at 3-year intervals)	Self-reported active commute, school PE, and LTPA type, duration and intensity.	High PA predicted high adulthood PA. Females less likely than males to track PA into adulthood. Tracking coefficient from 9-24y was 0.21 for females and 0.31 for males.	Not reported.
Cardiovascular Risk in Young Finns study. Telama et al., 2006[137]	Finland	1 606	9-18	21	Self-reported validated survey about organised sport participation and its training frequency. Follow-up survey contained frequency, duration, and intensity of PA.	Frequent organised sport participation at baseline increased the probability of being highly active at follow-up: OR=6, 95%CI=2.38-15.14 in females; and OR=5.11, CI=2.88-9.08 in males.	Not reported.

Appendix 2.1 Continued

Study (if applicable) and authors	**Country**	***n***	**Age at baseline** (years)	**Follow-up duration** (years)	**Measures**	**Tracking**	**Mean change**
Trois-Rivières Growth and Development study. Trudeau et al., 2004[214]	Canada	166	10-12	23-25	Self-reported weekly duration of total, vigorous-intensity, light-intensity, and organised PA.	Significant but weak tracking between childhood and adulthood total PA (r=0.2), vigorous PA (r=0.18), organised PA (r=0.12).	Not reported.
Amsterdam Growth and Health study. Twisk et al., 2000[85]	Netherlands	181	13	14	Interviews. Self-reported frequency, intensity and duration of total PA of the last three months.	Daily PA tracked low-moderately and significantly: stability coefficient was 0.34 (95%CI=0.19-0.49); OR=3.6 (CI=2.4-5.4).	Mean daily PA change (1 000 METs/wk) decreased 3.81±1.7-3.18±1.9 (females) and 4.99±2.0-2.91±2.3 (males).

±: standard deviation; CI: confidence interval; LTPA: leisure-time physical activity; METs: metabolic equivalent tasks; MVPA: moderate- to vigorous-intensity physical activity; NS: not significant; OR: odds ratio; PA: physical activity; PE: physical education; SE: standard error; y: years.

Appendix 3.1 Consolidated criteria for reporting qualitative research (COREQ) guidelines[195]

No	Item	Guide questions/description
Domain 1: Research team and reflexivity		
Personal Characteristics		
1.	Interviewer/facilitator	Jennifer Hatt.
2.	Credentials	BEx&SS(Hons).
3.	Occupation	PhD candidate.
4.	Gender	Sex: female. Gender: I identify as a woman.
5.	Experience and training	Research Assistant experience with Quantitative studies. Limited Qualitative training.
Relationship with participants		
6.	Relationship established	One participant was a first cousin once removed and another participant was a cousin-in-law. Otherwise, no.
7.	Participant knowledge of the interviewer	Occupation.
8.	Interviewer characteristics	Gender and undergraduate degree qualification.
Domain 2: study design		
Theoretical framework		
9.	Methodological orientation and Theory	The ecological model[20, 21] and the life transition model[18].
Participant selection		
10.	Sampling	Convenience and snowball.
11.	Method of approach	Convenience sampling, flyers, snowball sampling and social media.
12.	Sample size	29
13.	Non-participation	None.
Setting		
14.	Setting of data collection	Interviewer at place of study; participant at home (*n*=24), travelling (*n*=1) or face-to-face at place of study (*n*=4).
15.	Presence of non-participants	Yes, for four interviews: One Mum, two Dads, and members of the public on a train.
16.	Description of sample	See 3.4.1. Gender equal. All lived in an urban area. Most were 19-years-old, finished secondary school >1-year ago, living in a least-disadvantaged neighbourhood (the highest tertile of socio-economic area), and were concurrently working and studying.

Appendix 3.1 Continued

Data collection		
17.	Interview guide	Appendix 3.2. Questions, prompts, guides were pilot-tested and used.
18.	Repeat interviews	No.
19.	Audio/visual recording	Audio recording.
20.	Field notes	Few made during and/or after the interviews.
21.	Duration	Range: 11-30 mins. Mean 20.9±6.1 mins (SD)
22.	Data saturation	Yes. Rolling recruitment ceased at *n*=29.
23.	Transcripts returned	No.
Domain 3: analysis and findings		
Data analysis		
24.	Number of data coders	Two for 10% of sample. Dr. Felicity Pendergast and Jennifer Hatt. Otherwise, one.
25.	Description of the coding tree	Appendix 3.3. 75 codes sectioned into six categories.
26.	Derivation of themes	Derived from data.
27.	Software	QSR NVivo 12
28.	Participant checking	No.
Reporting		
29.	Quotations presented	Yes, and quotes identified via participant demographic characteristics.
30.	Data and findings consistent	Yes.
31.	Clarity of major themes	Major themes clearly presented in the findings.
32.	Clarity of minor themes	Diverse cases described and discussion.

Appendix 3.2 Qualitative study interview topic guide

[Preamble]
Hi,
This is Jenny Hatt from the LEAP study at Deakin University. How are you?
I am just calling to conduct the LEAP interview that you volunteered for. This interview is expected to take between 20-40 minutes; is that okay?
Okay, great. [*If no, arrange alternative time to call*]

Thank you for agreeing to take part in this study.
This interview is about your experiences and viewpoints about physical activity and sedentary behaviour over your transition out of high school. Very few studies have researched experiences during the transition out of high school.
I will record the interview, but your personal details will be kept confidential. There are no right or wrong answers. You do not need to answer questions that you would rather not. You can end the interview at any time for any reason. Is all of that okay?
Do you have any questions before we start?
Okay great.
[Start recording]

You indicated that you left school in 20xx. Can you tell me in what ways your life changed after leaving school?
[Clarification, examples, prompts if needed:]

- *Did you go straight to University or get a job?*
- *Travel, take time off?*
- *Did you move out of home?*
- *Did expectations of you at home change [if applicable]? Do you have more responsibilities now, do more chores or pay board?*
- *Did your friendship groups and social life change?*
- *Did you get your license and a car?*

I am now going to ask you about physical activity which means 'any bodily movement produced by skeletal muscles that requires energy expenditure'. Examples are walking, jogging, cycling, playing sport, swimming, non-organised things such as playing with a basketball or Frisbee, or other tasks like shopping and chores.
Can you please describe your physical activity when you were still at school? /How active were you when you were went to school?
[Clarification, examples, prompts if needed:]

- *Did you walk or cycle for transport - to/from school, to shops, friends' houses?*
- *Physical activity at school: Physical education classes, active during recess and lunch?*
- *Were you on any sports teams or have a gymnasium membership?*
- *Did you do any non-organised physical activity so going for walks or bike rides, shooting hoops?*
- *Did you have a job while you were at school and did you mainly sit, stand or move?*
- *Physical activity at home; e.g. chores, gardening?*

Can you please describe your physical activity now? Have there been any changes? More/less/same? / How active are you now?
[Clarification, examples, prompts if needed:]

- *Do you walk or cycle for transport - to/from university, work, shops, friends' houses? More, less or the same as when at school?*
- *Are you on any sports teams or have a gymnasium membership? More, less or the same as when at school?*
- *Do you do any non-organised physical activity in your leisure-time so walking, cycling, shooting hoops with family or friends? More, less or the same as when at school?*
- *Do you have a job now? Do you mainly sit, stand or move at your work? More, less or the same as when at school?*
- *Physical activity at home; e.g. chores? Mostly sit, stand, or move? More, less or the same as when at school?*
- *Physical activity at university: mostly sit, stand, or move? More, less or the same as when at school?*

Can you please summarise how your physical activity has changed since you left high school?
It is interesting that you mentioned that you did different physical activity while you were at school, compared to now. I'd like to pick up on that and hear a bit more about it. Can you list some reasons for that change?
Can you think of any other reasons?
Was there one particular influence that was more important than the others?
[If few self-identified reasons provided, prompt for the situational transitions after school (from the start of the interview) if not provided as reasons.]

- *How does your university influence how much physical activity you do?*
- *How does your work influence how much physical activity you do?*
- *How does your moved to a new house/change in home responsibilities influence how much physical activity you do?*
- *How do your friends influence how much physical activity you do?*
- *How does your family influence how much physical activity you do?*
- *How does having your license now/driving influence how much physical activity you do? More of a commute now?*
- *How does your gender, remoteness, socio-economic area/income influence how much physical activity you do?*

Can you think of anything that your school could have been done to help make you do more physical activity while you were there?
/after you left school?
Can you think of anything that could be done at university/ work/ home/ friends/ family can do now that would make you do more physical activity?

I'm now going to switch from physical activity to sedentary behaviour. Sedentary behaviour means any activity that you do while you are awake and sitting or reclining that requires low energy expenditure. Examples include time spent sitting at a desk, sitting to read, study, watch television, use a computer/tablet/mobile, play music or electronic games consoles, and sitting while travelling, such as when driving or on public transport.

Can you please describe your sedentary behaviour when you were still at school? / What kinds of sedentary behaviour did you do? / How much time did you spend sitting when you went to school?
[Clarification, examples, prompts if needed:]
In different settings:

- *Leisure-time*
- *At school*
- *At home*
- *At work?*
- *Travelling - driving? Commute? Train?*
- *How much do you watch television, read, watch movies, play video games, use a portable music player/ mobile/ tablet?*
- *When you sat, was it for a prolonged period (more than 30 minutes)?*

Can you please describe your sedentary behaviour now? Have there been any changes? More/less/same? What kinds of sedentary behaviour do you do? How much time do you spend sitting now?
[Clarification, examples, prompts if needed:]
In different settings:

- *Leisure-time*
- *At university*
- *At home*
- *At work*
- *Travelling - driving? Commute? Train?*
- *How much do you watch television, read, watch movies, play video games, use a portable music player/ mobile/ tablet?*
- *and is that more, less or the same as when you were in high school?*
- *When you sit, is it for a prolonged period (more than 30 minutes)?*
- *If you were to break up prolonged sitting time, would it only happen if you consciously decided to or do you naturally spontaneously break up your sitting time?*

Can you please summarise how your sedentary behaviour changed after you left school? It is interesting that you mentioned that you did different sedentary behaviour while you were at school, compared to now. I'd like to pick up on that and hear a bit more about it.
What were the reasons for that change?
Can you think of any other reasons?
Was there one particular influence that was more important than the others?
[If few self-identified reasons provided, prompt for the situational transitions after school (from the start of the interview) if not provided as reasons.]

- *How does your university influence how much you sit?*
- *How does your work influence how much you sit?*
- *How does your moved to a new house/change in home responsibilities influence how much you sit?*
- *How do your friends influence how much you sit?*
- *How does your family influence how much you sit?*
- *How does having your license now/driving influence how much you sit? More of a commute now?*
- *How does your gender, remoteness, socio-economic area /income influence how much you sit?*

Can you think of anything that your school could have been done to help make you sit less while you were there?
/after you left school?
Can you think of anything that could be done at university/ work/ home/ friends/ family that might help you sit less?
[Closing]

That is all of the questions that I have for you. Is there anything extra that you can think of that you feel we should have talked about, but we have missed? I am after a clear picture of how your physical activity and sedentary behaviour has changed since you left school, and why it has changed. Is there anything extra that you can add?
Do you have any questions for me or about the study?

In closing, has there been anyone else present while you have being doing this interview?

[*If they ask why*] I ask because I need to report that, as having other people around might bias some people's answers.

Could you please describe your setting right now? For example, are you at home?

[*If they ask why*] I ask because I need report that, as the setting you are in can bias some people's answers.

I would like to now offer you a $20 Coles Group and Myer voucher as compensation for participating in this study? Would you like one of those?

I will post it to you and you should get it soon.

If you want to get in touch again later, just email the LEAP email address.
Thank you so much for your time and for contributing to this study. Have a good day.

Appendix 3.3 Qualitative study coding tree

Code	Description of what the categories and codes referred to
Category: Gender 'GEN'	The young adult's self-identified gender.
Woman 'GEN WOM'	The young adult self-identified as a woman.
Man 'GEN MAN'	The young adult self-identified as a man.
Category: Changes 'CHA'	The young adults' experiences and viewpoints about what has changed since they have left secondary school that are not directly identified as being associated with PA or SB, including moving to a new house, changes in friendship groups and commencing employment.
Category: Levels 'LEV'	The young adults' experiences and viewpoints about how much PA and SB they engage in during secondary school and now.
Leisure-time physical activity 'LEV LEI PA'	Anything related to PA during leisure-time (after school and on weekends) including going to public gymnasiums, dog walking, non-organised PA such as walking, cycling, shooting hoops, as well as activities at home including chores, gardening and home gymnasiums.
Leisure-time sedentary behaviour 'LEV LEI SB'	Anything related to SB during leisure-time (after school and on weekends) including playing video games, reading, studying at home, doing homework, watching television, and watching movies at home or at a cinema.
Occupation physical activity 'LEV OCC PA'	Anything related to standing, moving and physical activities at work.
Occupation sedentary behaviour 'LEV OCC SB'	Anything related to sitting at work.
Prolonged sitting 'LEV PRO'	Anything related to unbroken prolonged sitting >30 mins and not being able to break up prolonged sitting without reminders or prompts.
Prolonged sitting breaks 'LEV PRO BR'	Anything related to prolonged sitting that is broken up into smaller bouts naturally and spontaneously without the need for reminders or prompts.
School physical activity 'LEV SCH PA'	Anything related to PA levels at school, including active breaks in the classroom, PE lessons, school sport, school sport carnivals and being active during school breaks (recess and lunchtime).
School sedentary behaviour 'LEV SCH SB'	Anything related to SB levels at school, including sitting during class and breaks (recess and lunchtime), and studying at school.
Sport 'LEV SPO'	Anything related to sport, including being a member of a sport team at school and/or in the community.
Technology 'LEV TEC'	Anything related to technology and electronic devices, including using social media, internet, mobile phones, computers, laptops, tablets, portable music players and video games, and whether they are used at home, school, place of tertiary study or work.

Place of tertiary study physical activity ‘LEV TER PA’	PA levels at the place of tertiary study (university and vocational training), including standing or moving during classes (lectures, tutorials and practicals) and moving during breaks between classes.
Place of tertiary study sedentary behaviour ‘LEV TER SB’	SB levels at the place of tertiary study (university and vocational training), including sitting during classes (lectures, tutorials and practicals), sitting to study on campus, and sitting during breaks between classes.
Transport physical activity ‘LEV TRA PA’	Anything related to active transport, including walking or cycling for transport, and standing on public transport.
Transport sedentary behaviour ‘LEV TRA SB’	Anything related to SB and transport, including sitting on public transport, driving, car ownership and having a driver’s license.
Category: Reasons ‘REA’	The young adults’ experiences and viewpoints about what are the reasons and influences that they have attributed to their changes in PA and SB over their transition out of secondary school
Age ‘REA AGE PA’	Anything related to age as a reason or influence on PA.
AGE ‘REA AGE SB'	Anything related to age as a reason or influence on SB.
Availability ‘REA AVA PA'	Anything related to availability as a reason or influence on PA, including the availability of and access to technology, resources and facilities.
Availability ‘REA AVA SB'	Anything related to availability as a reason or influence on SB, including the availability of and access to technology, resources and facilities.
Food ‘REA FOO PA’	Anything related to food, drink or energy intake as a reason or influence on PA.
Food ‘REA FOO SB’	Anything related to food, drink or energy intake as a reason or influence on SB.
Gender ‘REA GEN PA’	Anything related to gender as a reason or influence on PA.
Gender ‘REA GEN SB’	Anything related to gender as a reason or influence on SB.
Habits ‘REA HAB PA’	Anything related to habits, routines, structure and regimented days as a reason or influence on PA.
Habits ‘REA HAB SB’	Anything related to habits, routines, structure and regimented days as a reason or influence on SB.
Home ‘REA HOM PA’	Anything related to home, including moving out of the family home/changing residences, having more responsibilities now, having to do more chores and having to pay board as a reason or influence on PA.
Home ‘REA HOM SB’	Anything related to home, including moving out of the family home/changing residences, having more responsibilities now, having to do more chores and having to pay board as a reason or influence on SB.
Income ‘REA INC PA’	Anything related to income and money as a reason or influence on PA.
Income ‘REA INC SB’	Anything related to income and money as a reason or influence on SB.

Independence 'REA IND PA'	Anything related to independence levels and freedom as a reason or influence on PA.
Independence 'REA IND SB'	Anything related to independence levels and freedom as a reason or influence on SB.
Internal 'REA INT PA'	Related to anything internal as a reason or influence on PA, including maturity levels, being positively or negatively motivated internally (not externally by social networks, for example), feelings of shame or embarrassment, mental health and depression, personal preference (likes, dislikes, being bored, attention span, interest and enjoyment levels) and attitude.
Internal 'REA INT SB'	Related to anything internal as a reason or influence on SB, including maturity levels, being positively or negatively motivated internally (not externally by social networks, for example), feelings of shame or embarrassment, mental health and depression, personal preference (likes, dislikes, being bored, attention span, interest and enjoyment levels) and attitude.
Main reason 'REA MAI PA'	The reason that is the most important and influential for their PA.
Main reason 'REA MAI SB'	The reason that is the most important and influential for their SB.
Occupation 'REA OCC PA'	Anything related to the occupation, including the choice of occupation and changes in occupation (commencing full-time work, part-time work and casual work) as a reason or influence on PA.
Occupation 'REA OCC SB'	Anything related to the occupation, including the choice of occupation and changes in occupation (commencing full-time work, part-time work and casual work) as a reason or influence on SB.
Pet ownership 'REA PET PA'	Anything related to having a pet, especially walking a dog as a reason or influence on PA.
Pet ownership 'REA PET SB'	Anything related to having a pet, including owning a cat, rather than a dog as a reason or influence on SB.
Injury 'REA PHY PA'	Anything related to an injury, a physical impairment or physical health, including conditions and illnesses such as asthma, allergies, and a lack of sleep/being tired as a reason or influence on PA.
Injury 'REA PHY SB'	Anything related to an injury, a physical impairment or physical health, including conditions and illnesses such as asthma, allergies, and a lack of sleep/being tired as a reason or influence on SB.
Priorities 'REA PRI PA'	Anything related to planning, time management, priorities or goal setting as a reason or influence on PA.
Priorities 'REA PRI SB'	Anything related to planning, time management, priorities or goal setting as a reason or influence on SB.
Remoteness 'REA REM PA'	Anything related to remoteness as a reason or influence on PA, including changes from living in a rural area to an urban area.
Remoteness 'REA REM SB'	Anything related to remoteness as a reason or influence on SB, including changes from living in a rural area to an urban area.

School 'REA SCH PA'	Anything related to school as a reason or influence on PA, including size and quality of grounds, play equipment, oval, sport teams and facilities, or studying, assignments, exams and homework.
School 'REA SCH SB'	Anything related to school as a reason or influence on SB, including size and quality of grounds, play equipment, oval, sport teams and facilities, or studying, assignments, exams and homework.
Social support 'REA SOC PA'	Anything related to the young adult's social network, including their friends, family, housemates, peers and health practitioners as a reason or influence on PA.
Social support 'REA SOC SB'	Anything related to the young adult's social network, including their friends, family, housemates, peers and health practitioners as a reason or influence on SB.
Technology 'REA TEC SB'	Anything related to technology-use as a reason or influence on SB, including video games, social media, computer, mobile phone, portable music players and televisions.
Study 'REA TER PA'	Anything related to tertiary study as a reason or influence on PA, including time spent studying, time on campus (contact hours), the choice of course, being educated and the grounds/facilities.
Study 'REA TER SB'	Anything related to tertiary study as a reason or influence on SB, including time spent studying, time on campus (contact hours), the choice of course, being educated and the grounds/facilities.
Time 'REA TIM PA'	Anything related to time as a reason or influence on PA, including free time, spare time, routines, regimented days and holidays.
Time 'REA TIM SB'	Anything related to time as a reason or influence on SB, including free time, spare time, routines, regimented days and holidays.
Transport 'REA TRA PA'	Anything related to transport as a reason or influence on PA, including walking or cycling for transport, public transport, driving, car ownership, driver's license and commute duration/distance.
Transport 'REA TRA SB'	Anything related to transport as a reason or influence on SB, including walking or cycling for transport, public transport, driving, car ownership, driver's license and commute duration/distance.
Weather 'REA WEA PA'	Anything related to weather as a reason or influence on PA, including hot and cold temperature, rain and sunshine.
Weather 'REA WEA SB'	Anything related to weather as a reason or influence on SB, including hot and cold temperature, rain and sunshine.
Weight 'REA WEI PA'	Anything related to weight as a reason or influence on PA, including body image, weight levels, weight loss and weight gain.
Category: Influences 'INF'	The young adults' experiences and viewpoints about what influences their PA and SB in a positive or negative way.
Negative influences 'INF NEG'	All types of influences that resulted in PA decreasing or SB increasing.

No influence 'INF NON'	Anything that was deemed not an influence.
Positive influences 'INF POS'	All types of influences that resulted in PA increasing or SB decreasing.
Category: Action 'ACT'	Any suggested actions and strategies that the young adults suggested could be changed at school, university, home, work or within their social network that could result in more PA and less SB.
Home 'ACT HOM PA'	Any strategies to increase PA that could be implemented at home.
Home 'ACT HOM SB'	Any strategies to decrease SB that could be implemented at home.
Occupation 'ACT OCC PA'	Any strategies to increase PA that could be implemented at their place of occupation.
Occupation 'ACT OCC SB'	Any strategies to decrease SB that could be implemented at their place of occupation.
Other 'ACT OTH PA'	Any strategies to increase PA where there has not been a setting or context specified, or are general, overall, other, random or uncommon.
Other 'ACT OTH SB'	Any strategies to decrease SB where there has not been a setting or context specified, or are general, overall, other, random or uncommon.
School 'ACT SCH PA'	Any strategies to increase PA that could be implemented at their secondary school.
School 'ACT SCH SB'	Any strategies to decrease SB that could be implemented at their secondary school.
Social network 'ACT SOC PA'	Any strategies to increase PA that could be implemented by their social network, including their friends, family, housemates and peers.
Social network 'ACT SOC SB'	Any strategies to decrease SB that could be implemented by their social network, including their friends, family, housemates and peers.
Study 'ACT TER PA'	Any strategies to increase PA that could be implemented at their place of tertiary study, including university or vocational training.
Study 'ACT TER SB'	Any strategies to decrease SB that could be implemented at their place of tertiary study, including university or vocational training.

PA: physical activity; SB: sedentary behaviour.

Appendix 4.1 ProjectADAPT two-year follow-up telephone survey

Participant ID: ___ ___ ___ ___ *(4 DIGITS ONLY)*
Interviewer ID: ___ ___ *(2 DIGITS)*

SECTION 1: Eating Behaviour

The first section of the interview is about things that you eat.

1 How many serves of VEGETABLES do you USUALLY eat each day?
This can include fresh, dried, frozen and tinned vegetables, but not potatoes, hot chips or fried potato (a serve is equal to ½ cup of cooked vegetables or 1 cup of salad vegetables).

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o None/don't eat vegetables
- o Less than one serve a day
- o 1 serve
- o 2 serves
- o 3 serves
- o 4 serves
- o 5 serves
- o 6 serves or more

2 How many serves of FRUIT do you USUALLY eat each day? This can include all fresh, dried, frozen, and tinned fruit, but not fruit juice (a serve is equal to 1 medium piece or 2 small pieces of fruit, or 1 cup of diced pieces of fruit).

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o None/don't eat fruit
- o Less than one serve a day
- o 1 serve
- o 2 serves
- o 3 serves
- o 4 serves
- o 5 serves
- o 6 serves or more

3 What type of BREAD do you USUALLY eat?
(If more than one type, ask which one they eat most often).

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- None/Don't eat bread
- High fibre white bread
- Regular white bread
- Wholemeal (brown) bread
- Rye bread
- Multigrain bread
- Other bread

4 What type of MILK do you USUALLY drink?
(*If more than one type, ask which type they drink most often*).

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o None/don't drink milk
- o Whole milk (full-cream)
- o Trim, low or reduced-fat milk (eg. Rev)
- o Skim (no fat) milk
- o Flavoured milk (eg. chocolate)
- o Other type of milk (eg. soy, rice, goat)
- o Evaporated or sweetened condensed milk

5 How much WATER do you USUALLY drink each day? This can be plain tap water, mineral water or bottled water (*Clarify per WEEK or per DAY ;* 1 cup = 250ml, 1 average bottle = 2 cups, 1 litre bottle = 4 cups)..

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o None
- o Less than 1 cup/glass a **day** (<250ml)
- o ~1 cup/glass a **day** (<250ml)
- o ~2 cups/glasses a **day** (~500ml)
- o ~3 cups/glasses a **day** (<750ml)
- o ~4 cups/glasses a **day** (~1litre)
- o 5 or more cups/glasses a **day** (>=1.25litre)

6 How much FRUIT JUICE do you USUALLY drink in a day or week?
(*Clarify per WEEK or per DAY;* 1 cup = 250ml, a Prima / Popper / Tetra pack = 1 cup).

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o None/don't drink fruit juice
- o Less than 1 cup/glass a **week**
- o ~1-3 cups/glasses a **week**
- o ~4-6 cups/glasses a **week**
- o ~1-2 cups/glasses a **day**
- o ~3-4 cups/glasses a **day**
- o 5 or more cups a **day**

7 How much DIET SOFT DRINKS, DIET CORDIAL or DIET SPORTS DRINKS do you USUALLY drink in a week or day? (*Clarify per WEEK or per DAY;* 1 cup = 250ml, one can of diet soft drink = 1 ½ cups).

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o None
- o Less than 1 cup a **week**
- o ~1-3 cups a **week**
- o ~4-6 cups a **week**
- o ~1-2 cups a **day**
- o ~3-4 cups a **day**
- o 5 or more cups a **day**

8 How much <u>REGULAR</u> SOFT DRINK, CORDIAL, ENERGY DRINK or SPORTS DRINK do you USUALLY drink in a week or day? (*Clarify per WEEK or per DAY;* 1 cup = 250ml, one can of soft drink = 1 ½ cups) Do not include diet soft drinks.

[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- ○ None
- ○ Less than one cup a **<u>week</u>**
- ○ ~1-3 cups a **<u>week</u>**
- ○ ~4-6 cups a **<u>week</u>**
- ○ ~1-2 cups a **<u>day</u>**
- ○ ~3-4 cups a **<u>day</u>**
- ○ 5 or more cups a **<u>day</u>**

9 I'm now going to ask you about how often you eat a range of foods
How often do you:

[DO NOT READ RESPONSE OPTIONS] (SELECT ONE OPTION ONLY FOR EACH ITEM)

a) Eat RED MEAT such as beef or lamb? This includes all steaks, chops, roasts, mince, stir fries and casseroles, but not pork or chicken?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

b) Eat MEAT PRODUCTS such as sausages, hot dogs, ham, devon, sausage rolls, salami, meat pies or bacon?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

c) Eat FISH, including fresh, canned or frozen, but not battered or crumbed? *[INCLUDES TUNA]*

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

d) Have ICE CREAM, ICY POLES or ICE BLOCKS?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

e) Eat HOT CHIPS, FRENCH FRIES, WEDGES or FRIED POTATOES?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

f) Eat POTATO CRISPS/CHIPS or OTHER SALTY SNACKS (such as Twisties, corn chips)?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

g) Have meals or snacks such as BURGERS, PIZZA, CHICKEN or CHIPS from places like McDonalds, Hungry Jacks/Burger King, Pizza Hut, KFC, Red Rooster or local take away food places?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

h) Eat CONFECTIONERY, such as lollies and chocolates?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

i) Eat SWEET FOODS, such as sweet biscuits, cakes or muffins?

Never	<1 time/ **week**	1-2 times/ **week**	3-4 times/ **week**	5-6 times/ **week**	Once/day/ **everyday**	2 times/ **day**	≥3 times/ **day**

10 How often do you add salt to your food either during cooking or after it's cooked? Would you say:

[READ OPTIONS] (SELECT ONE ONLY)

o	Never or rarely
o	Sometimes
o	Usually OR
o	Always

11 How many MEALS (including breakfast, lunch and dinner) do you usually eat in a typical day, including evenings?

[DO NOT READ] (SELECT ONE ONLY)

o	None
o	1
o	2
o	3
o	4 or more

12 How many times did you snack or eat between meals yesterday?

_____ times

13 On how many days per week do you usually…..

[DO NOT READ OPTIONS] [SELECT ONE FOR EACH]

	0	1	2	3	4	5	6	7
a. Have something to eat for breakfast?	O	O	O	O	O	O	O	O
b. Eat lunch?	O	O	O	O	O	O	O	O
c. Eat dinner?	O	O	O	O	O	O	O	O
d. Eat meals in front of the TV?	O	O	O	O	O	O	O	O
e. Eat snacks in front of the TV?	O	O	O	O	O	O	O	O
f. Drink any soft drink in front of the TV?	O	O	O	O	O	O	O	O

14 About how often is FRUIT available in your HOME? Would you say…..
[READ OPTIONS] **[***CHOOSE ONE OPTION]*

	Never	Sometimes	Usually OR	Always
a. Fruit	O	O	O	O
b. WHAT ABOUT… Vegetables	O	O	O	O
c. Potato chips or other salty snack foods	O	O	O	O
d. Chocolate or other lollies	O	O	O	O
e. Sweet biscuits, cakes or muffins	O	O	O	O
f. Ice cream, icy poles or ice blocks	O	O	O	O
g. Reduced or no-fat milk	O	O	O	O
h. DIET Soft drink, cordial or sports drinks	O	O	O	O
i. REGULAR soft drink, cordial, sports drinks or energy drinks	O	O	O	O

15 How confident are you that you could eat healthy foods when you are…..
[READ OPTIONS] (SELECT ONE FOR EACH)

	Not at all	Slightly	Moderately	Very OR	Extremely confident
a. At the shops? Would you say you are:	O	O	O	O	O
Using the same scale, how confident are you that you could eat healthy foods when you are…..					
b. Hungry after University/TAFE or work?	O	O	O	O	O
c. With your friends?	O	O	O	O	O
d. Feeling down, bored or stressed?	O	O	O	O	O
e. Eating out?	O	O	O	O	O
f. Alone?	O	O	O	O	O

16a About how confident are you that you ….
[DO NOT READ OPTIONS UNLESS NECESSARY] (SELECT ONE FOR EACH)

	Not at all	Slightly	Moderately	Very	Extremely confident
a. Could prepare and cook vegetables at home? (*includes vegies cooked in microwave)*	O	O	O	O	O
b. Could cook a range of dishes?	O	O	O	O	O
c. Could read and understand food labels?	O	O	O	O	O

16b Do you feel confident cooking:

	Yes	No
a. Red meat	O	O
b. **WHAT ABOUT**… Chicken	O	O
c. Fish	O	O
d. Beans and lentils	O	O
e. Pasta	O	O
f. Rice	O	O
g. Potatoes	O	O

17 How many times in the past month did you…..
[DO NOT READ UNLESS NECESSARY] (CHOOSE ONE OPTION)

	Never/ rarely	<once/ wk	Once/wk	About 2-3 times/ wk	About 4-6 times/ wk	Every-day
a. Shop for food, or help shop for food, for your household?	O	O	O	O	O	O
b. Plan ahead what you would eat at meals at home?	O	O	O	O	O	O
c. Make a grocery shopping list for your household?	O	O	O	O	O	O
d. Prepare a meal for your household on your own?	O	O	O	O	O	O
e. Help to prepare a meal for your household?	O	O	O	O	O	O

18 How often over the past 6 months have you been hungry because you or your family couldn't afford more food? Would you say….. *(CHOOSE ONE ONLY)*

Almost every month	Some months, but not every month	One or two months, OR	You have not been hungry for this reason	I don't want to answer
O	O	O	O	O

19a Are you currently a vegetarian?

- o Yes
- o No- Skip to SECTION 2

19b As a vegetarian, do you eat any of the following?
(SELECT AS MANY AS APPLY)

o	Eggs
o	Dairy food (such as milk or cheese)
o	Chicken
o	Fish
	None of the above

SECTION 2: Physical activity
The next section is about the physical activity you do in your everyday life. We are interested in two types of physical activity – vigorous and moderate.
VIGOROUS PHYSICAL ACTIVITY takes hard physical effort and makes you breathe much harder than normal.
MODERATE PHYSICAL ACTIVITY makes you breathe somewhat harder than normal.

TRANSPORTATION PHYSICAL ACTIVITY
Now, think about how you travel from place to place, including travel to work and to other places like shops and the movies etc.

20a On how many days in a usual week do you travel in a motor vehicle like a train, bus, car or tram?
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q20c							

20b On <u>one of those days</u>, how much time in total do you usually spend *traveling in a car, bus, train or other kind of motor vehicle?*

_____hours per day

and/or _____minutes per day

For the next few questions we are only interested in physical activity you do for at least 10 *uninterrupted* minutes.

20c On how many days in a usual week do you cycle *to go from place to plac*e for at least 10 minutes at a time?
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q20e							

20d On <u>one of those days</u>, how much time in total do you usually *cycle from place to plac*e?

_____hours per day

and/or _____minutes per day

20e On how many days in a usual week do you walk *to go from place to place* for at least 10 minutes at a time*?*
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q21a							

20f On <u>one of those days</u>, how much time in total did you usually spend walking *from place to plac*e?
_____hours per day

and/or _____minutes per day

RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY
Now, think about all the physical activities that you do in a usual week solely <u>for recreation, sport, exercise or leisure</u>.

21a On how many days in a usual week, do you walk for at least 10 minutes at a time *in your leisure time*, <u>not counting any walking you have already mentioned</u>?
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q21c							

21b On <u>one of those days</u>, how much time in total do you usually spend *walking in your leisure time?*
_____hours per day

and/or _____minutes **per day**

21c On how many days in a usual week do you do vigorous physical activities *in your leisure time* for at least 10 minutes at a time?
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q21e							

21d On <u>one of those days</u>, how much time in total do you usually spend doing vigorous physical activities *in your leisure time*?

_____hours per day

and/or _____minutes **per day**

21e On how many days in a usual week do you do <u>moderate</u> physical activities *in your leisure time* for at least 10 minutes at a time?
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q22a							

21f On <u>one of those days</u>, how much time in total do you usually spend doing moderate physical activities *in your leisure time*?

_____hours per week

and/or _____minutes **per day**

HOUSEWORK, HOUSE MAINTENANCE AND CARING FOR FAMILY
Now think about physical activity that you do in a usual week in and around the house

22a On how many days in a usual week do you do physical activities that take moderate or vigorous effort in the garden or in your home for at least 10 minutes at a time. Examples include carrying heavy loads, scrubbing floors, sweeping
[DO NOT READ] (SELECT ONE ONLY)

None	1 day	2 days	3 days	4 days	5 days	6 days	7 days
O	O	O	O	O	O	O	O
SKIP to Q23a							

22b. On one of those days, how much time in total did you usually spend doing moderate or vigorous activities in the garden or in your home?
____ hours ___ minutes

23a Over the past 6 months, have you been….. *[DO NOT READ OPTIONS]*

	Yes	**No**
a. A member of a gym or fitness club?	O	O
b. A participant in a sporting club or squad?	O	O
c. A participant in any other organised physical activity?	O	O

23b Over the past 6 months, how many sports teams have you been part of?
(If you play for more than 1 team of the same sport or play across 2 seasons (e.g., two football teams), count this as 2.)

_____ teams

24 How confident are you that you could do physical activity even when …… *[READ OPTIONS] (CHOOSE ONE FOR EACH ITEM)*

	Not at all	Slightly	Moderately	Very	Extremely confident
a. You are tired? **Would you say…**	O	O	O	O	
On the same scale, how confident are you that you could do physical activity even when you….					
b. You feel sad, stressed or in a bad mood?	O	O	O	O	O
c. You are on holiday?	O	O	O	O	O
d. You feel you don't have time?	O	O	O	O	O
e. It's raining?	O	O	O	O	O

25 How many times in the past month did you…
[DO NOT READ OPTIONS UNLESS NECESSARY] (CHOOSE ONE OPTION)

	Never/ rarely	<once/ week	Once/ week	About 2-3 times/ week	About 4-6 times/ week	Every-day
a. Set a goal for how much physical activity you would like to do?	O	O	O	O	O	O
b. Plan particular days on which you would do physical activity?	O	O	O	O	O	O
c. Meet someone to do physical activity with?	O	O	O	O	O	O

SECTION 3: Sedentary behaviour
The next questions are about the time that you spend sitting while you are at work, University, TAFE, at home, while studying and during your free time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch TV. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26a In a usual week, how much time in total do you spend *sitting* on a week day? This includes the day and evening. Include sitting at all locations and time spent lying down while you are awake as well as sitting.

_____hours (Mon-Fri)

and/or _____minutes (Mon-Fri)

26b In a usual week, how much time in total do you spend sitting on a weekend day?

_____hours (Sat and Sun)

and/or _____minutes (Sat and Sun)

The next questions are about your LEISURE TIME – the time when you are not at work, University/TAFE, travelling or sleeping. These questions ask you to add up time from Monday to Friday and across weekends.

27a What is the total time from Monday to Friday that you usually spend SITTING watching TV, DVDs or videos?

_____hours (Mon-Fri)

and/or _____minutes (Mon-Fri)

27b What about on weekends, so Saturday and Sunday?

_____hours (Sat and Sun)

and/or _____minutes (Sat and Sun)

28a What is the total time from Monday to Friday that you usually spend SITTING using a computer, laptop or tablet such as an IPAD for entertainment, so not for work or study (e.g. streaming)?

_____hours (Mon-Fri)

and/or _____minutes (Mon-Fri)

28b What about on weekends, so Saturday and Sunday?

_____hours (Sat and Sun)

and/or _____minutes (Sat and Sun)

29a Do you usually play electronic games such as Nintendo, X-Box or Playstation <u>while SITTING</u>?

[DO NOT READ]

ALERT: Skip sequence

- o Yes
- o No ***SKIP TO Q30a***

29b What is the total time from Monday to Friday that you usually spend playing electronic games <u>while SITTING?</u>

_____hours (Mon-Fri)

and/or _____minutes (Mon-Fri)

29c What about on weekends, so Saturday and Sunday?

_____hours (Sat and Sun)
and/or _____minutes (Sat and Sun)

30a How many TVs do you have in your house?

_____ TV's
IF ZERO (0), SKIP TO Q32

ALERT: Skip sequence

30b Do you have a TV in your bedroom?

- o Yes
- o No

31 How confident are you that you could… *[READ OPTIONS]*

	Not at all	Slightly	Moderately	Very OR	Extremely confident
a. Watch less TV even when you are bored?	O	O	O	O	O
Using the same scale, how confident are you that you could…..					
b. Turn off the TV even when there is a program you enjoy?	O	O	O	O	O
c. Watch less TV even when it is raining?	O	O	O	O	O
d. Watch less TV even if others want to watch it?	O	O	O	O	O
e. Turn off the TV when you are doing something else?	O	O	O	O	O
f. Not eat meals while watching TV?	O	O	O	O	O
g. Not eat snacks while watching TV?	O	O	O	O	O

32 Do you have access to the following AT HOME…
[DO NOT READ OPTIONS]

	Yes	No
a. Mobile phone	O	O
b. Laptop	O	O
c. Tablet/IPAD	O	O
d. Desktop computer *[eg. PC or Mac]*	O	O
e. Active games console, like a Wii or Kinect	O	O
f. Other games console	O	O
g. Treadmill or other gym equipment	O	O
h. Basketball/netball ring	O	O
i. Bike	O	O
j. Tennis court	O	O
k. Swimming pool	O	O

33 Do you do any of the following things in your bedroom?
[DO NOT READ OPTIONS]

	Yes	No
a. Watch TV shows or movies	O	O
b. Play electronic games	O	O
c. Use the internet	O	O

34 Do you agree, strongly agree, disagree, strongly disagree or neither agree nor disagree with the following statements?
[DO NOT READ OPTIONS] (CHOOSE ONE FOR EACH ITEM)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	*N/A*
a. I enjoy cooking and preparing meals	O	O	O	O	O	O
b. I enjoy trying new foods	O	O	O	O	O	O
c. I enjoy the taste of many vegetables	O	O	O	O	O	O
d. I regularly go without food or other necessities because I cannot afford them	O	O	O	O	O	O
e. I enjoy doing physical activity	O	O	O	O	O	O
f. I enjoy playing sport	O	O	O	O	O	O
g. I enjoy going for walks or walking places	O	O	O	O	O	O
h. I am good at physical activity	O	O	O	O	O	O

i. At home, there are enough supplies and pieces of sports equipment (like balls, bikes and racquets) to use for physical activity	O	O	O	O	O	O
j. My parents always pick me up and drop me off when I go places	O	O	O	O	O	O
k. I am too busy to eat healthy foods	O	O	O	O	O	O
l. I am too rushed in the morning to eat a healthy breakfast	O	O	O	O	O	O
m. Eating healthy meals just takes too much time	O	O	O	O	O	O
n. I don't have time to think about healthy eating	O	O	O	O	O	O
o. I don't have time to cook meals	O	O	O	O	O	O
p. Doing physical activity or exercise is important to me	O	O	O	O	O	O
q. Eating a healthy diet is important to me	O	O	O	O	O	O
r. I don't have enough time to do more physical activity, exercise or sport	O	O	O	O	O	O
s. Memberships and sports fees are too expensive	O	O	O	O	O	O
t. My parents give me money to buy food	O	O	O	O	O	O
u. My parents help me to pay for sport, gym memberships or other physical activity	O	O	O	O	O	O

SECTION 4: Social environment

The next section of the survey is about your family, friends, colleagues and people you live with. First I will ask you about your family.
Family members include: parents/step-parents, siblings, cousins, aunts, uncles and grandparents.

35 Over the past 6 months, how often did <u>a family member</u>:
[READ OPTIONS] (SELECT ONE ONLY)

	Never	Rarely	A few times	Often OR	Very often
a. Do physical activity with you? **Would you say…..**	O	O	O	O	O
During the past 6 months, how often did a family member....					
b. Encourage you to be physically active?	O	O	O	O	O
c. Take you to places where you can do physical activity or sport?	O	O	O	O	O
d. Discourage you from sitting too much (e.g. watching too much TV)?	O	O	O	O	O
e. Watch TV or DVDs with you?	O	O	O	O	O
f. Play electronic games with you?	O	O	O	O	O
g. Encourage you to eat healthy, low-fat foods?	O	O	O	O	O
h. Discourage you from eating unhealthy foods?	O	O	O	O	O
i. Encourage you to cook or prepare a meal?	O	O	O	O	O

36 How many times per week do you usually eat dinner together with your family?
[DO NOT READ OPTIONS] (SELECT ONE ONLY)

- o Rarely/Never
- o Less than once a **<u>week</u>**
- o ~1-3 times a **<u>week</u>**
- o ~4-6 times a **<u>week</u>**
- o Everyday
- o *N/A*

37a Do you live together with family members?
[DO NOT READ] (SELECT ONE ONLY)

- o Yes ***<u>SKIP TO Q39a</u>***
- o No

ALERT: Skip sequence

The next questions are about the people that you live with.

37b How often do you usually eat dinner together with all, or most, of the people living in your household? Would you say…

- o I live alone ***SKIP TO Q39a***
- o Rarely/Never
- o Less than once a **week**
- o ~1-3 times a **week**
- o ~4-6 times a **week**
- o Everyday

ALERT: Skip sequence

38 During the past 6 months, how often did people that you live with:
[READ OPTIONS] (SELECT ONE ONLY)

	Never	Rarely	A few times	Often OR	Very often
a. Do physical activity with you?	O	O	O	O	O
During the past 6 months, how often did people that you live with…..					
b. Encourage you to be physically active?	O	O	O	O	O
c. Take you to places where you can be active?	O	O	O	O	O
d. Discourage you from sitting too much?	O	O	O	O	O
e. Watch TV or DVDs with you?	O	O	O	O	O
f. Play electronic games with you?	O	O	O	O	O
g. Encourage you to eat healthy, low-fat foods?	O	O	O	O	O
h. Discourage you from eating unhealthy foods?	O	O	O	O	O
i. Encourage you to cook or prepare a meal?	O	O	O	O	O

39a Do you currently have a boyfriend or girlfriend?
[DO NOT READ] (SELECT ONE ONLY)

- o Yes
- o No ***SKIP TO Q40***

ALERT: Skip sequence

39b How long have you been in this relationship?
_____ years AND/OR _____ months

39c During the past 6 months, how often did your boyfriend or girlfriend:
[READ OPTIONS] (SELECT ONE ONLY)

	Never	Rarely	A few times	Often OR	Very often
a. Do physical activity with you? **Would you say…..**	O	O	O	O	O
During the past 6 months, how often did your boyfriend or girlfriend…..					
b. Encourage you to be physically active?	O	O	O	O	O
c. Take you to places where you can be active?	O	O	O	O	O
d. Discourage you from sitting too much?	O	O	O	O	O
e. Watch TV or DVDs with you?	O	O	O	O	O
f. Play electronic games with you?	O	O	O	O	O
g. Encourage you to eat healthy, low-fat foods?	O	O	O	O	O
h. Discourage you from eating unhealthy foods?	O	O	O	O	O
i. Encourage you to cook or prepare a meal?	O	O	O	O	O

The next questions are about your friends or work colleagues.

40 During the past 6 months, how often did friends or work colleagues:
[READ OPTIONS] (SELECT ONE ONLY)

	Never	Rarely	A few times	Often OR	Very often
a. Do physical activity with you? **Would you say…..**	O	O	O	O	O
During the past 6 months, how often did friends or work colleagues…..					
b. Encourage you to be physically active?	O	O	O	O	O
c. Take you to places where you can be active?	O	O	O	O	O
d. Discourage you from sitting too much?	O	O	O	O	O
e. Watch TV or DVDs with you?	O	O	O	O	O
f. Play electronic games with you?	O	O	O	O	O
g. Encourage you to eat healthy, low-fat foods?	O	O	O	O	O
h. Discourage you from eating unhealthy foods?	O	O	O	O	O
i. Encourage you to cook or prepare a meal?	O	O	O	O	O

SECTION 5: Neighbourhood context
The following questions are about your 'neighbourhood' or the area in which you live. Some people may live in two households or residences.

ALERT: Skip sequence

41 Do you have more than one residence?
[DO NOT READ] (SELECT ONE ONLY)

o	Yes	***NOTE THIS ON THE INTERVIEW FORM***
o	No	***SKIP TO Q44***

42 What are the postcodes of the places in which you live?

a. Postcode 1: __ __ __ __

b. Postcode 2: __ __ __ __

c. Postcode 3: __ __ __ __

43 In which of these postcodes do you live most of the time?
If this is equal, answer for the household you are living in today.

__ __ __ __

Please answer the next questions for the place you live in most of the time.
SKIP TO Q45

44 What is your postcode?

__ __ __ __

45 About how long have you lived at this address?

_____ months and/or _____ years

46 Do you currently live in… *[READ OPTIONS]*

Major city	Large town	Small town OR	Rural property, such as a farm?
O	O	O	O

47 The next question is about how long it would take to get from your home to the nearest business or facility if you <u>WALKED</u> to them.

About how long would it take to get from your home to the nearest….
[DO NOT READ OPTIONS UNLESS NECESSARY] (SELECT ONE ONLY)

	1-5 mins	6-10 mins	11-20 mins	21-30 mins	>30 mins	*N/A*	Don't know
a. Milkbar, convenience or small grocery store	O	O	O	O	O	O	O
b. Supermarket	O	O	O	O	O	O	O
c. Fruit & vegetable shop or market	O	O	O	O	O	O	O
d. Fast food outlet	O	O	O	O	O	O	O
e. Café or restaurant	O	O	O	O	O	O	O
f. Public transport stop (bus, tram, train)	O	O	O	O	O	O	O
g. Park	O	O	O	O	O	O	O
h. Bike or walking track	O	O	O	O	O	O	O
i. Indoor recreation or exercise facility, such as a gym	O	O	O	O	O	O	O
j. Swimming pool	O	O	O	O	O	O	O
k. Playing fields, such as football ovals or tennis courts	O	O	O	O	O	O	O
l. Your University, TAFE or college	O	O	O	O	O	O	O
m. Your work if you have one	O	O	O	O	O	O	O

48 Do you agree, strongly agree, disagree, strongly disagree or neither agree nor disagree with the following statements about the area in which you live?
[DO NOT READ OPTIONS] (CHOOSE ONE FOR EACH ITEM)

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a. A large selection of fresh fruits and vegetables is available in my neighbourhood	O	O	O	O	O
b. The fresh fruits and vegetables in my neighbourhood are of high quality	O	O	O	O	O
c. There are many opportunities to purchase fast food in my neighbourhood	O	O	O	O	O
d. I do not buy many fruits because they cost too much	O	O	O	O	O
e. I do not buy many vegetables because they cost too much	O	O	O	O	O
f. Local sports clubs and other facilities in my neighbourhood offer many opportunities to get exercise	O	O	O	O	O
g. I often see other people walking in my neighbourhood	O	O	O	O	O
h. I often see other people exercising (for example, jogging, bicycling, playing sports) in my neighbourhood	O	O	O	O	O
i. I feel safe walking in my neighbourhood, day or night	O	O	O	O	O
j. My neighbourhood is safe from crime	O	O	O	O	O
k. People around here can be trusted	O	O	O	O	O
l. People around here are willing to help their neighbours	O	O	O	O	O
m. There is a lot of noise in my neighbourhood	O	O	O	O	O
n. My neighbourhood is attractive	O	O	O	O	O

o. In my neighbourhood it is easy to walk places	O	O	O	O	O
p. My neighbourhood has heavy traffic	O	O	O	O	O
q. This is a close-knit neighbourhood	O	O	O	O	O
r. People in this neighbourhood generally don't get along with each other	O	O	O	O	O
s. people in this neighbourhood do not share the same values	O	O	O	O	O
t. It is cheaper for me to buy unhealthy foods than healthy foods	O	O	O	O	O
u. Soft drink is good value for money	O	O	O	O	O
v. Fast food is good value for money	O	O	O	O	O

SECTION 6: Changes in your life

49 On a scale of 1 to 10, where one means you have "little or no stress" and 10 means you have "a great deal of stress," how would you rate your average level of stress during the <u>past month</u>?

(SELECT ONE ONLY)

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

50 Compared to the same time last year, would you say that your average level of stress is currently more, less or about the same?

(SELECT ONE ONLY)

More	Less	About the same
O	O	O

51 How much do you agree or disagree with the following statements?

(CHOOSE ONE FOR EACH ITEM)

	Strongly agree	**Agree**	**Neither agree nor disagree**	**Disagree**	**Strongly disagree**
a. I have lots of spare time	O	O	O	O	O
b. I feel like I am always on the go	O	O	O	O	O
c. I am dependent on my parents for money	O	O	O	O	O
d. I have too many competing demands on my time	O	O	O	O	O
e. I am good at managing my time	O	O	O	O	O

52a How much sleep do you usually get at night on weekdays?

_____ hours & _____ minutes

52b How much sleep do you usually get at night on weekends?

_____ hours & _____ minutes

52c Compared to the same time last year, on average, would you say that you currently get more, less or about the same amount of sleep?

(SELECT ONE ONLY)

More	Less	About the same
O	O	O

53 In general, how well do you feel you have adjusted to changes in your life over the last 12 months?

[READ OPTIONS] (SELECT ONE ONLY)

Very well	Well	Not well	Not very well at all
O	O	O	O

54a How many adults aged 18 years or over usually live in your household?
If you live in more than one residence, answer for the household you spend most of your time in.
If this is equal, answer for the household you are living in today.
_____ adults

54b How many children or young people aged less than 18 years? ***(Include yourself if you are under 18 years)***
_____ children

54c How many times have you moved house in the last 12 months?
_____ times

54d Can you tell me who is <u>presently living with you</u>?
(SELECT AS MANY AS APPLY)

ALERT: Skip sequence

- o Live alone ***<u>SKIP TO Q54f</u>***
- o Mother
- o Father
- o Stepmother
- o Stepfather
- o House master/mistress
- o Partner/spouse
- o Boyfriend/girlfriend
- o Sister(s) → How many?_____
- o Brother(s) → How many?_____
- o Cousin(s) → How many?_____
- o Friend → How many?_____
- o Own child → How many?_____
- o Other relative (Please specify) _____

54e Do you have your own bedroom for yourself?
[DO NOT READ] (SELECT ONE ONLY)

- o Yes
- o No

<u>54f Where do you live for the majority of the time?</u>

- o Parents home (rent free)
- o Parents home (pay board)
- o Rent or share rent
- o Residence hall
- o Other relative's home
- o Other (please specify)_____

55a Are you currently attending secondary school?

ALERT: Skip sequence

- o Yes- SKIP TO Q55c
- o No

55b When did you leave secondary school?

- o Last year
- o This year, during Term 1
- o This year, during Term 2
- o This year, during Term 3
- o This year, during Term 4
- o This year, after Term 4 exams
- o Refused

Confirm coding decision with participant if necessary. Eg. If participant responds with a timeframe such as two months ago, ask 'So during Term X?' OR 'Was that Term 3 or Term 4?)

TERM GUIDE:
Term 1: Feb-April + April holidays
Term 2: April-June + June/July holidays
Term 3: July-September + Sept/Oct holidays
Term 4: Oct-Nov + study break + exam period

Code school holidays as the preceding Term. Eg. July holidays = Term 2).

55c Are you currently studying full or part-time?

Full time	Part time	Deferred	No study
O	O	O	O

SKIP to Q56a ***SKIP to Q56a***

55d How many hours a week do you spend at University or TAFE (e.g. in class and studying on campus)?

- o 0 hours/ Week (Off-campus/ online) SKIP to 55e
- o 1-5 Hours/ Week - SKIP to 55f
- o 6-10 Hours/ Week- SKIP to 55f
- o 11-15 Hours/ Week- SKIP to 55f
- o 16-20 Hours/ Week- SKIP to 55f
- o 21-25 Hours/ Week- SKIP to 55f
- o 26-30 Hours/ Week- SKIP to 55f
- o 36+ Hours/ Week- SKIP to 55f

55e How many hours, on average, do you usually spend studying (e.g. completing modules/ coursework, ect)?

_____ Hours/ week ***SKIP to Q56a***

55f How many hours, on average, do you usually spend studying while not on campus?

_____ Hours/ week

56a Do you currently have a….

(CAN SELECT BOTH PAID & VOLUNTEER)

- o …..a paid job OR
- o ….a volunteer job? ***IF <u>ONLY</u> 'VOLUNTEER' SELECTED, <u>SKIP TO Q56c</u>***
- o I don't work ***<u>SKIP TO Q57a</u>***

ALERT: Skip sequence

56b Do you have an apprenticeship?

- o Yes
- o No

56c Are you currently working on a full-time, part-time or a casual basis?
(SELECT AS MANY AS NEEDED)

Full-time	Part-time	OR casual basis
O	O	O

56d What is your MAIN job outside of school?

_____

56e How many hours per week do you spend in this job?

_____ hours per week

56f Do you currently have more than one job?

o	Yes
o	No ***SKIP TO Q56i***

ALERT: Skip sequence

56g How many jobs do you have?

_____ jobs

56h How many hours in total do you usually spend in these jobs per week?

_____ hours

56i When you are at work, which of the following best describes what you do? Would you say….

If you have more than one job, answer for your main job.

[READ OPTIONS] (SELECT ONE ONLY)

Mostly standing	Mostly sitting	Mostly walking OR	Mostly heavy labour or physically demanding work
O	O	O	O

57a Are you currently looking for a… *[SELECT AS MANY AS NEEDED]*

Casual job	Part-time job	full-time job	Not looking for a job
O	O	O	O ***SKIP to Q57c***

ALERT: Skip sequence

57b How long have you been looking for a job?

_____ months and/or _____weeks

57c What are you MAINLY doing this year? (by mainly we mean things that occupy most of your time.

(SELECT AS MANY AS APPLY)

Studying at TAFE
Studying at University
Have a part-time job
Have a full-time job
Looking for a job
Doing an apprenticeship
Volunteering
Doing a traineeship
Defence Forces: Army, navy, air force
Other (please specify)_____

58 Please indicate in which bracket your current weekly income falls before tax. Include all sources of income, such as work income and government benefits. Is it:

[READ OPTIONS] (SELECT ONE ONLY)

- o Less than $50 per week?
- o $51- $150 per week?
- o $151-$250 per week?
- o $251-$350 per week?
- o $351-$450 per week?
- o $451 -$550 per week? OR
- o More than $550 per week?
- o Don't know
- o Refused

59a How many close friends would you say you have?

_____ friends

59b Compared to the same time last year, would you say your network or close friends; increased, decreased or stayed about the same?

Increased	Decreased	Stayed about the same
O	O	O

59c On average, how much time do you usually spend during a typical week socializing with friends? *[DO NOT READ OPTIONS] (SELECT ONE ONLY)*

- o None
- o Less than 1 hour
- o 1-2 hours
- o 3-5 hours
- o 6-10 hours
- o 11-15 hours
- o 16-20 hours
- o Over 20 hours

59d Compared to the same time last year, would you say the time you usually spend socializing with friends increased, decreased or stayed about the same?

Increased	Decreased	Stayed about the same
O	O	O

60 What is your date of birth? _____ . _____ . 19_____

Day Month Year

1 *January*	***2*** *February*	***3*** *March*	***4*** *April*	***5*** *May*	***6*** *June*
7 *July*	***8*** *August*	***9*** *September*	***10*** *October*	***11*** *November*	***12*** *December*

61a Do you currently have a….. *[READ OPTIONS] (SELECT AS MANY AS APPLY)*

- o Probationary or full Driver's licence?
- o Probationary or full Motorbike licence?
- o Car for transport?
- o Motorbike for transport?

61b What is your main form of transport? *[READ OPTIONS] (SELECT ONE ONLY)*

Public transport	Car	Walking/cycling	Refused
O	O	O	O

61c Compared to last year, do you spend more, less or about the same time travelling by the following modes? *[READ OPTIONS] (SELECT ONE PER LINE)*

	More	Less	About the same
Public transport	O	O	O
Car (as driver)	O	O	O
Car (as passenger)	O	O	O
Walk	O	O	O
Bike	O	O	O

The last few questions are about your general health.

62a What is your current height, without shoes?

_____ metres

& _____ cm

62b What is your current weight, without shoes?

_____ kg

63a Are you currently trying to:

[READ OPTIONS] (SELECT ONE ONLY)

- o Lose weight
- o Gain weight
- o Maintain your current weight
- o Not doing anything for your weight

64a Do you have a serious illness, long-term injury or disability that prevents you from being physically active?

- o Yes
- o No *SKIP TO Q65*

ALERT: Skip sequence

64b What is the illness, long-term injury or disability?

_____ *(ALLOW FOR 70 CHARACTERS)*

65 Would you say your health is:

[READ OPTIONS] (SELECT ONE ONLY)

- o Excellent
- o Very good
- o Good
- o Fair OR
- o Poor

66 Are you willing for us to contact you about further research in the future?

- o Yes
- o No

SIGN-OFF

That is the end of the survey. Thank you very much for your participation and for all the information you have provided. We really appreciate it. In a couple of weeks, we will send you a $25 gift voucher as a token of our appreciation.

This was the final survey as part of ProjectADAPT. We cannot thank you enough for your involvement in this study as without you it's not possible. Have a great day/night.

Appendix 4.2 Sample profile (*n*=1 022) according to remoteness and area-level SEP

	Remoteness		**Area-level SEPs**		
	Urban	**Rural**	**Lowest**	**Mid**	**Highest**
	%	%	%	%	%
(n)	(721)	(301)	(243)	(307)	(471)
Recruitment method, schools, n=1 022	**31.6*** **	51.2	**48.6*** **	41.0	29.3
Survey delivery mode, online, n=1 022	**95.7*** **	85.0	**88.1** **	92.5	94.9
Age (mean years±SD, n=1 008)	16.9±0.4	16.8±0.4	16.9±0.4	16.8±0.5	16.9±0.4
Gender, girl, n=1 021	75.4	70.1	70.4	73.5	75.8
Remoteness, urban, n=1 022	-	-	**39.5*** **	65.8	89.6
Tertiles of area-level SEP, n=1 020					
Lowest	**13.3*** **	48.8	-	-	-
Mid	**28.1*** **	34.9	-	-	-
Highest	**58.6*** **	16.3	-	-	-
Parent tertiary educated					
Mother, *n*=1 018	**56.9*** **	48.5	**44.0*** **	47.2	64.5
Father, *n*=1 017	**49.4*** **	30.6	**26.7*** **	35.5	58.0
Employment					
Not employed, *n=1 016*	**46.2*** **	30.6	35.8	42.3	43.9
Casual, *n=1 014*	38.7	51.2	46.5	42.7	40.1
Part-time, *n=1 014*	19.8	23.3	23.0	17.6	21.9
Income <$150/wk, *n=805*	67.3	71.1	**69.5*** **	63.5	70.9
Birth country (Australia)					
Participant, *n=1 015*	**80.9*** **	95.0	86.8	84.2	84.6
Mother, *n=1 011*	**52.0*** **	84.7	**66.3*** **	63.5	58.0
Father, *n=1 004*	**50.9*** **	85.7	66.7	59.9	59.0
English as primary language spoken at home, n=1 018	**80.4*** **	96.7	82.7	86.3	85.8

***p<0.01, ***p<0.001: Continuous variables by binary subgroups used independent t-test or one-way ANOVA for the non-binary subgroup, and categorical variables used Pearson's χ^2 test of significance.*

SD: standard deviation.

Appendix 4.3 Sample profile (*n*=1 022) according to survey delivery mode and recruitment method

	Survey delivery mode		**Recruitment method**	
	Telephone	**Online**	**Schools**	**Social media**
n	76	947	383	640
Recruitment method, schools, n=1 022	**93.4*** **	32.9	-	-
Survey delivery mode, online, n=1 022	-	-	**81.4*** **	99.2
Age (mean years±SD, n=1 008)	**16.5±0.4*** **	16.9±0.4	**16.8±0.4*** **	16.9±0.4
Gender (%), girls, n=1 022	73.7	73.9	**69.9***	76.2
Remoteness (%), urban, n=1 022	**40.8*** **	72.9	**59.7*** **	77.0
Tertiles of area SEP(%), n=1 020				
Lowest	**38.2****	22.6	**30.9*** **	19.6
Mid	**30.3****	30.1	**33.0*** **	28.3
Highest	**31.6****	47.3	**36.1*** **	52.1
Parent tertiary educated (%)				
Mother, *n=1 018*	46.1	55.1	53.4	55.0
Father, *n=1 017*	39.5	44.2	39.8	46.3
Employment (%), n=1 016				
Not employed	34.2	42.2	**46.3***	38.8
Casual, *n=1 014*	44.7	42.2	39.5	44.1
Part-time, *n=1 014*	18.4	21.0	17.8	22.7
Income <$150/wk, n=805	84.2	67.1	68.1	68.6
Birth country (Australia) (%)				
Participant, *n=1 015*	84.2	85.1	83.9	85.7
Mother, *n=1 011*	**75.0***	60.6	64.7	59.8
Father, *n=1 004*	**73.7***	60.1	63.6	59.7
English as primary language spoken at home (%), n=1 018	88.2	85.0	84.6	85.6

**p<0.05, **p<0.01, ***p<0.001: Independent t-test for continuous variables between binary subgroups or Pearson's chi-squared test of significance.*

SD: standard deviation.

Appendix 4.4 Individual survey items' test-retest reliability scores

Survey items		**Kappa** ±SE	**Weighted kappa** ±SE	**ICC** (95%CI)	**Percent agreement** (%)
PA variables					
LTPA:					
MPA	*(day/wk)*	-	0.46±0.07	0.78 (0.65, 0.86)	85.7
	(mins/day)	-	-	0.57 (0.33, 0.72)	-
VPA	*(day/wk)*	-	0.70±0.07	0.88 (0.81, 0.92)	90.2
	(mins/day)	-	-	0.79 (0.67, 0.86)	-
Walking	*(day/wk)*	-	0.46±0.07	0.69 (0.52, 0.80)	85.5
	(mins/day)	-	-	0.59 (0.36, 0.73)	-
AT:					
Cycling	*(day/wk)*	-	0.68±0.08	0.85 (0.77, 0.90)	96.6
	(mins/day)	-	-	0.39 (0.05, 0.60)	-
Walking	*(day/wk)*	-	0.59±0.08	0.84 (0.76, 0.90)	83.6
	(mins/day)	-	-	0.66 (0.47, 0.78)	-
School PA:					
Main activity level during school breaks *(%)*		-	0.65±0.08	0.84 (0.76, 0.90)	90.0
PE classes/wk *(%)*		-	0.82±0.08	0.94 (0.91, 0.96)	95.4
Participate in school sport *(%)*		0.76±0.11	-	-	88.0
School sport teams count *(%)*		0.62±0.11	-	-	75.0
Occupational PA:					
Main activity level at work *(%)*		0.54±0.09	-	-	74.1

Appendix 4.4 Continued

Survey items		**Kappa** ±SE	**Weighted kappa** ±SE	**ICC** (95%CI)	**Percent agreement** (%)
SB variables					
SB (excluding transport)	*(h/wkday)*	-	-	0.60 (0.37, 0.74)	-
	(h/wkend day)	-	-	0.74 (0.59, 0.83)	-
Recreational screen-time:					
Computer, laptop or tablet	*(h/wkday)*	-	-	0.63 (0.43, 0.76)	-
	(h/wkend day)	-	-	0.78 (0.65, 0.86)	-
E-games	*(h/wkday)*	-	-	0.47 (0.18, 0.66)	-
	(h/wkend day)	-	-	0.04 (-0.5, 0.38)^{NS}	-
TV, DVD, videos	*(h/wkday)*	-	-	0.65 (0.46, 0.78)	-
	(h/wkend day)	-	-	0.67 (0.48, 0.79)	-
Sedentary transport	*(day/wk)*	-	0.55±.07	0.83 (0.73, 0.89)	88.6
	(h/day)	-	-	0.34 (-0.02, 0.58)	-
School SB:					
Main activity level during school breaks *(%)*		-	0.65±0.08	0.84 (0.76, 0.90)	90.0
Occupational SB:					
Main activity level at work *(%)*		0.54±0.09	-	-	74.1

Appendix 4.4 Continued

Survey items	**Kappa** ±SE	**Weighted kappa** ±SE	**ICC** (95%CI)	**Percent agreement** (%)
Individual-level variables (scores)				
PA enjoyment	-	0.68±0.08	0.77 (0.65, 0.85)	90.1
	-	0.73±0.08	0.76 (0.63, 0.84)	91.7
	-	0.51±0.07	0.57 (0.34, 0.72)	88.9
PA goal setting	-	0.54±0.07	0.86 (0.78, 0.91)	84.1
	-	0.57±0.07	0.80 (0.70, 0.87)	84.6
	-	0.59±0.08	0.70 (0.54, 0.81)	88.8
PA competence	-	0.72±0.08	0.75 (0.62, 0.84)	90.1
PA self-efficacy	-	0.50±0.07	0.81 (0.71, 0.88)	82.5
	-	0.59±0.07	0.82 (0.73, 0.89)	84.5
	-	0.47±0.07	0.75 (0.61, 0.84)	82.6
	-	0.41±0.07	0.71 (0.55, 0.81)	81.4
	-	0.59±0.07	0.84 (0.75, 0.89)	84.8
TV avoidance self-efficacy	-	0.52±0.07	0.68 (0.51, 0.80)	82.4
	-	0.49±0.07	0.70 (0.54, 0.81)	83.1
	-	0.56±0.07	0.74 (0.60, 0.83)	83.3
	-	0.44±0.08	0.63 (0.43, 0.76)	79.1
	-	0.50±0.08	0.71 (0.55, 0.81)	82.1

Appendix 4.4 Continued

Survey items	**Kappa** ±SE	**Weighted kappa** ±SE	**ICC** (95%CI)	**Percent agreement** (%)
Social-level variables (scores)				
Family:				
E-games co-participation	-	0.37±0.08	0.58 (0.36, 0.73)	86.0
PA co-participation	-	0.61±0.07	0.71 (0.55, 0.81)	85.9
TV/DVDs co-participation	-	0.48±0.07	0.72 (0.57, 0.82)	82.2
PA social support	-	0.61±0.07	0.86 (0.78, 0.91)	85.9
		0.47±0.07	0.75 (0.61, 0.84)	80.3
	-	0.60±0.08	0.89 (0.83, 0.93)	86.3
SB discouragement	-	0.47±0.07	0.71 (0.55, 0.81)	85.5
Friends/colleagues:				
E-games co-participation	-	0.50±0.08	0.39 (0.06, 0.61)	84.4
PA co-participation	-	0.43±0.08	0.79 (0.67, 0.86)	79.7
TV/DVDs co-participation	-	0.35±0.08	0.13 (-0.35, 0.43)	79.4
PA social support	-	0.43±0.08	0.76 (0.62, 0.84)	79.7
		0.34±0.07	0.67 (0.49, 0.79)	78.4
	-	0.37±0.08	0.64 (0.44, 0.77)	84.1
SB discouragement	-	0.33±0.08	0.15 (-0.32, 0.45)	86.6
Social network count	-	-	0.96 (0.93, 0.97)	-
	-	-	0.93 (0.89, 0.96)	-
	-	-	0.00 (-0.56, 0.36)^{NS}	-
Gym membership	0.76±0.11	-	-	91.5

Appendix 4.4 Continued

Survey items	**Kappa** ±SE	**Weighted kappa** ±SE	**ICC** (95%CI)	**Percent agreement** (%)
Environment-level variables (scores)				
Home environment:				
E-devices, no. of	0.00±0.00	-	-	98.8
	0.55±0.11	-	-	96.3
	0.88±0.11	-	-	95.1
	0.57±0.11	-	-	82.7
	0.81±0.11	-	-	92.6
	0.70±0.11	-	-	85.2
PA equipment, no. of	0.78±0.11	-	-	88.9
	0.78±0.11	-	-	88.9
	0.70±0.11	-	-	88.9
	0.36±0.11	-	-	92.6
	0.79±0.11	-	-	91.4
TVs, no. of	-	-	0.96 (0.94, 0.98)	-
Neighbourhood environment:				
Noise	-	0.30±0.08	0.44 (0.14, 0.64)	80.0
Walking environment	-	0.19±0.08	0.48 (0.19, 0.66)	75.9
	-	0.46±0.08	0.69 (0.53, 0.80)	81.6
	-	0.29±0.08	0.69 (0.52, 0.80)	78.8
	-	0.36±0.08	0.46 (0.16, 0.65)	80.6

Appendix 4.4 Continued

Survey items	**Kappa** ±SE	**Weighted kappa** ±SE	**ICC** (95%CI)	**Percent agreement** (%)
Safety	-	0.50±0.08	0.68 (0.51, 0.79)	80.9
	-	0.55±0.08	0.60 (0.39, 0.74)	81.9
Social cohesion	-	0.45±0.09	0.71 (0.55, 0.81)	77.8
	-	0.46±0.09	0.65 (0.46, 0.77)	79.1
Land use mix diversity	-	0.76±0.08	0.94 (0.91, 0.96)	93.5
	-	0.71±0.07	0.92 (0.88, 0.95)	89.4
	-	0.54±0.07	0.81 (0.70, 0.87)	87.9
	-	0.59±0.07	0.80 (0.70, 0.87)	87.3
	-	0.65±0.07	0.85 (0.76, 0.90)	87.2
	-	0.63±0.08	0.85 (0.77, 0.90)	93.1
	-	0.68±0.07	0.89 (0.83, 0.93)	92.9
	-	0.80±0.07	0.94 (0.91, 0.96)	93.8
Recreation facilities	-	0.62±0.08	0.86 (0.78, 0.91)	90.9
	-	0.67±0.08	0.88 (0.82, 0.93)	89.1
	-	0.68±0.08	0.89 (0.83, 0.93)	91.3
	-	0.58±0.07	0.85 (0.76, 0.90)	87.1
	-	0.65±0.08	0.83 (0.74, 0.89)	90.4

CI: confidence interval; AT: active transport; DVDs: digital versatile discs; e-devices: electronic devices; e-games: electronic games; h: hours; ICC: internal correlation coefficient; LTPA: leisure-time physical activity; min: minutes; MPA: moderate-intensity physical activity; no.: number; NS: not significant; PA: physical activity; PE: physical education; SB: sedentary behaviour; SE: standard error; TV: television; VPA: vigorous-intensity physical activity; wk: week.

Appendix 4.5 Baseline distribution (mean±SD) for independent variables according to remoteness and area-level SEP

	Remoteness		Area-level SEP		
	Urban	**Rural**	**Lowest**	**Mid**	**Highest**
Individual-level variables (scores)					
PA enjoyment	11.7±2.6	11.8±2.6	11.6±2.7	11.8±2.6	11.8±2.6
PA goal setting	8.6±4.0	8.7±3.6	**8.1±3.6****	9.0±3.8	8.7±4.0
PA competence	**3.5±1.2***	3.5±1.3	3.4±1.3	3.5±1.2	3.6±1.1
PA self-efficacy	14.2±5.0	14.7±5.0	13.7±4.9	14.5±5.0	14.6±5.0
TV avoidance self-efficacy	16.1±4.7	15.9±4.7	15.2±4.9	15.6±4.6	16.8±4.6
Social-level variables					
Family (scores):					
E-games co-participation	**1.7±1.1***	1.6±1.0	**1.8±1.0****	1.8±1.2	1.5±0.9
PA co-participation	2.6±1.3	2.7±1.3	**2.5±1.2***	2.7±1.3	2.7±1.3
TV/DVDs co-participation	**3.4±1.2****	3.4±1.1	3.4±1.2	3.5±1.2	3.3±1.2
PA social support	9.4±3.3	9.8±3.2	9.0±3.3	9.7±3.2	9.7±3.2
SB discouragement	3.1±1.3	3.0±1.3	3.0±1.3	3.1±1.3	3.0±1.3
Friends/colleagues (scores):					
E-games co-participation	2.1±1.3	2.1±1.3	2.0±1.2	2.2±1.3	2.0±1.2
PA co-participation	2.8±1.4	3.0±1.4	2.9±1.4	2.9±1.4	2.9±1.3
TV/DVDs co-participation	2.8±1.2	2.8±1.2	2.8±1.2	2.8±1.2	2.8±1.2
PA social support	7.4±3.2	7.8±3.2	7.5±3.2	7.5±3.4	7.6±3.1
SB discouragement	1.7±1.0	1.7±1.0	1.8±1.1	1.8±1.1	1.7±0.9
Social network count	11.6±9.8	12.5±10.6	12.7±12.9	10.9±7.3	12.0±9.9
Gym membership	27.4%	30.9%	28.4%	26.1%	29.9%

Appendix 4.5 Continued

	Remoteness		Area-level SEP		
	Urban	**Rural**	**Lowest**	**Mid**	**Highest**
Environmental-level variables (scores)					
Home environment:					
E-devices, no. of	4.6±1.2	4.4±1.1	4.5±1.2	4.6±1.2	4.6±1.1
PA equipment, no. of	**1.9±1.2*** **	2.4±1.2	2.2±1.2	2.1±1.2	2.0±1.2
TV, no. of	**2.5±1.3** **	3.0±3.6	**2.9±4.0***	2.8±1.5	2.4±1.2
Neighbourhood environment:					
Noise	**2.6±1.0*** **	2.3±1.0	2.6±1.0	2.6±1.0	2.5±1.0
Walking environment	**16.0±2.8*** **	15.1±3.4	**15.4±2.9** **	15.3±3.2	16.3±2.8
Safety	7.2±1.9	7.5±1.9	**6.9±2.0*** **	7.1±2.0	7.7±1.7
Social cohesion	**7.2±1.6** **	7.7±1.7	**7.0±1.7*** **	7.2±1.8	7.7±1.5
Land use mix diversity	**3.4±2.1*** **	2.0±2.3	**2.6±2.3*** **	2.7±2.3	3.4±2.2
Recreation facilities	**2.6±1.4*** **	2.0±1.6	**2.3±1.6*** **	2.1±1.5	2.6±1.4

**p<0.05, **p<0.01, ***p<0.001: Pearson's χ^2 test of significance by remoteness or area-level SEP for categorical variables; independent t-test for continuous variables by remoteness; or one-way ANOVA for continuous variables by area-level SEP.*

DVD: digital versatile disc; e-devices: electronic devices; e-games: electronic games; PA: physical activity; SB: sedentary behaviour; SD: standard deviation; SEP: socio-economic position; TV: television.

Appendix 7.1 Time by gender, remoteness or area-level SEP interactions for changes in physical activity and sedentary behaviour between baseline and the two-year follow-up[1]

	Gender (Women *vs* men)		**Remoteness** (Rural *vs* urban)		**Area-level SEP** (Mid *vs* lowest, highest *vs* lowest)	
	B (95%CI)	*p*	B (95%CI)	*p*	B (95%CI)	*p*
Discretionary PA (mins/day)	-2.9 (-14.8, 9.1)	0.638	-1.4 (-12.6, 9.7)	0.803	-3.1 (-17.3, 11.1)	0.666
					9.4 (-3.5, 22.4)	0.153
LTPA (mins/day)	1.8 (-7.2, 10.8)	0.697	2.3 (-6.0, 10.7)	0.585	-0.9 (-11.6, 9.7)	0.862
					4.8 (-4.9, 14.5)	0.330
Walking	2.0 (-2.0, 6.0)	0.318	2.1 (-1.6, 5.8)	0.269	1.0 (-3.7, 5.8)	0.674
					1.6 (-2.7, 5.9)	0.469
Other MPA	-1.1 (-5.2, 3.0)	0.594	1.1 (-2.7, 4.9)	0.575	-1.8 (-6.6, 3.1)	0.470
					0.1 (-4.3, 4.5)	0.951
VPA	0.9 (-3.8, 5.7)	0.699	-0.5 (-4.9, 3.9)	0.823	0.3 (-5.3, 5.9)	0.922
					3.2 (-2.0, 8.3)	0.228
Active transport (mins/day)	-4.1 (-10.2, 2.0)	0.187	-3.0 (-8.7, 2.7)	0.298	-1.9 (-9.2, 5.3)	0.599
					5.0 (-1.6, 11.6)	0.140
Cycling for transport	0.9 (-3.1, 1.2)	0.382	-1.0 (-3.0, 0.9)	0.304	-1.7 (-4.2, 0.8)	0.182
					1.6 (-0.7, 3.9)	0.173
Walking for transport	-3.2 (-8.7, 2.4)	0.266	-2.0 (-7.2, 3.2)	0.454	-0.2 (-6.9, 6.4)	0.947
					3.4 (-2.7, 9.5)	0.271
Total SB (h/day)	-0.3 (-0.9, 0.3)	0.305	-0.9 (-1.5, -0.4)	**0.001**	0.1 (-0.6, 0.9)	0.689
					0.5 (-0.1, 1.2)	0.103
Sitting (excluding transport)	-0.2 (-0.8, 0.3)	0.383	-0.4 (-0.9, 0.1)	0.123	0.0 (-0.6, 0.7)	0.976
					0.4 (-0.2, 1.0)	0.202
Sedentary transport	-0.1 (-0.3, 0.1)	0.360	-0.5 (-0.7, -0.3)	**0.000**	0.1 (-0.1, 0.3)	0.356
					0.1 (-0.1, 0.3)	0.189

Appendix 7.1 Continued

	Gender (Women *vs* men)		**Remoteness** (Rural *vs* urban)		**Area-level SEP** (Mid *vs* lowest, highest *vs* lowest)	
	B (95%CI)	*p*	B (95%CI)	*p*	B (95%CI)	*p*
Total recreational screen time (h/day)	-0.1 (-0.7, 0.4)	0.575	-0.5 (-1.0, -0.1)	**0.027**	0.2 (-0.4, 0.8)	0.471
					0.6 (0.1, 1.2)	**0.020**
Watching TV, DVDs or videos	-0.1 (-0.4, 0.2)	0.418	-0.2 (-0.4, 0.1)	0.202	0.3 (0.0, 0.7)	**0.045**
					0.5 (0.2, 0.8)	**0.001**
Computer, laptop or tablet	0.0 (-0.3, 0.3)	0.841	-0.2 (-0.5, 0.1)	0.178	-0.1 (-0.4, 0.3)	0.733
					0.2 (-0.1, 0.5)	0.206
E-games	0.0 (-0.1, 0.1)	0.901	-0.1 (-0.2, -0.0)	**0.030**	-0.0 (-0.1, 0.1)	0.909
					0.1 (-0.1, 0.2)	0.350

[1] *Baseline to 1-year follow-up data not shown and there were two p-values <0.05 for time by area-level SEP highest* vs *lowest tertiles for discretionary PA and total recreational screen time.*

B: correlation coefficient; CI: confidence interval; DVD: digital versatile disc; e-games: electronic games; h: hours; LTPA: leisure-time physical activity; mins: minutes; MPA: moderate-intensity physical activity; PA: physical activity; SB: sedentary behaviour; TV: television; VPA: vigorous-intensity physical activity.

Appendix 7.2 Interactions between situational transitions and changes in discretionary physical activity and total sedentary behaviour

Situational transition at the 2-year follow-up	*n* (%)	Changes in discretionary PA				Changes in total SB			
		T2-1 (*p*[a])	T3-1 (*p*[a])	AIC[b]	AIC[a]	T2-1 (*p*[a])	T3-1 (*p*[a])	AIC[b]	AIC[a]
Tertiary student status				24312.47	24313.12			10420.75	**10395.48**
Yes	631 (79.3)	0.153	0.087			0.405	**0.000**		
No (ref.)	165 (20.7)								
Work hour				24479.00	24479.98			10511.66	**10465.45**
≥20 h/wk	219 (27.2)	0.425	0.584			0.866	**0.000**		
<20 h/wk	401 (49.9)	0.552	0.789			0.813	0.602		
Not working (ref.)	184 (22.9)								
Lived with parents status				24160.34	24162.50			10411.27	**10407.56**
Yes	638 (80.9)	0.183	0.662			0.659	**0.009**		
No (ref.)	167 (19.1)								
Study and work combinations				24283.21	24289.84			10390.20	**10367.09**
Worked exclusively	145 (18.2)	0.775	0.900			0.624	0.276		
Studied exclusively	163 (20.5)	0.729	0.612			0.728	0.349		
Concurrently studied and worked	468 (58.9)	0.848	0.446			0.896	0.718		
Neither studied nor worked (ref.)	19 (2.4)								
Studied and lived with parents status				24002.37	24005.29			10729.23	**10701.49**
Studying while living with parents	493 (62.8)	0.082	0.071			0.561	**0.000**		
Studying while living independently	127 (16.2)	0.779	0.357			0.495	0.177		
Not studying (ref.)	165 (21.0)								
Worked and lived with parents status				24244.32	24247.99			10840.00	**10834.58**
Working while living with parents	515 (64.8)	0.727	0.498			0.818	**0.024**		
Working while living independently	96 (12.1)	0.085	0.659			0.640	**0.001**		
Not working (ref.)	184 (23.1)								

[a] Situational transition was an interaction term in models; [b] Situational transition was an independent variable in models. Mixed-effects multi-level linear regression models adjusted for English as the primary language at home, age, gender and survey mode, and accounted for school clusters.

Appendix 8.1 Interaction effects[1] between baseline levels of the independent variables and situational transitions on discretionary physical activity (mins/day) after leaving secondary school

	Tertiary student status (Ref: no)		**Working ≥20 h/wk** (Ref: working <20 h/wk)		**Living with parents status** (Ref: no)	
	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*
Individual-level variables (scores)						
PA enjoyment	-12.5 (-38.3, 13.4)	0.345	24.8 (-0.3, 49.9)	0.053	8.4 (-18.9, 35.8)	0.546
PA goal setting	-19.2 (41.1, 2.8)	0.087	18.7 (-0.9, 38.2)	0.061	5.0 (-17.1, 27.2)	0.655
PA competence	-10.5 (-32.3, 11.3)	0.346	14.7 (-5.0, 34.3)	0.144	6.3 (-15.6, 28.2)	0.571
PA self-efficacy	-14.6 (-36.2, 7.1)	0.187	27.4 (8.1, 46.6)	**0.005**	18.9 (-2.9, 40.7)	0.089
TV avoidance self-efficacy	12.9 (-8.9, 34.6)	0.247	6.2 (-13.3, 25.8)	0.532	-0.0 (-22.6, 22.5)	0.999
Social-level variables						
Family (scores):						
E-games co-participation	-10.0 (-52.3, 32.3)	0.642	20.0 (-17.9, 57.9)	0.302	25.4 (-18.2, 69.0)	0.254
PA co-participation	-9.7 (-34.7, 15.3)	0.446	31.3 (9.3, 53.4)	**0.005**	7.2 (-16.6, 31.0)	0.554
TV/DVDs co-participation	-20.3 (-42.1, 1.5)	0.068	3.3 (-16.3, 23.0)	0.738	2.1 (-19.8, 24.0)	0.850
PA social support	1.3 (-20.2, 22.8)	0.906	8.4 (-10.9, 27.7)	0.392	14.8 (-7.4, 36.9)	0.192
SB discouragement	-27.0 (-49.6, -4.5)	**0.019**	-5.5 (-25.7, 14.8)	0.598	-22.7 (-45.2, -0.3)	**0.047**
Friends/colleagues (scores):						
E-games co-participation	-11.8 (-39.5, 15.8)	0.402	21.0 (-6.0, 48.1)	0.127	40.3 (5.1, 75.4)	**0.025**
PA co-participation	-0.3 (-22.3, 21.6)	0.976	3.6 (-16.5, 23.6)	0.728	11.0 (-11.4, 33.5)	0.335
TV/DVDs co-participation	-3.7 (-26.4, 19.0)	0.750	10.6 (-9.8, 31.1)	0.308	24.8 (0.9, 48.7)	**0.042**
PA social support	-3.3 (-27.0, 20.4)	0.786	4.3 (-17.6, 26.2)	0.700	21.4 (-3.5, 46.4)	0.092
SB discouragement	-33.9 (-79.7, 11.8)	0.146	62.6 (21.8, 103.4)	**0.003**	9.4 (-33.6, 52.5)	0.667
Social network count	3.5 (-18.1, 25.1)	0.750	-4.0 (-23.3, 15.4)	0.689	-1.5 (-23.4, 20.4)	0.891
Gym membership	8.1 (-15.4, 31.7)	0.497	13.7 (-6.9, 34.3)	0.193	17.6 (-5.7, 41.0)	0.139

Appendix 8.1 Continued

	Tertiary study status (Ref: no)		**Working ≥20 h/wk** (Ref: working <20 h/wk)		**Living with parents status** (Ref: no)	
	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*
Environmental-level variables						
Home environment:						
E-devices, no. of	-7.3 (-35.0, 20.4)	0.606	26.2 (1.7, 50.8)	**0.036**	11.1 (-16.1, 38.4)	0.423
PA equipment, no. of	15.8 (-6.0, 37.7)	0.156	1.9 (-17.9, 21.7)	0.850	22.4 (0.2, 44.6)	**0.048**
TVs, no. of	-23.5 (-45.2, -1.8)	**0.034**	9.1 (-10.6, 28.7)	0.365	-0.3 (-22.7, 22.1)	0.979
Neighbourhood environment (scores):						
Noise	-5.9 (-32.5, 20.7)	0.663	4.7 (-19.8, 29.2)	0.707	1.8 (-24.9, 28.6)	0.894
Walking environment	-1.3 (-32.7, 30.1)	0.935	15.2 (-12.5, 42.9)	0.282	-0.3 (-29.9, 29.3)	0.985
Safety	2.0 (-20.5, 24.5)	0.862	9.2 (-11.3, 29.7)	0.380	0.4 (-22.4, 23.2)	0.972
Social cohesion	11.0 (-12.6, 34.5)	0.361	11.6 (-9.1, 32.4)	0.271	6.0 (-17.4, 29.5)	0.614
Land use mix diversity	15.0 (-6.4, 36.4)	0.169	-20.1 (-39.4, -0.8)	**0.041**	-2.0 (-24.2, 20.2)	0.859
Recreation facilities	-6.7 (-28.5, 15.1)	0.546	12.5 (-7.0, 31.9)	0.209	1.8 (-20.3, 24.0)	0.872

B: correlation coefficient; CI: confidence interval; DVD: digital versatile disc; e-devices: electronic devices; e-games: electronic games; mins: minutes; no.: number; PA: physical activity; ref: reference group; SB: sedentary behaviour; TV: television.

Generalised estimation equations: PA models adjusted for baseline PA, maternal education, English as the primary language spoken at home, area-level SEP, age, gender, survey mode and school clusters; SB models adjusted for baseline SB, paternal education, English as the primary language spoken at home, participant born in Australia, remoteness, age, gender, survey mode and school clusters.

[1] *Coefficient of the interaction term (independent variable*situational transition).*

Appendix 8.2 Interaction effects[1] between baseline levels of the independent variables and situational transitions on total sedentary behaviour (h/day) after leaving secondary school

	Tertiary study status (Ref: no)		**Working ≥20 h/wk** (Ref: working <20 h/wk)		**Living with parents status** (Ref: no)	
	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*
Individual-level variables (scores)						
PA enjoyment	0.5 (-0.9, 1.9)	0.510	-0.7 (-2.1, 0.7)	0.311	0.4 (-1.2, 1.9)	0.639
PA goal setting	0.1 (-1.1, 1.3)	0.877	0.3 (-0.8, 1.3)	0.621	-0.8 (-2.0, 0.5)	0.220
PA competence	-0.5 (-1.7, 0.7)	0.430	-0.1 (-1.2, 0.9)	0.809	0.3 (-0.9, 1.5)	0.645
PA self-efficacy	-0.1 (-1.3, 1.1)	0.849	0.8 (-0.3, 1.8)	0.158	-0.1 (-1.3, 1.2)	0.920
Social-level variables						
Family (scores):						
E-games co-participation	-0.9 (-3.3, 1.4)	0.431	1.3 (-0.7, 3.4)	0.198	0.8 (-1.6, 3.2)	0.521
PA co-participation	0.8 (-0.6, 2.1)	0.274	-0.1 (-1.3, 1.1)	0.822	1.4 (0.1, 2.8)	**0.037**
TV/DVDs co-participation	0.6 (-0.6, 1.8)	0.358	0.3 (-0.8, 1.3)	0.614	-0.1 (-1.3, 1.1)	0.880
PA social support	-0.1 (-1.2, 1.1)	0.931	0.4 (-0.7, 0.4)	0.471	0.2 (-1.0, 1.5)	0.721
SB discouragement	1.1 (-0.2, 2.3)	0.090	-0.7 (-1.8, 0.4)	0.193	-0.2 (-1.5, 1.0)	0.726
Friends/colleagues (scores):						
E-games co-participation	0.3 (-1.2, 1.8)	0.715	0.4 (-1.1, 1.9)	0.583	-0.1 (-2.0, 1.8)	0.927
PA co-participation	0.0 (-1.2, 1.2)	0.985	0.8 (-0.3, 1.8)	0.173	0.6 (-0.6, 1.9)	0.331
TV/DVDs co-participation	1.0 (-0.3, 2.2)	0.128	-0.1 (-1.2, 1.0)	0.838	-0.4 (-1.8, 0.9)	0.531
PA social support	-0.4 (-1.7, 0.9)	0.514	0.8 (-0.3, 2.0)	0.165	0.9 (-0.4, 2.3)	0.180
SB discouragement	0.9 (-1.7, 3.4)	0.508	-3.5 (-5.6, -1.3)	**0.002**	1.8 (-0.6, 4.2)	0.146
Social network count	0.6 (-0.6, 1.8)	0.293	0.4 (-0.7, 1.5)	0.459	0.0 (-1.2, 1.3)	0.941
Gym membership	0.0 (-1.3, 1.3)	0.964	0.1 (-1.0, 1.3)	0.816	0.3 (-1.0, 1.6)	0.630

Appendix 8.2 Continued

	Tertiary study status (Ref: no)		**Working ≥20 h/wk** (Ref: working <20 h/wk)		**Living with parents status** (Ref: no)	
	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*	B (95%CI)[1]	*p*
Environmental-level variables						
Home environment:						
E-devices, no. of	-1.2 (-2.8, 0.3)	0.126	0.0 (-1.3, 1.4)	0.964	1.1 (-0.5, 2.6)	0.173
PA equipment, no. of	0.6 (-0.6, 1.8)	0.337	-0.7 (-1.8, 0.3)	0.182	-0.2 (-1.4, 1.1)	0.793
TVs, no. of	-0.3 (-1.5, 0.9)	0.640	0.1 (-1.0, 1.2)	0.870	0.0 (-1.2, 1.3)	0.991
Neighbourhood environment (scores):						
Noise	-0.5 (-2.0, 1.0)	0.504	-0.3 (-1.7, 1.1)	0.670	-1.1 (-5.6, 0.4)	0.156
Walking environment	0.3 (-1.5, 2.1)	0.754	0.5 (-1.1, 2.0)	0.561	1.1 (-0.6, 2.8)	0.215
Safety	-0.3 (-1.6, 1.0)	0.647	0.1 (-1.0, 1.3)	0.837	-0.4 (-1.7, 0.9)	0.515
Social cohesion	-1.0 (-2.3, 0.4)	0.151	0.6 (-0.5, 1.8)	0.287	-0.4 (-1.7, 1.0)	0.596
Land use mix diversity	0.2 (-1.0, 1.4)	0.777	-0.7 (-1.7, 0.4)	0.221	0.3 (-0.9, 1.5)	0.630
Recreation facilities	0.2 (-1.0, 1.4)	0.777	-0.2 (-1.3, 0.8)	0.657	-0.2 (-1.5, 1.0)	0.724

B: correlation coefficient; CI: confidence interval; DVD: digital versatile disc; e-devices: electronic devices; e-games: electronic games; no.: number; PA: physical activity; ref: reference group; SB: sedentary behaviour; TV: television.

Generalised estimation equations: PA models adjusted for baseline PA, maternal education, English as the primary language spoken at home, area-level SEP, age, gender, survey mode and school clusters; SB models adjusted for baseline SB, paternal education, English as the primary language spoken at home, participant born in Australia, remoteness, age, gender, survey mode and school clusters.

[1] *Coefficient of the interaction term (independent variable*situational transition).*

Appendix 8.3 Associations between situational transitions and difference in adjusted marginal means of discretionary physical activity and total sedentary behaviour at the two-year follow-up, stratified by significant baseline moderators

		Discretionary PA (mins/day) B (95%CI)	**Total SB** (h/day) B (95%CI)
Studied (Ref: No), n=796			
SB discouragement from family score	Low (≤3)	9.6 (-3.6, 22.8)	-
	High (>3)	-15.1 (-34.7, 4.5)	-
TVs, no. of	Low (≤2)	**15.2 (0.3, 30.1)***	-
	High (>2)	-12.6 (-29.6, 4.3)	-
Worked ≥20 h/wk (Ref: Worked <20 h/wk), n=804			
PA self-efficacy score	Low (≤15)	6.3 (-4.6, 17.1)	-
	High (>15)	**30.2 (12.0, 48.4)****	-
PA co-participation with family score	Low (≤3)	**13.2 (2.2, 24.3)***	-
	High (>3)	**36.1 (14.7, 57.6)****	-
SB discouragement from friends/colleagues score	Low (≤3)	**13.5 (3.4, 23.6)****	**-1.8 (-2.4, -1.3)*****
	High (>3)	**113.9 (65.2, 162.6)*****	**-5.8 (-7.9, -3.7)*****
E-devices, no. of	Low (≤3)	-2.4 (-21.6, 16.8)	-
	High (>3)	**24.2 (13.1, 35.3)*****	-
Land use mix diversity	Low (≤2)	**24.9 (10.7, 39.2)****	-
	High (>2)	10.2 (-3.7, 24.1)	-
Lived with parents (Ref: No), n=805			
PA co-participation with family score	Low (≤3)	-	-0.2 (-0.9, 0.6)
	High (>3)	-	**1.5 (0.4, 2.7)****
SB discouragement from family score	Low (≤3)	12.7 (-1.1, 26.4)	-
	High (>3)	-6.5 (-24.3, 11.3)	-
E-games co-participation with friends/colleagues score	Low (≤3)	-4.1 (-15.0, 6.8)	-
	High (>3)	41.6 (-2.6, 85.9)	-
TV/DVD co-participation with friends/colleagues score	Low (≤3)	-5.5 (-18.6, 7.5)	-
	High (>3)	**21.3 (2.3, 40.2)***	-
PA equipment, no. of	Low (≤2)	-7.0 (-20.3, 6.3)	-
	High (>2)	11.6 (-7.2, 30.3)	-

**p<0.05, **p<0.01, ***p<0.001: generalised estimating equation.*

B: correlation coefficient; CI: confidence interval; DVD: digital versatile disc; e-devices: electronic devices; e-games: electronic games; h: hours; mins: minutes; no.: number; ref: reference group; PA: physical activity; SB: sedentary behaviour; TV: television; wk: week.