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Prevalence and socioecological correlates of sedentary behaviour among university students in England

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy. The candidate has already achieved 180 credits for assessment of taught modules within the blended learning PhD programme

June 2020

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I declare that this thesis is my own work and has not been submitted for the award of a higher degree elsewhere

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Abstract

Sedentary behaviour (sitting time) holds public health significance as it is associated with detrimental effects on morbidity and mortality. The objective of this thesis was to examine the prevalence and socio-ecological correlates of sedentary behaviour amongst university students, with an emphasis on ethnic minority university students. The socio-ecological model of sedentary behaviour was employed as a theoretical framework to inform a series of regression models that identified the intrapersonal, interpersonal, perceived environmental, behaviour setting and policy-related correlates of sedentary behaviour. These models were estimated using secondary data from the Health Survey of England (HSE) and primary data collected at a London university. In Study 1 there was a focus on measuring the prevalence and intrapersonal correlates of sedentary behaviour in sub-samples of university students drawn from two waves of the HSE (2008 and 2012). Study 1 measured sedentary behaviour with two questions about time spent sitting watching television or for any other activity both on weekdays and weekends. In Study 2, primary data from a sample of 340 students was analysed and there was focus on socio-ecological correlates of sedentary behaviour at a university with a large ethnically diverse student population. Study 2 utilized the Marshall sitting questionnaire that collects data about domain-specific sedentary behaviour that includes: sitting at work, during travel, sitting at university, sitting for leisure time without watching television, sitting at home using computer and watching television both on the weekdays and weekends. Study 1 revealed that students in England spent around six (± 1.4) hours/day sitting, comparable with the general population. The intrapersonal and some interpersonal factors, such as age, ethnicity, physical activity, mental wellbeing and health-related quality of life, were statistically significantly associated with sedentary behaviour. Study 2 found that students at the London university spent on average 11.7 ± 3.3 hours/day sitting (mainly sitting at university or using a computer), nearly twice that of the general population in England. In Study 2, gender, employment status, income, social status and place of residence were statistically significantly associated with sedentary behaviour. In a subgroup analysis of ethnic minority students versus White students, gender, income, and employment status were significantly associated with sedentary time among ethnic minority students, whereas among White students only social class was significantly associated with sedentary time. Overall, the socio-ecological correlates found to be more strongly associated with sedentary behaviour in White and ethnic minority students were intrapersonal and interpersonal factors rather than environmental factors. Interventions and university policies targeting the intrapersonal and interpersonal correlates of sedentary behaviour may prove successful in reducing sedentary time amongst university students.

Acknowledgements

I take this opportunity to express my gratitude to the person who has been most instrumental in my pursuing a PhD degree, my father Mr. Abdul Hayee. He taught me to read and always wanted me to acquire more knowledge because he told me that knowledge is an indispensable asset that no one can steal from you and it makes you better than others. It was his dream to see me complete this PhD but unfortunately, only recently I lost him. I hope I can still make him proud by the successful completion of it.

I also want to show my greatest appreciation to Dr Paula Holland and Dr Eugenio Zucchelli for their tremendous support and encouragement during the thesis.

Chapter 1

Introduction

1 Introduction to the study

Globally, sedentary behaviour (too much sitting) independent of physical activity, is a major public health issue because most adults are sedentary for 50-60% of their waking hours and physically active for only 3% of this time (Healy, 2011; Biddle & Bennie, 2017). More specifically, if an individual sleeps for eight hours in a day and undertakes 30 minutes' physical activity, their remaining 15.5 hours are mostly spent in sedentary pursuits (Hamilton et al., 2011).

An analysis of the Global Burden of Diseases, Injuries and Risk Factors Study (2015) found that sedentary behaviour (time spent sitting) and low participation in physical activities were estimated to be the most important risk factors to health in England (Newton et al., 2015). The overall costs of physical inactivity to the National Health Service (NHS) in England were around £450 million a year (Public Health England, 2016).

Recent advancements in society have resulted in an increased reliance on technology due to which people tend to spend more time in sedentary pursuits. This change in lifestyle has contributed to an epidemiological transition, resulting in an increased prevalence of non-communicable diseases (Bhopal, 2005; Mckeown, 2009). The observation of the link between sedentary behaviour and adverse health outcomes dates to the pioneering work of Morris et al. (1953). The authors observed that men in sedentary occupations had a higher prevalence of mortality from cardiovascular diseases compared to their active counterparts. The cardiovascular mortality rates of

London double-decker bus conductors (who spent their working hours walking up and down the stairs of the buses collecting fares from passengers) was compared with bus drivers who predominantly sat behind the steering wheel. The conductors were reported to be not only slimmer, as suggested by the smaller size of their uniform, but also had a lower incidence of cardiovascular disease compared to bus drivers. Morris et al. (1953) also compared the cardiovascular disease rates of postmen (an active occupation) with telephone operators (a sedentary occupation) and found that the latter had a higher prevalence of cardiovascular disease. Morris and colleagues later conducted longitudinal studies, which demonstrated that physical activity protects against the development of cardiovascular diseases (cited in Paffenbarger et al., 2001).

Several further studies have reported adverse health outcomes associated with sedentary behaviour. For example, an Australian cohort study reported sedentary behaviour to be a strong predictor of waist circumference (Dunstan et al., 2010). Two international meta-analyses found that sedentary behaviour was linked with a higher risk of diabetes; heart disease; cancer mortality; and an increased risk of all-cause mortality (Wilmot et al., 2012; Biswas et al., 2015). Similarly, Edwardson et al. (2012) report in a meta-analysis that sedentary individuals had a 73% increased chance of getting a metabolic syndrome when compared with the least sedentary group. This is supported by a review of prospective studies among adults as a positive relationship between sedentary behaviour and Type II Diabetes and all-cause mortality was reported by Proper et al. (2011).

1.1 Physical inactivity and sedentary behaviour

It is important that the distinction between physical inactivity and sedentary behaviour is clarified. Physical inactivity is being insufficiently physically active to meet the

present physical activity recommendations of the Chief Medical Officer (2019) (Trembley et al., 2017). Biddle et al. (2018) posit that physical inactivity is insufficient physical activity or non-adherence to the physical activity recommendations or not enough physical activity for health gains. It includes, not following the physical activity guidelines whereas sedentary behaviour only involves sitting or lying down while awake. Moderate-to-vigorous physical activities include cycling, swimming, and running. These require energy expenditure of 3-8 times the basal metabolic rate (3-8 METs) (Owen et al., 2010). One may follow the physical activity recommendations yet remain sedentary for the rest of the day (Biddle et al., 2018; Marshall et al., 2002; CMO, 2019). For example, a highly active person could be running daily (moderate or vigorous activity for 30 minutes) but sitting for the rest of the day (Biddle et al., 2018).

Evidence suggests that physical activity has a protective effect on health (Anokye et al., 2012). Participation in moderate-to-vigorous physical activity reduces the chances of developing chronic diseases, such as diabetes, heart disease, hypertension and cancers (Department of Health and Human Services, 2008; Anokye et al., 2012). Most high-income countries have developed national guidelines for physical activity. These guidelines are very similar and suggest that adults should endeavour to engage in 150 minutes of moderate physical activity or 75 minutes of vigorous activity over a week (Table 1.1). According to these guidelines, individuals who do not achieve these levels of activity are regarded as insufficiently active but there has been confusion as to whether to label them as sedentary (WHO, 2015). Bames et al. (2012) state that individuals should be classified as insufficiently active if they do not meet the guidelines of physical activity, and that the use of the term ‘sedentary behaviour’ should be utilized only when refereeing to time spent sitting or lying down while awake.

Table 1. 1

A comparison of recommendations to improve physical activity and reduce sedentary behaviour

Type of activity	Explanation	Example	Recommendations	METS
Vigorous Physical Activity	Requires a large amount of effort and causes rapid breathing and a substantial increase in heart rate.	Jogging Swimming	75 minutes per week. Or in 10-minute bouts summing up to 75 minutes per week.	>6 METS
Moderate Physical Activity	Activity that requires a moderate amount of effort and slightly increases the heart rate.	Brisk walking Cycling	5 X 30 minutes per week. Or in bouts of 10 minutes summing up to 150 minutes per week.	3-6 METS
Sedentary Behaviour	At rest, minimal energy expenditure.	Sitting	Reduce sitting time addition in 2019 is to break up long periods of inactivity with exercise	<1.5 METS

Notes: METs are multiples of metabolic rate (one MET is the energy spent resting quietly which means an oxygen uptake of 3.5 ml/kg/min and in terms of calories, a 70 kg adult burns about 1.2 kcal/min while sitting) (CMO, 2011 & 2019; Ainsworth et al., 2000; Pate et al., 2008; Jette et al., 1990.

1.2 Conceptual and definitional ambiguity about sedentary behaviour

Ambiguity remains about the quantitative guidelines on how much sedentary behaviour is harmful to health. In England, the CMO's physical activity guidelines state that individuals (adults and children) should spend less time sitting per day, but without any specific quantification (2011 & 2019). However, the Canadian Society of Exercise Physiology (2017) published guidelines for youth and children stating that recreational sedentary behaviour should be minimized to two hours per day (cited in Trembaly et al., 2011). The American Society of Paediatrics (2016) states that children should spend a maximum of two hours watching television but does not advise on other forms of sedentary behaviour. Most of these guidelines only refer to sedentary time in one context, screen viewing time, disregarding other forms of sedentary behaviour.

Leitzmann et al. (2017) argue that in the literature there are inconsistencies in what is termed sedentary behaviour. 'Sedentary' originates from the Latin term 'sedere', which means to sit (Marshall and Ramirez, 2011). Sedentary behaviour and physical inactivity are both an absence of physical activity and initially both terms were often confused. The American College of Sports Medicine (2006) defined sedentary behaviour as not meeting the physical activity recommendations suggested by the US Surgeon General (Center for Disease Control, 2015). Pate et al. (2008) provided a specific definition, stating that it is any activity that does not increase energy expenditure above the resting level and only includes activities that involve sitting. Trembley et al. (2017) defines sedentary behaviour as any waking behaviour characterized by an energy expenditure of ≤1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture.

Marshall et al. (2002) proposed that when describing sedentary behaviour, it should include a description of the topography, in other words what the individual was doing at that time. There are two dimensions: time spent being sedentary (volume of sedentary behaviour) and type (sitting or lying) (Marshall et al., 2002). Several factors could influence an individual's choice to engage in sedentary pursuits. Sallis et al. (2008) suggest that the socio-ecological theory recognises that the individual's behaviour is dependent on dynamic relationships among many factors, such as the socio-cultural environment, policy, natural and built environment; and across several levels, such as intrapersonal and interpersonal factors. The socio-ecological framework has been applied to physical activity research in several studies (Prince et al., 2011; Giles-Corti et al., 2002). The same theory has been applied to sedentary behaviour by Owen and colleagues (2011) to understand the factors associated with sedentary behaviour in different contexts and is adopted for the research for this thesis. The authors describe four domains of sitting-time: transport, occupation, home, and leisure-time (elaborated in Chapter 2) (Owen et al. 2011). Marshall et al. (2010) have classified the domains into five categories: 1) traveling to and from places; 2) occupation; 3) watching television; 4) computer use at home; and 5) leisure activities other than watching television.

1.3 Problem statement

Higher levels of sedentary behaviour are associated with adverse health outcomes across the life span, in children of school-age, adolescents, working age adults and older adults (Carson et al., 2016; Stamatakis et al., 2012; Biddle et al., 2011; Van Uffelen et al., 2010). There is a well-established stream of research around sedentary behaviour

and its relevance is rapidly developing especially in the last decade **(**Leitzmann et al., 2017; Biddle et al., 2017). Previous studies have focused on pre-schoolers, school children, adolescents and different occupational groups, although less is known about sedentary behaviour among university students (Steward-Brown et al., 2000; Biddle et al., 2011; Ryan et al., 2011; Thorp et al., 2012; Parry & Staker, 2013). However, university students are an equally important high-risk subgroup because of the sedentary nature of their academic studies. There is a scarcity of research about university students but the limited evidence that exists suggests that they spend most of their time in sedentary behaviour (Rouse & Biddle, 2010; Prapavessis et al., 2015; Castro et al., 2020).

Importantly, both public health practitioners and academics argue that university students have been overlooked within sedentary behaviour research (Leslie et al., 1999; Steward-Brown et al., 2000; Rouse & Biddle, 2010). University students may be considered an important group in the light of sedentary behaviour research as nearly half of the adults in high-income countries have attended university (Organisation for Economic Co-operation and Development, 2009). University students often engage in activities that require sitting, such as attending lectures, seminars, workshops and studying for exams. Technological advancements in education and entertainment may have contributed to an increase in sedentary time amongst students (Sparling, 2003). For instance, a Canadian study amongst university students reports that students spend around more than 11 hours per day in sedentary pursuits and that their sedentary behaviour levels equal or even surpass those of desk-based workers (Moulin & Irwin, 2017). Macneela et al. (2012) report that during a week, students in Ireland, UK generally spend 17.3 hours in class and tutorials and 10.6 hours engaging with personal study either on or off campus. A study conducted in the US reported

that university students' daily sitting time significantly increased from their first year of university (329.6±192 min/day) to their final year (405.2±240.3 min/day) (Johnson et al., 2010). Buckworth and Nick (2004) report that a large proportion of university students' sitting time is accumulated while in class. There is limited evidence on university students' sedentary behaviour, requiring a need for further research, especially in the UK as only one study conducted by Rouse and Biddle (2010) has appropriately examined the prevalence of sedentary behaviour amongst UK university students.

In the UK, the start of university coincides with the end of formal physical activity education, which is included in the curriculum of primary and secondary schools (Department for Education, 2020). As a result, the evidence suggests that a large proportion of university students often engage in lower levels of physical activity than before (Sports England, 2019). This is supported by studies conducted in the US and Germany, which reported a decline in physical activity participation by students transitioning from high school to university (Deforche et al., 2015; Diehl & Hilger, 2016). In England, university students have been reported to have a low prevalence of physical activity: around 34.5% complied with the physical activity guidelines of 150 minutes per week suggested by the Chief Medical officer (CMO) (Al Ansari et al., 2011). Conversely, 50% of American and Canadian students comply with physical activity recommendations (Irwin, 2004; American College Health Association, 2009). Although some universities encourage students to participate in physical activities, for instance by subsidizing gym memberships, Leslie et al. (1999) and Sparling (2003) argue that only students that are already motivated and previously active before attending university tend to exploit such opportunities.

A large proportion of students entering university report high stress levels (Adlaf et al., 2001; National Union of Students, 2017); extreme pressure to succeed; and difficulties related to financial constraints and family responsibilities (Iarovici, 2014). In the last decade, in England students' fees have substantially increased and so have students' debts and loans (Brown Report, 2012). Eisenberg et al. (2007) suggest that students who feel the financial strain or burden of a loan during their time at university tend to suffer higher levels of mental health problems. This is supported by research from the US, where students often pay their university fees by taking loans that they repay later (Kruisselbrink, 2013).

Keating et al. (2005) state that the stress of university students can be managed if they engage in regular physical activity. Research suggests that regular engagement is positively associated with better psychological wellbeing, improved cognitive performance and better academic achievement (Fox, 1999; Keating et al., 2005; Biddle & Asare, 2011).

In addition to high stress levels, students often have unhealthy eating habits (Brunt & Rhee, 2007) and are also known to have a high intake of alcohol relative to their peers in the general population (Burke et al., 2005; Slutske et al., 2005). Some university students tend to gain weight during university because of a poor diet and lack of physical activity (Jackson et al., 2009).

The health of university students has not been investigated as closely as other population sub-groups (Steward-Brown et al., 2000). University is a transition phase in an individual's life and health behaviours of students during this time are often influenced by temporary time constraints, lack of resources and stress. Research shows that health habits formed at university generally tend to last long-term (Steptoe et al.,

2005; Keating et al., 2005). Changes in health-related habits occurring during this critical period, therefore, may play a major role in determining an individual's future health. University life is considered as students' formative years which provides an excellent opportunity to raise health consciousness (Abercrombie, Gatrell & Thomas, 2000). This is particularly important given that some graduates will become future policy makers, public health professionals, healthcare professionals or academics, responsible for influencing the health of future generations (Gaffney et al., 2002; Steptoe et al., 2005; Fernandez et al., 2010).

Another important issue associated with sedentary behaviour is the increasing ethnic diversity among British university students, partly influenced by the government's widening participation agenda and immigration (Higher Education Funding Council for England, 2014). In this thesis the definition and understanding of ethnicity will be in accordance to the UK Census data. In the UK, membership of an ethnic group is considered subjectively meaningful to the concerned person, it is their own prerogative to identify the group they feel and think they have a sense of belonging to (Wimmer, 2008; Office of National Statistics, 2020). In the UK, ethnic minorities are divided into five main categories with further subcategories: 1) White, 2) Mixed multiple ethnic groups, 3) Asian/ Asian British, 4) Black / African / Caribbean / Black British and 5) Other ethnic groups (Office of National Statistics, 2020). Both the 2001 and 2011 Census data reported that all ethnic minorities in the UK, except for Chinese people, had poorer health than White British people, and this was true for both males and females (Centre for Dynamics of Ethnicity, 2013). In the 2011 Census 50% of ethnic minorities in England reported to have a limiting long-term illness (Becares et al., 2012). Ethnic minorities especially Black ethnic minorities report a higher rate of hypertension than White people (Karlsen & Nazroo, 2010). Diabetes was five times

higher in Asian people than White British (International Centre for Lifecourse Studies, 2010).

In addition, ethnic minority groups have lower rates of participation in sports and physical activity and higher rates of sedentary lifestyles compared to White groups (Sports England, 2018). Research about physical activity participation among ethnic minority university students in the US showed that Black and Asian females were less physically active than White students (Suminski et al., 2002; Irwin, 2004). This is supported by research in England, which found that 60% of students did not follow the physical activity guidelines and Asian and Black university students made up a large proportion of this insufficiently active group (Waldhäusl et al., 2016). Students reported that a lack of resources to purchase gym membership and time constraints prevented them from participating in physical activity (Waldhäusl et al., 2016).

It is important to understand that ethnic minority students may experience university life differently (Forbus et al., 2011), as they might be the first in their family to attend university and may lack parental support in choosing their course of study (Taylor & House, 2010). Another observation by Woolf et al. (2011) was that around 30% of ethnic minority students studying at UK universities belong to low socio-economic groups and often enter university as mature students. In addition to university attendance and academic work, around 43% of ethnic minority students either have full-time or part-time work, dependent children and, in most cases, financial constraints (Taylor & House, 2010). Most ethnic minority students have been reported to be living in two worlds: the world of college and the world of their family responsibilities (Taylor & House, 2010). Woolf et al. (2011) report that some ethnic minority students tend to underperform academically compared to White students due to lack of financial and

family support in their studies. As a result, ethnic minority students report a higher prevalence of mental health issues, poor mental wellbeing, increased social problems, such as social exclusion, difficulties in socializing and lack of social support, as well as lack of energy and increased fatigue compared to White students (Carney-Crompton & Tan, 2002).

Therefore, it is possible that ethnic minority students, relative to their White counterparts, are more vulnerable to poor health outcomes in general, not only from sedentary behaviour but because they may belong to a lower socio-economic group, have longer working hours, family responsibilities and/or poor mental wellbeing (Carney-Crompton & Tan, 2002; Woolf et al., 2011). However, comprehensive data about the sedentary behaviour of ethnic minority university students in the UK are not currently available. This thesis aims to explore the prevalence and correlates of sedentary behaviour among university students and to explore whether they vary by ethnic group.

One framework that will be helpful in understanding the focus of the current thesis is the behavioural epidemiology framework. Sallis et al. (2000) explained that it provides a systematic process for conducting descriptive, analytical or intervention research that can ultimately lead to the development of evidence-based solutions for improving population health (Sallis et al., 2000). The framework has five phases: (i) measurement of the behaviour; (ii) the study of health outcomes; (iii) correlates of behaviour; (iv) interventions to change behaviour; and (v) translation of findings (Sallis et al., 2000). Biddle et al. (2018) applied this framework to their study of sedentary behaviour (table 1.2). The thesis aims to focus on phase I (measurement of the prevalence of sedentary behaviour) and phase III (correlates of sedentary behaviour).

Table 1.2

The behavioural epidemiology framework applied to sedentary behaviour

Phase of the framework	Key issues	Example in the thesis
1. Measurement of sedentary behaviour	Measurement of sedentary behaviour in research.	Prevalence of total and domain-specific sedentary behaviour amongst university students using questionnaires.
2. Establishing a relationship between sedentary behaviour and health outcomes	Evidence that may link sedentary behaviour with health outcomes	
3. Correlates of sedentary behaviour	Correlates of sedentary behaviour	Although the focus should be on identifying the individual level correlates, but this study applied the socio-ecological model to examine individual as well as the social, and environmental correlates of sedentary behaviour.
4. Interventions to reduce sedentary behaviour	Interventions that can reduce sedentary behaviour	
5. Translation of finding	Can the interventions to reduce sedentary behaviour be rolled out	

In the next section, there will be a discussion of the current physical activity guidelines and the meaning of the term sedentary behaviour, followed by a statement of the research questions.

Chapter 2

Theoretical Framework

2 Theoretical models used in health behaviour research

This chapter reviews health behaviour theoretical frameworks and identifies the most relevant one for this thesis. Sedentary behaviour is influenced by multiple factors and is a complex behaviour (Buck et al., 2019). A range of theories and models from social, educational, and health psychology have been applied in the context of sedentary behaviour. There has been a progression in theories of health behaviours (Rajeski et al., 2019): first there was a focus on cognitive behaviour theories which assume that behaviour decisions are influenced by individuals' choices, beliefs and their rational evaluation of information (Brand and Cheval, 2019). Cognitive-behaviour theories, however, have been criticised for neglecting the importance of affective and automatic processes (Ekkekakis, 2017). Moreover, the cognitive-behaviour theories were considered to be too narrow because they do not focus on the wider social and environmental factors which influence individuals' behaviour (Biddle, 2017). Later there was a focus on theories that take into consideration essential elements such as affect, habit and automatic processes (Ekkekakis, 2017). However, these theories also fail to take into consideration the wider determinants of health and factors such as the environment and policy-level factors. Other theoretical frameworks, such as the determinants of health model (Dahlgren & Whitehead, 1991) and the socio-ecological model (Owen et al., 2011), are more holistic and consider a wide range of personal, social and environmental factors underpinning behaviour. This chapter discusses and critiques theoretical frameworks concerning health behaviour and presents the model selected to underpin this thesis.

Cognitive-behaviour theories

2.1 Health belief model

According to the HBM (Rosenstock, 1974), an individual makes rational decisions by assessing the perceived susceptibility and benefits of a health behaviour, before deciding whether to engage in it. Four factors influence the HBM: perceived susceptibility, or the degree to which an individual feels susceptible to the consequences of the behaviour; perceived severity, or the degree to which an individual considers the seriousness of contracting an illness; perceived benefits, that is, an individual's understanding of how an action will benefit his/her health or cause illness; and perceived barriers, that is, an individual's perception of the obstacles to performing a health action (Rosenstock, 1974). Rosenstock (1988) added two more components to the HBM: a person's ability to conduct the behaviour (self-efficacy) and the stimulus required to carry out a behaviour (cues for action). The HBM has been critiqued for focusing on the individual's beliefs and does not include behaviour and social factors that influence health decisions (Edberg, 2013).

2.2 The theory of planned behaviour

The theory of planned behaviour (Ajzen, 1991) assumes that individuals think in a rational and linear way when deciding to carry out a health behaviour. This theory suggests that intention is an immediate precursor for a behaviour and is driven by an individual's attitude, normative beliefs and perception of behaviour control. The attitude component in the model depends on the beliefs and perceived value of the outcome of that behaviour (Ajzen, 1991). For example, a belief may be "being less sedentary makes me more alert" or a perceived value may be that "it's satisfying to move more and sit less" (Biddle 2017, p 416). According to Biddle (2017) the affective element of attitude has more effect on behaviour change; eliciting positive feelings about less sedentary behaviour may be difficult as these are mostly linked with enjoyable sedentary behaviours such as relaxing and watching television.

Another component of the theory of planned behaviour is perceived behavioural control; this is the perception about how easy or difficult the behaviour is, mostly based on prior experience. Thus, sedentary behaviour is easy, has few obstacles (Biddle 2017), is mostly intentional and planned, and strongly associated with attitude (Rhodes and Dean, 2012), which makes it difficult to change (Biddle, 2017).

2.3 Transtheoretical model

The transtheoretical model (Prochaska & De Clemente, 1985) is termed as a stage of change model that can occur in six stages:1) pre-contemplation — an individual may not take any action and simply thinks that a specific behaviour is not a problem; 2) contemplation — in this stage an individual starts to think about changing the behaviour, for example becoming more active; 3) preparation — the individual is ready to change behaviour; 4) action — a person acts and starts a change of behaviour, for example by trying to be less sedentary; 5) maintenance — a person now changes the behaviour and becomes less sedentary and tries to maintain the behaviour; and 6) termination — the change in behaviour is accomplished. However, the authors recognise that people do not always go through a fixed set of stages. Instead, people are likely to progress cyclically, going from one stage to the next and then going back and starting the process again. Edberg (2013) critiques the models mentioned above because each emphasise individual choices and ignore external or environmental factors. Biddle (2017) suggests that there is a lack of research of the transtheoretical model in sedentary behaviour.

2.4 Social cognitive theory

In contrast to the previous models, social cognitive theory that was postulated by Bandura (1986) suggests that an individual learns and modifies his or her behaviour based on interaction between personal, behavioural and external environmental influences. According to Bandura (1986) behaviour is determined by four factors that include goals, outcome expectancies, self-efficacy

(termed as efficacy expectancies) and socio-structural variables. The outcome expectancies are similar to the idea of behaviour beliefs and people reflect on their actions thinking mainly about the consequences of their behaviours. In the self-efficacy element people think about their own capabilities and belief that they can carry out a behaviour. In other words, efficacy expectancies are the degree of confidence a person has to perform a behaviour despite facing several obstacles. Biddle (2018) applied the social cognitive theory to sedentary behaviour and explains that for outcome expectancies (consequences of the behaviour) of sedentary behaviour an individual can think about the benefits or the costs of being less sedentary. In terms of efficacy expectancies (the capabilities) the individual may reflect and think about whether they can or cannot carry out a behaviour. For example, seeing others standing in a meeting may help to reduce sedentary behaviour by modelling or imitating that behaviour.

Operational, biological and environmental criticisms of social cognitive theory have been reported (Zimmerman, 2002). The main criticism is that this theory has a complex structure which may make it difficult to implement in research and practice. It assumes that a change in the outside environment directly changes behaviour. It may be argued that the behaviour of some individuals may not change even with the change in the environment or situation (Lee, 2010). Zimmerman (2002) argues that this model overemphasizes the role of cognitive abilities and does not give enough relevance to individual and biological determinants.

The intra-individual theories are limited and narrow with a focus on individual choices and beliefs and the rational evaluation of information (Biddle, 2017). They are paradigmatically similar cognitivist theories and do not capture other essential elements such as affect, habit and automatic processes (Ekkekakis, 2017). The next section discusses the parsimonious behaviour change wheel (BCW) (Michie et al., 2011), and affective-reflective theory (Ekkekakis, 2017).

Theories related to affect, reflection and habit

2.5 Behaviour Change Wheel

The BCW is a comprehensive framework devised by Michie et al. (2011) for designing interventions by explicitly integrating behaviour theory to understand and target mechanisms of action. The wheel consists of three layers: in the first layer the three main sources of behaviour include capability (C) that is physical and psychological capabilities; social and physical opportunities (O) and reflective and automatic forms of motivation (M) that influence behaviour (B). The acronym used to describe this model is COM-B framework.

Motivation in the BCW is a dual-process approach because it includes both the processes of being reflective and automatic. The reflective approach involves the processing of information, thinking and reflecting about the behaviour and then performing the behaviour. In contrast, automatic processing occurs without much forethought or planning. Biddle (2017) provides an example specific to sedentary behaviour, stating that in the presence of seating, such as a chair or sofa, it is often an automatic response to sit. However, if there is no chair/sofa one may not automatically consider sitting down (Biddle, 2017).

In the BCW the second layer is about interventions. There are nine intervention functions: Education, Persuasion, Incentivisation, Coercion, Training, Enablement, Modelling, Environmental Restructuring and Restrictions. Interventions can consist of multiple intervention functions. An example specific to sedentary behaviour may be the introduction of sit-to-stand desks in the occupational setting. The introduction of such desks in the office setting is an example of environmental restructuring but this may also include an educational component that may include the health education messages or counselling sessions about the benefits of standing more and how the sit-to-stand desk can reduce sedentary time (Biddle, 2017). The third and final component in the model are the policy related characteristics that can be utilized to support the delivery of interventions (Michie et al., 2011).

The strength of the BCW framework is that it is a holistic framework that assists in gaining clarity about the intervention and also supports the implementation and evaluation of the intervention processes. However, the weakness of the BCW framework is that even though the proposed framework appears to be a comprehensive framework there is a possibility that it may be difficult to use (Biddle, 2017). Moreover, as BCW is specific to interventions it is a model not relevant to this study.

2.6 Affective-reflective theory

The affective-reflective theory (ART) is a dual-process theory that emphasises the importance of the interplay of automatic and reflective mental processes (Brand and Ekkekakis, 2018). The automatic (type 1) process are fast and require only limited cognitive effort. The reflective mental process (type 2) is slower and uses reasoned and controlled use of the person's memory. ART is a theory grounded in exercise psychology and closely linked with the research on affective responses to exercise. ART aims to explain as well as predict behaviour in which either people are not active (sedentary behaviour) or initiate an action (physical activity). The ART suggests an automatic association with exercise that is linked with the present state: for example, physical inactivity results in an automatic valuation (positive or negative) which is then directly connected to an immediate action impulse (Brand and Ekkekakis, 2018). A negative automatic valuation of exercise may be understood to act as a restraining force that may lead a person to maintain their state of physical inactivity. In contrast, a positive affective valuation may lead a person to become active. The affective valuation is the basis for type-2 processes, that are comprised of complex cognitive operations such as reasoning and the reflective evaluation of exercise and these result into action plans. Brand and Ekkekakis (2018) state that the type 1 (automatic) and type 2 (reflective) processes can interact and there is a belief that the brief availability of self-control can influence whether the rational action plan can override the automatic action impulse.

The ART attempts to incorporate findings of several theories and studies on exercise motivation that include cognitivist theorizing, for instance, the social cognitive theory (Bandura, 1986) and the theory of planned behaviour (Ajzen, 1991). It puts an emphasis on the role of rational thinking when making behaviour choices. However, the ART is more comprehensive because it also offers an explanation— not just the lack of motivation to change behaviour—for why people choose to be inactive. It explains that the affective valence of being physically inactive may be more positive than the affective valence of being physically active. Therefore, people choose to be inactive (Brand and Ekkekakis, 2018).

2.7 Habit and health behaviour

Hagger (2019) recently reviewed the measurement, conceptualization, development and maintenance of habit as it applies to physical activity. According to the author habits are specific behavioural responses that co-occur with environmental cues or contextual features. Habits are enacted with little conscious effort and tend to occur with automatic processing without consideration of goals and require low effort (Hagger, 2019). There is an assumption that repeated performance of a behaviour tends to lead to the development of habitual action. Therefore, habits are learnt through repetition and require time to develop.

Hager (2019) suggests that the behaviour that should be adopted or should ultimately become a habit is initially controlled by goals and rewards. This shifts to non-conscious or automatic processing as habits develop.

When habits are considered in terms of behaviour change efforts are made to ensure that a positive behaviour change becomes a habit such as regular engagement in physical activity or a reduction of a negative habit such as sedentary behaviour (Biddle, 2017; Hagger, 2019). Habits involve behavioural patterns that are often context dependent. When a familiar context is encountered, for example coming home from work, a habitual response can automatically cue, such as sitting on

the sofa to watch television. These contextual cues are held in affective memory (Biddle, 2017; Hagger, 2019). On the other hand, in novel circumstances behaviour regulation occurs through conscious decision making through the reflective component and the intentions of performing that behaviour (Hagger, 2019).

Habit theories have been applied to understanding the habits about physical activity by Hagger (2019) but there are a few limitations. To understand and design the theories of habit Hagger (2019) has drawn from several domains such as social and health psychology, cognition and learning and neuroscience. However, there is a limitation that there is no integrated theory of habit that draws from different disciplines and provides a comprehensive explanation of different processes of habit development (Hagger, 2019).

The BCW (Michie et al., 2011), affective-reflective theory (Brand and Ekkekakis, 2018) and habit theories (Hagger, 2019) are broader than the cognitively focused theories because they are cognizant of both affect and automatic response. However, sedentary behaviour is influenced by multiple factors including the wider social environmental and policy related factors. Therefore, more holistic theories such as the determinants of health model and the socio-ecological model will be discussed in the next section of this chapter.

Wider and more holistic theories

2.8 Determinants of health model

Dahlgren and Whitehead's (1991) model is a widely accepted one that is focused on the determinants of health. This model suggests that health is influenced by multiple interacting layers. These include non-modifiable factors, such as age, gender, ethnicity and genetics, and modifiable factors, such as personal lifestyle, physical and social environment and the wider cultural and environmental conditions (Dahlgren & Whitehead, 1991). Public health policy makers have been

criticized for focusing on interventions aimed at individuals' lifestyle choices (Glanz et al., 2008). In recent years, however, there has been more of a shift in public health policy perspectives from a focus on individual lifestyle choices to the broader influence of wider structural or upstream factors as determinants of health (Bambra et al., 2010). This model has influenced health inequalities research in the UK, enabling policymakers to understand the upstream factors responsible for health inequalities (Marmot, 2012). Although it is widely accepted its main criticism is that it shows many influences on health but none of them go into any depth about the nature of the influence and how these interact. Thus, there is a lack of detail in describing the extent to which the determinants influence health (Warwick-Booth et al., 2012).

2.9 The socio-ecological model

There is another model that has been devised and applied more often to health behaviour research which is termed the socio-ecological model (Sallis et al., 2006; Owen et al., 2011). This model draws on research undertaken by Bronfenbrenner (1994) who suggested multiple levels of influences on a child's behaviour. McLeroy et al. (1988) also included factors, such as intrapersonal, interpersonal, social and policy characteristics. Sallis and Owen (2015) suggest that the socio-ecological model must be specific to certain behaviours, for example the socio-ecological model for obesity may not be transferable to physical activity. They devised one specific to physical activity (Sallis et al., 2006). Owen et al. (2011) expanded and applied the information gathered from the ecological model of physical activity and developed one specifically for sedentary behaviour. This model was designed as a conceptual framework to study the determinants of domain-specific sedentary behaviour (Owen et al., 2011), which implies that sedentary behaviour occurs in different contexts. The strength of the socio-ecological model is that it acknowledges that the determinants of sedentary behaviour are multifaceted and interacting (Sallis & Owen, 2015). The model is shaped in a concentric circle and there are multiple layers of

influence (see Figure 2). This model identifies five constructs of the determinants of sedentary behaviour: 1) intrapersonal: individual characteristics of a person, such as age, gender, ethnicity, education, employment and income; 2) interpersonal, such as marital status and number of children, social support, social networks and social capital (the value individuals give to their social networks); 3) perceived neighbourhood environment, such as neighbourhood safety, cleanliness in the neighbourhood and aesthetics, and the availability of transport and parks for exercise; 4) behaviour settings, such as the workplace environment that may support or inhibit activity, or the home setting, or, specific to this thesis, the university environment that may either encourage or discourage activity; and 5) policy-level factors, including national or organisational policies (Owen et al., 2011). The socio-ecological model is useful in understanding how individuals behave and identifying the characteristics that influence a certain behaviour, however, it does not give insight into which characteristics have more influence compared to others (Sallis & Owen, 2015).

The socio-ecological model of sedentary behaviour underpins research for this thesis (Figure 2) and was the framework utilized to understand the sedentary behaviour patterns among university students in England. Since Study 1 is based on secondary data, it was only possible to examine the intrapersonal and some interpersonal correlates of sedentary behaviour. However, in Study 2 conducting primary research enabled an examination of all five domains outlined by the model.

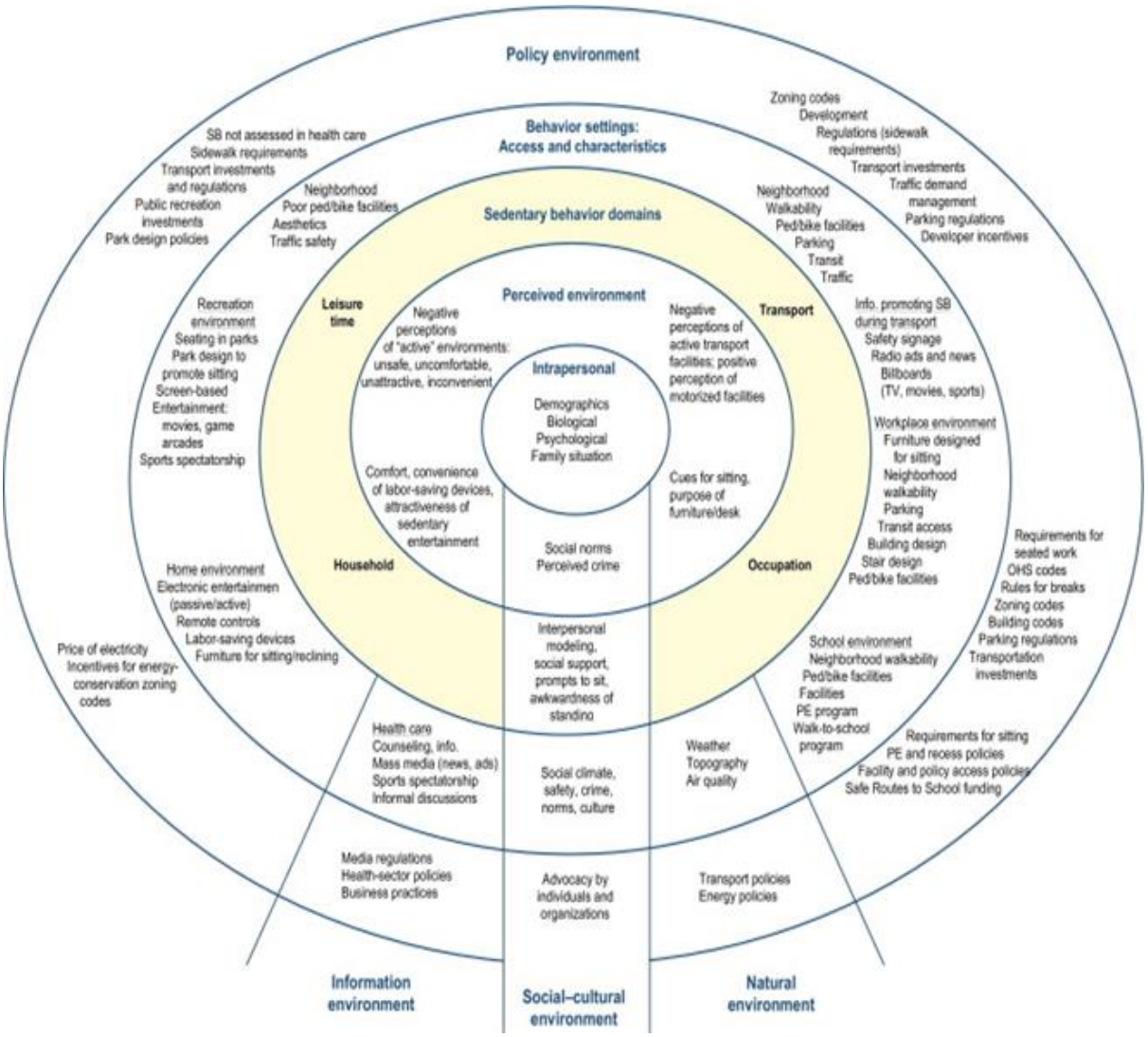

Figure 1 *Ecological Model of Four Domains of Sedentary Behaviour*

Source : Owen et al. (2011)

Chapter 3

Literature review

3 Introduction to the literature review

This literature review aimed to provide a context for this study by critically reviewing research on the prevalence and correlates of sedentary behaviour. In the following sections, the aim, search strategy, selection criteria, quality assessment and main findings of the studies are reported.

3.1 Aim of the literature review

This literature review examined previous research on the prevalence and socio-ecological correlates of sedentary behaviour among the general population and university students.

3.2 Search strategy

A search strategy was developed, and the following databases were searched, originally on 10th March 2015 and again on 5th January 2020: PubMed, Web of Science, Psychinfo, CINAHL, SportDiscus and OpenGrey. The search strategy was based on search terms related to the following topics: a) sedentary behaviour and synonyms b) types of sedentary behaviour c) prevalence of sedentary behaviour; d) correlates and synonyms and e) university students and relevant terms, such as undergraduates, postgraduates and higher education. To ensure no articles were missed the reference lists of relevant articles were hand searched. The PRISMA flow chart depicting the search strategy and inclusion and exclusion criteria is shown in Figure 2. Retrieved literature was stored in an Mendeley database and duplicates were removed.

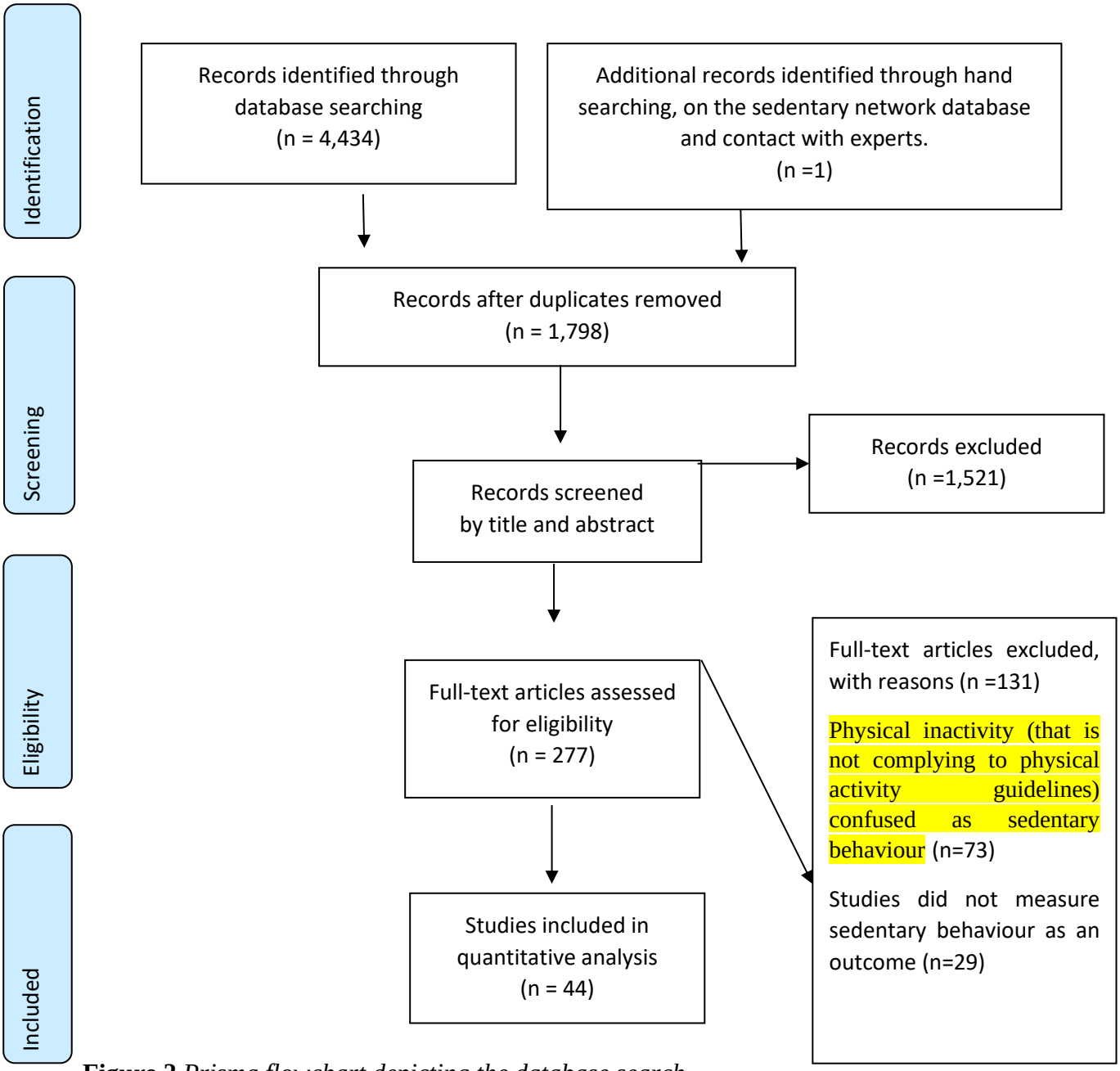

Figure 2 *Prisma flowchart depicting the database search*

3.3 Selection of studies

To be included in the review, research articles had to meet the following criteria:

1. They defined sedentary behaviour as the time spent sitting.

2. They measured the prevalence and/or the socio-ecological correlates of sedentary behaviour.

3. They were published in English.

Studies were excluded based on the criteria below:

1. They were conducted in the laboratory to only calibrate instruments, such as accelerometers.

2. Physical inactivity (that is not complying to physical activity guidelines) confused as sedentary behaviour.

3. They did not examine the prevalence of sedentary behaviour.

4. Studies did not measure sedentary behaviour as an outcome.

4. They did not examine the socio-ecological correlates of sedentary behaviour.

The search identified 4,434 studies and after applying the inclusion and exclusion criteria 44 quantitative studies relevant to the research aims and questions were identified.

3.4 Quality assessment

To assess the quality of the included studies the quality assessment criteria for evaluating primary research papers from a variety of fields was utilized (Kmet et al., 2004) (Table in Appendix 1).

This scoring system was beneficial because it made the process systematic and reproducible. For the assessment of quantitative studies there was a checklist of 14 questions. There were four options for the answers; yes, partial, no and not applicable. A score between 0-2 was scored for each item; the yes option was given 2 points, partial one point, and no or not applicable were allocated 0 points. To calculate the final score the following calculation was used: Total sum ((number of yes x 2 points) + (number of partial x 1)) / total possible sum (28 – (number of not applicable x 2). This quality assessment tool focused on methodology and findings.

3.5 Study characteristics

Of the 44 studies included, 28 were conducted in North America, eight in Europe, five in the UK, 10 in Australia, one in Hong Kong, one in Argentina, one across Scotland and the Netherlands and one study was conducted across 20 countries. All the studies were observational; the most common observational study design was cross-sectional (n=40) and the remaining four studies were longitudinal. Of the 44 studies, only ten examined the prevalence of sedentary behaviour among university students; five studies examined the prevalence of sedentary behaviour in the workplace; and the remaining 29 studies examined the prevalence and correlates of sedentary behaviour in the general population. The included studies focused on adults aged between 18 and 65 years. In terms of gender, two studies were conducted amongst women only while the remainder included both men and women.

3.6 Measurement of sedentary behaviour

Leitzmann et al. (2017) state that there is no consensus on defining high cut-off points for sedentary time. Prevalence of sedentary behaviour is either the mean or median time spent sitting or alternately the proportion of individuals sitting per day with no specification of the length of time (Leitzmann et al., 2017).

The studies included in this review defined sedentary time as overall sitting time per day or only the time spent sitting watching television. Clark et al. (2009) report in their systematic review of adults in the general population that a majority (65.0%) of studies operationalized sedentary time as television viewing. This was previously considered as a justifiable approach but recently there has been more emphasis on understanding the different domains in which sedentary behaviour occurs (Rhodes et al. 2012). Owen et al. (2011) describe four domains of sitting time: transport, occupation, home, and leisure-time. Similarly, Marshall et al. (2010) have classified the domains further into five distinct categories: 1) traveling to and from places, 2) occupation, 3) watching television, 4) computer use at home, and 5) for leisure, that does not include television viewing time.

3.6.1 Prevalence of sedentary behaviour in adults

For adults in Europe the literature search identified twelve studies that examined the prevalence of sedentary behaviour. The prevalence of sedentary time reported in these studies varied from 2.5 hours/day up to 10 hours/day across different countries. The lowest sitting time was reported in Romania, Portugal, Malta and Lithuania (between 180–236 minutes/day) and the highest was reported in the Netherlands, Denmark, Czech Republic and Greece (between 376–407 minutes/day) (Bennie et al., 2013). The International Prevalence Study conducted in 20 countries by Bauman et al. (2011) reported the median sitting time of five hours per day. Countries that reported the lowest sedentary time were Colombia, Brazil and Portugal (a median of 3 hours per day) and highest sedentary time was reported in Saudi Arabia, Hong Kong, Norway, Taiwan and Japan (median of 6 hours per day) (Bauman et al., 2011).

Both Loyen et al. (2016) and Milton et al. (2015) measured the prevalence of sitting using the International Physical Activity Questionnaire (IPAQ) short form questionnaire and asked respondents to report their sitting time per day. They reported a north-south difference in sitting

time across Europe: northern countries reported a higher prevalence of sedentary behaviour compared to the southern countries (Loyen et al., 2016; Milton et al., 2015). An alternative explanation for the north-south divide may be that the Eurobarometer survey occurred between the months of October and December and it was possible that people in the northern countries remained indoors because of the cold weather, used more motorized transport, and replaced their physical activity that they may have done in the summer months with sedentary time in the winter months (Milton et al., 2015; Loyen et al., 2016). Bennie et al. (2013) analysed prevalence of sedentary behaviour across Europe and reported that men in their sample were significantly more sedentary than women.

3.6.2 Prevalence of sedentary behaviour amongst different ethnic groups

Children, adolescents and adults belonging to Black and Asian ethnic groups residing in the US and Europe have been reported to be more sedentary than White people in the general population (Broderson et al., 2007; Loyen et al., 2016). In England, Asian, Chinese and Black respondents were more physically inactive compared with White British; their compliance to physical activity guidelines followed the same pattern (Figure 3) (Active Live Survey, 2015).

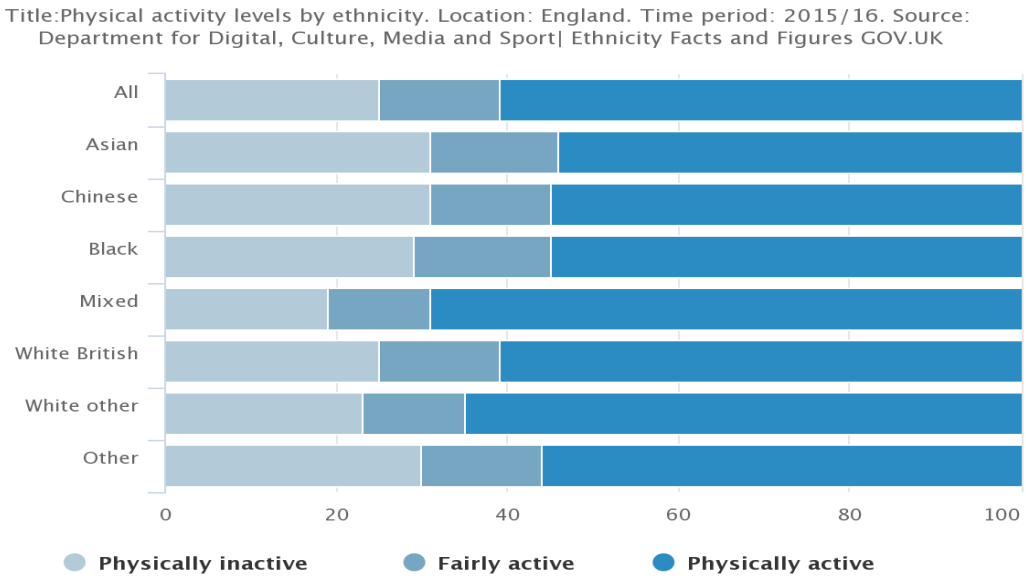

Figure 3 *Physical activity levels by ethnicity in England*

In the Netherlands, sedentary behaviour among different ethnic groups (Moroccan, African Surinamese, South-Asian Surinamese and Turkish ethnic origin) and White adults was compared; highest sedentary time was reported amongst African Surinamese respondents and lowest in White respondents (Stronks et al., 2013). Overall, ethnic minorities in the Netherlands had a higher prevalence of sedentary time than the White respondents (Stronks et al., 2013). The studies conducted in the US (Broderson et al., 2007), UK (Active Live Survey, 2015) and Netherlands (Stronks et al., 2013) suggest that ethnic minorities have a higher prevalence of sedentary behaviour compared to White respondents.

3.6.3 Prevalence of occupational sedentary time

Prevalence of sedentary time was examined in different occupational settings in a study in the UK (Kazi et al., 2014). The highest sedentary time was reported in employees of the telecommunications sector and service followed by employees working in the education sector. The lowest sedentary time was spent by respondents working in the retail sector (Kazi et al., 2014). Similarly, Australian studies amongst office workers report that the prevalence of sedentary

behaviour was between 10.0 and 11.5 hours per day compared to adults in the general population who spent around five hours sitting per day (Thorpe et al., 2012; Toomingas et al., 2012; Parry & Straker, 2013). Time use surveys from the US report that office workers spend most of their time sitting at work, (80.0%) of their working day (Department of Labour, 2009).

3.6.4 Prevalence of sedentary behaviour amongst university students

Only ten studies in the review focused on sedentary behaviour prevalence amongst university students. Five of these studies were from the US (Buckworth & Nigg, 2004; Fountaine et al., 2011; Quartiroli & Maeda, 2014; Maher et al., 2014; Peterson et al., 2018), three from the UK **(**Rouse & Biddle, 2010; Hawker, 2011; Epstein, 2014), one from Argentina **(**Farinola & Bazan, 2011) and one from Canada (Moulin & Irwin, 2017). According to the studies from the US and Argentina, students spent 10-30 hours/week of their time sitting (Buckworth & Nigg, 2004; Fountaine et al., 2011; Farinola & Bazan, 2011; Peterson et al., 2018), whereas British university students spent 35 hours/week of their time sitting (Rouse & Biddle, 2010; Hawker, 2011; Epstein, 2014). However, the Canadian study reported students spent 59.5 hours per week sitting (Moulin & Irwin, 2017). These studies mainly concentrate on the sitting time of students on weekdays so do not report the accurate time students may spend sitting during the whole week. The findings from these studies show geographical variation in sitting time amongst university students. The data demonstrates that the students in the US and Argentina report fewer hours spent sitting a week than the students in the UK and Canada.

In these studies, students spent their time in a range of sedentary endeavours. Amongst the most common sedentary pursuits were time spent sitting to study (between 13.3-24.7 hours per week), using the computer (5.9-11.1 hours per week) and television viewing (8.0-10.6 hours per week) (Buckworth & Nigg, 2004; Rouse & Biddle, 2010; Fountaine et al., 2011; Moulin & Irwin, 2017; Patterson et al., 2018). Only one study conducted in the UK by Rouse and Biddle (2010) provides

a clear understanding of students' sedentary behaviour in different domains whereas the studies conducted by Epton (2014) and Hawker (2012) only report the total sitting time during the day. The majority of the studies reported the prevalence of sedentary behaviour in students in different countries, but they did not seek to differentiate prevalence rates by ethnicity. In the next section of the literature review there will be a discussion about correlates of sedentary behaviour in the general population followed by a focus on university students.

3.7 Correlates of sedentary behaviour in the general population

The term correlate refers to a variable or a characteristic that is statistically significantly associated with the outcome variable. Examining the correlates of sedentary behaviour can help in identifying population groups that report high levels of sedentary behaviour and in understanding the factors that contribute to this. They can also provide ideas for developing targeted interventions and for policy development to reduce sedentary behaviour.

3.7.1 Intrapersonal correlates of sedentary behaviour

In previous research, there has been a focus on socio-demographic variables, health behaviours and mental health (Rhodes et al., 2013; O'Donoghue et al., 2016). The demographic correlates of sedentary behaviour, namely age, gender and ethnicity, have been termed as non-modifiable correlates (Castro et al., 2018). A null association between gender and screen time (television viewing and computer use) was reported in systematic reviews by Rhodes et al. (2012) and O'Donoghue et al. (2016). However, men were significantly more sedentary than women in other studies (Xie et al., 2014; Mabry et al., 2014), and most of their time was spent in computer use and playing video games (Saidj et al., 2015; De Cocker et al., 2014).

In terms of ethnicity, studies in the US identified that African Americans spent significantly more time watching television compared to people of other ethnicities (Kronenberg et al., 2000; Yang

& Oliver, 2000; King et al., 2009). In terms of employment, there was a positive association between unemployment and sedentary behaviour and unemployed respondents spent more time television viewing (Kronenberg et al., 2000: Sugiynama et al., 2007). For those in work, sedentariness in leisure time varied with the type of employment; manual employment was reported to be positively associated with sedentary time in non-working hours (Stamatakis et al., 2014; Wilson et al., 2014; Barnet et al., 2014); the authors suggest those less sedentary during work would be more likely to rest in their leisure time. Non-manual employment was negatively associated with sedentary time in non-working hours (Stamatakis et al., 2014; De Cocker et al., 2014; Saidj et al., 2015). In the next paragraph the relationship between health behaviours and sedentary behaviour is reported.

Mansoubi et al. (2014) reported in a systematic review of 26 studies that there was a negative correlation between physical activity and sedentary behaviour. The authors suggest that low intensity physical activity displaces sedentary behaviour. There was also a positive association between smoking and sedentary time (Van Uffele et al., 2012; Ding et al., 2012; Kaufman, Augustson & Patrick 2012; Seguin et al., 2014). Depression and anxiety were also positively associated with sedentary behaviour (Hamer et al., 2010; De Vit et al., 2011; Li et al., 2012). The authors suggest that screen use can reduce direct communication between individuals and can reduce social interaction resulting in a potential increase in depression. In addition, the time spent in sedentary behaviour reduces the time that could have been spent in physical activity that is known as an effective treatment and prevention strategy for depression (Hamer et al., 2010; Biddle & Asare, 2011; De Vit et al., 2011; Li et al., 2012). There was positive association between poor quality of life and sedentary behaviour (Trost et al., 2002; Leal et al., 2001).

3.7.2 Interpersonal correlates of sedentary time

In previous research two spheres of interpersonal correlates of sedentary behaviour were

identified: family-related and social factors (Owen et al., 2011; Rhodes et al., 2012; O'Donoghue et al., 2016). These have been termed as the modifiable correlates of sedentary behaviour (Castro et al., 2018).

Previous studies that have explored the association between sedentary time and marital status report inconclusive results. In a systematic review by Rhodes et al. (2012) a few studies reported a positive association, whereas some studies reported a negative association with sedentary behaviour. Similarly, the systematic review by O'Donoghue (2016) reports inconclusive results. With regards to children, Rhodes et al. (2010) did not find an association between having children and sedentary time but Kozo et al. (2012) reported that respondents without children were more sedentary than those with children. In some studies, the number of children in the family was also correlated with sedentary time, as European adults who had more than three children reported significantly less sedentary time than those with fewer than three children (Van Uffele et al., 2012; Clark et al., 2014; Saidj et al., 2015; Loyen et al., 2016).

Some previous studies have examined the association between sedentary behaviour and social capital. Social capital recognises that individuals are a part of both formal and informal networks and through these they may get support during times of need (Green & Fletcher, 2003). Previous research in Sweden and the US found a positive relationship between social capital and physical activity (Lindstrom et al., 2003; Griener et al., 2004). Similarly, a recent study amongst Dutch and Belgian adults reported that respondents with higher social capital reported lower time in sedentary pursuits (Nassau et al., 2017). In deprived London neighbourhoods, it was reported that individuals who had social networks within their neighbourhoods were significantly less sedentary than the ones who did not (Watts et al., 2017).

3.7.3 Environmental correlates of sedentary behaviour

In previous research the spheres of environmental correlates identified were neighbourhood safety,

aesthetics, availability of green space and area of residence. Koohsari et al. (2015) reported that residents of an urban area were significantly less sedentary than residents of a rural area. In contrast, Van Uffelen et al. (2012) and Uijtdewilligen et al. (2014) reported that residing in an urban area was associated with more sitting time amongst women.

Respondents who reported that their neighbourhood aesthetics were poor reported a higher time in sedentary behaviour (Van Uffelen et al., 2012). People who lived near a green space or had a higher density of green space in their neighbourhood spent less time sitting (Astell-Burt et al., 2014: Van-Holle et al., 2014).

Shaw et al. (2017) reported that fear of crime in the neighbourhood was associated with higher sedentary time in adults residing in Glasgow, UK. Conversely, in a London, UK based study it was reported that respondents who perceived their neighbourhood as safe were significantly less sedentary (Watts et al., 2017).

3.8 Policy-related correlates of sedentary behaviour.

Owen et al. (2011) suggested that policy-related factors may also have an influence on sedentary behaviour. In the UK, there are no explicit policies recommending a reduction in sedentary behaviour; instead the CMO (2019) has recommended individuals reduce the time they spend in sedentary pursuits and the new guidelines suggest limiting sedentary behaviour as often as possible. However, at the organisational level, research demonstrates that when a sedentary behaviour policy was introduced in the workplace of office workers it reduced their sedentary behaviour (Crespo et al., 2011; Knox et al., 2017).

3.9 Correlates of sedentary behaviour amongst university students

The socio-ecological model of sedentary behaviour was utilized to study the correlates of sedentary

behaviour amongst university students as this is the most applicable model as suggested in the literature (Owen et al., 2011).

3.9.1 Intrapersonal correlates of sedentary time among university students

In previous research that has been carried out amongst university students only a few studies have examined the correlates of sedentary behaviour (Castro et al., 2018). Like adults in the general population (Xie et al., 2014; Mabry et al., 2014), Greenberg et al. (2010) report that there was a negative relationship between being a female and sedentary behaviour. Male students spent more sitting time playing video games and using screens (Fountaine et al., 2011), whereas female students spent significantly more time using mobile phones and sitting for studying (Fountaine et al., 2011; Rouse & Biddle, 2010). However, a systematic review amongst university students reports no association between gender (female students) and sedentary behaviour (Castro et al., 2018). These findings are similar to those reported by Rhodes et al. (2012) in a systematic review on the correlates of sedentary behaviour in the general population. There is a need for further research to determine the role of gender in total sedentary behaviour and in different domains among students. Melton (2014) reported that students with a regular intake of fruit reported statistically lower sedentary time. Unsurprisingly, an inverse relationship between physical activity and sedentary behaviour was reported in studies amongst university students (Maher, 2014; Quartiroli et al., 2014; Rouse & Biddle, 2010).

Castro et al. (2018), in a recent systematic review of studies about the correlates of sedentary behaviour amongst university students, suggested that there was insufficient data about the interpersonal, environmental, behavioural and policy-related correlates identified by the socio-ecological model of sedentary behaviour (Owen et al., 2011; Castro et al., 2018). The authors suggest that there is a need for further research that focuses on the potential correlates of sedentary behaviour covering the full breadth of the socio-ecological model of sedentary behaviour (Sallis

et al., 2008; Owen et al., 2011; Castro et al., 2018). Moreover, there will be a benefit of focusing on both the non-modifiable and modifiable correlates of sedentary behaviour to address the issues on reducing it among university students.

3.10 Conclusion

The lack of evidence in research of sedentary behaviour amongst university students leaves an important gap in the literature for three reasons. First, there is a need to take a broader view on sedentary behaviour in order to explore the time students spend in sedentary pursuits beyond television viewing, as most studies so far only focus on television viewing rather than other types of sedentary behaviours. Second, there is a lack of research on sedentary behaviour amongst ethnic minority adults in general, and on students from ethnic minority groups. The population in the UK and the rest of Europe has seen a rise in ethnic minority groups due to migration; the disease and health risk profiles of ethnic minority groups tend to differ and often minority populations present higher rates of ill-health (Smith et al., 2009; Karlson & Nazroo, 2010; Bacares, 2013; Evandrou et al., 2016). For example, there is a higher prevalence of cardiovascular diseases and type-2 diabetes among ethnic South Asian migrants especially the first generation immigrants, a higher prevalence of stroke amongst people originating from Africa and a higher risk of infectious diseases among all ethnic minorities compared to their White British counterparts (Smith et al., 2009; Karlson & Nazroo, 2010; Bacares, 2013; Evandrou et al., 2016). In the UK, there has been an increase in the proportion of ethnic minority university students since the government's widening participation agenda was introduced (Higher Education Funding Council for England, 2014). Considering the poorer health outcomes of ethnic minorities, it is possible that such students have a higher risk of poor health outcomes than other students.

Third, as reported in previous reviews on sedentary behaviour among both adults (Rhodes et al., 2012; O'Donoghue et al., 2016) and university students (Castro et al., 2018), the focus so far has

been on intrapersonal and interpersonal correlates of sedentary behaviour and only a limited number of studies have examined environmental, or policy-related variables. This underlines the need for more research on potential correlates that cover the full breadth of the socio-ecological model of sedentary behaviour (Owen et al., 2011). When these correlates have been identified, interventions can be designed to encourage students to be more active and spend less time in sedentary pursuits.

Sedentary behaviour research amongst university students has been carried out in several countries and the prevalence of sedentary behaviour was higher, at between 6.0 and 11.9 hours per day, compared to the general population in, for example, England and Europe who spent around 5.5 to 5.8 hours sitting per day (Buckworth & Nigg, 2004; Rouse & Biddle et al., 2010; Fountaine et al., 2011; Farinola & Bazan, 2011; Loyen et al., 2016; Health and Social Care Information Centre, 2017; Peterson et al., 2018). However, as previously mentioned, the shortcoming of most studies except three (Rouse & Biddle et al., 2010; Moulin & Irwin, 2017; Peterson et al., 2018) was that they only accounted for the sitting time that respondents spent when viewing television. In addition, previous research only focused on intrapersonal correlates that were mostly demographic factors (such as gender) rather than the other socio-ecological correlates identified by the socio-ecological model of sedentary behaviour, such as interpersonal factors, behaviour setting, environmental and policy-related factors (Castro et al., 2018). Little is known about the prevalence and correlates of sedentary behaviour of university students, particularly of those from ethnic minority groups in the England, and more research in this area would be useful. The aim of this PhD thesis is to examine the prevalence of sedentary behaviour among university students in different ethnic groups and identify the socio-ecological correlates of sedentary behaviour, such as intrapersonal factors, interpersonal factors, environmental, behaviour setting and policy-related correlates.

Chapter 4

Methodology

4 Introduction

This chapter outlines the philosophical underpinning of the research methodology used in this thesis, followed by the details of methods employed for data collection and analysis.

4.1 Aims and research questions

The aim of this study was to understand the prevalence of sedentary behaviour and identify socio-ecological correlates of sedentary time (total and domain-specific) amongst university students. The research consists of two studies. The research questions they seek to address are:

Study 1:

1. What is the prevalence of sedentary behaviour amongst university students in England and how does it compare to that of the general population?

2. Does the prevalence of sedentary behaviour in students and the general population vary by ethnic group?

3. What is the relationship between students' personal and socio-economic characteristics and their sedentary behaviour?

Study 2:

4. What is the prevalence of sedentary behaviour among university students at a university in London and are there any differences by ethnic group?

5. Do socio-ecological characteristics correlate with total sedentary time among university

students?

6. What are the socio-ecological correlates of domain-specific sedentary behaviour amongst university students?

4.2 A quantitative paradigm

The research paradigm most appropriate for this study was the quantitative paradigm. Quantitative research is objective, deductive and general (Long & Godfrey, 2004; Ercikan & Roth, 2006). Objectivity is maintained by detaching from the respondents and attempting to understand the concepts through measurement (Ercikan & Roth, 2006; Bryman, 2012). Quantitative research is deductive because it works from theories to observations (Long & Godfrey, 2004). Lastly, it focuses on generality because it focuses on research in a wider perspective (Long & Godfrey, 2004; Ercikan & Roth, 2006; Bryman, 2015).

In quantitative research a survey questionnaire is considered as the most appropriate instrument for meeting the requirements of positivism, objectivity, deduction and generality (Ercikan & Roth, 2006; Bryman, 2012). This is because with individual items in questionnaires the concepts can be operationalized, objectivity can be maintained by asking respondents to complete self-administered questionnaires, and generality can be achieved by studying a wider audience. It is also possible to replicate the research instrument in a different setting (Ercikan & Roth, 2006; Bryman, 2012).

4.3 Study design

Cross-sectional surveys are commonly used to estimate the prevalence of a problem or disease and are useful in identifying associations between a set of variables (Mann, 2003). Cross-sectional studies have the advantage of being less resource intensive than other observational studies, such

as case-control and cohort studies, and can be completed in a relatively short duration.

In this thesis there were two studies: Study 1 used data from the Health Survey for England (HSE), a repeated cross-sectional survey undertaken in England annually (discussed in detail in the next section). Study 2 was a cross-sectional primary study which collected data about prevalence of sedentary behaviour and examined factors associated with it. A longitudinal study design, which often involves a baseline survey and a follow-up study, was not considered appropriate because Study 2 did not involve the implementation and evaluation of an intervention.

4.4 Methods of Study 1

Study 1 consisted of secondary analysis of existing survey data. This approach has several advantages. First, the HSE was a rich survey that included many relevant variables for the analysis of sedentary behaviour. It was based on repeated cross-sections of large representative samples of the English population which included sizeable sub-samples of university students. Secondly, the HSE was conducted by professionally trained interviewers ensuring that the data were accurately recorded (Joint Survey Unit, 2008 and 2012).

Data for Study 1 were drawn from the HSE 2008 and 2012. The HSE is a health-focused repeated cross-sectional survey conducted annually since 1991 in England. Data about respondents' physical activity and sedentary behaviour were collected. Although other surveys, such as the Active People Survey; the National Travel Survey; the General Household Survey; and the National Diet and Nutrition Survey (National Obesity Observatory, 2015) include information about physical activity, they did not collect data about sedentary behaviour.

HSE used a random sampling strategy to identify a representative sample of individuals residing in England (Joint Survey Unit, 2008 and 2012). Stratification was used to order the sampling units. First, the postcode sectors were stratified by Government office regions to ensure that each area of

the country was proportionally represented. Stratification then ensured a representative and proportionate spread across the spectrum of areas with higher and lower proportions of non-manual workers as heads of households (a criterion used to classify respondents' socio-economic status) (Joint Survey Unit, 2008 and 2012; Bowling, 2008).

A nationally representative sample was taken from the postcode address file in two stages; the primary sampling units were the postcode sectors that were stratified by the percentage of non-manual households with the individual households selected in the second stage. In the selected households, all adults and up to two children were recruited for data collection. In 2008, 16,056 addresses were selected, and 15,102 adults interviewed. In 2012, 9,024 addresses were selected, and 8,291 adults interviewed. Despite the smaller sample in 2012, the household response rate in both years was similar, at around 64.0%, and between those of other national surveys, such as 48.0% for the 2012 Labour Force Survey and 76.0% for the 2011 British Crime Survey (Office of National Statistics, 2015). The 2008 HSE included 751 university students and the 2012 wave included 472 university students (Joint Survey Unit, 2008 and 2012).

After taking oral informed consent from participants, professionally trained interviewers used computer-assisted electronic devices for data collection. Data were collected about the participants': demographic characteristics; employment; income; self-rated health and wellbeing; disability; and lifestyle choices. The latter included information about smoking; alcohol consumption; eating habits; physical activity; and sedentary behaviour. Ethical approval for the HSE was granted by the Oxford Research Ethics Committee (Joint Survey Unit, 2008 and 2012).

4.4.1 Outcome variable

The primary outcome measure in Study 1 was sedentary time measured in minutes per day. In the HSE 2008 and 2012, participants were asked to self-report the time spent sitting while watching television, including watching digital video discs; sitting during leisure time (excluding watching

television); and sitting or standing at work. The exact wording of these are reported in Table 4.1.

Table 4. 1

Sedentary behaviour questions in the HSE 2008 and 2012 (Joint Survey Unit, 2008 and 2012)

Sedentary behaviour questions
1. In the last four weeks, how much time did you spend sitting down watching television (including DVDs and videos) on an average weekday (that is Monday to Friday)? In hours-Range: 0...20 In minutes-Range: 0...59
2. In the last four weeks, how much time did you spend sitting down doing any other activity on an average weekday (that is Monday to Friday)? Please do not include time spent doing these activities while at work. (Examples include reading, studying, drawing, using a computer, playing video game). In hours-Range: 0...20 In minutes-Range: 0…59
3. In the last 4 weeks, how much time did you spend sitting down watching television (including DVDs and videos) on an average weekend day (that is Saturday and Sunday)? In hours-Range: 0…20 In minutes-Range: 0…59
4. In the last four weeks, how much time did you spend sitting down doing any other activity on an average weekend day (that is Saturday and Sunday)? Please do not include time spent doing these activities while at work. (Examples include reading, studying, drawing, using a computer, playing video game). In hours-Range: 0…20 In minutes-Range: 0…59

Study 1 summed data from the four questions outlined in Table 4.1 to calculate sedentary time in minutes per day and minutes per week and the focus was on sedentary behaviour activities undertaken outside of work (leisure time).

However, the HSE also asked economically active respondents (those who had worked in the last four weeks) to report time spent sitting or standing at work: 'On an average work day in the last four weeks, how much time did you usually spend sitting down or standing up? Previously sitting and standing were considered separate behaviours as Levine et al. (2000) stated that one expends 20 percent more calories while standing than sitting; even if only static standing (Biddle et al., 2018). According to Biddle et al. (2018) and Tremblay et al. (2017) in passive standing the energy expenditure is less than 2 METS and in active standing it is more than or equal to 2 METS. The HSE question did not specify whether it was referring to passive or active standing. Moreover, the patterning and social and behaviour context of standing in the workplace was not clear in the question (Biddle et al., 2018). This question failed to disaggregate sitting and standing therefore it was not accounted for in the calculation of sedentary time in Study 1.

4.4.2 Independent variables for Study 1 identified using the socio-ecological model of sedentary behaviour

The independent variables included in Study 1 are outlined in Table 4.2 below. In Study 1 only intrapersonal factors and some interpersonal factors included in the socio-ecological model of sedentary behaviour could be examined. The HSE only included these variables and did not ask questions concerned with what the socio-ecological model would define as environmental and policy-related factors.

4.4.3 Recoding of the variables

Several variables in Study 1 were recoded prior to analysis. Variables before and after recoding are reported in Table 4.3 (the justification for the recoding has been reported in Appendix 3).

Table 4. 2

Independent Variables for Study 1, derived from the HSE 2008 and 2012 datasets

Independent variables	Variables	Level of measurement
Socio-demographic variables Age	Age last birthday	Continuous
Gender	Male Female	Binary
Ethnicity	White-British White-Irish Any other White background Mixed-White and Black Caribbean Mixed-White and Asian Any Other mixed background Asian or Asian British-Indian Asian or Asian British-Pakistani Asian or Asian British-Bangladeshi Black or Black British-Caribbean Black or Black British-African Any Other Black and Black British Background Chinese Any Other please describe here?	Categorical
Marital status	Single Married Civil partnership Separated Divorced Widowed Cohabitees	Categorical
Children	No child One child Two children Three children Four children Five or more	Categorical

NS-SEC 3 variable classification This was the social class of the Household Reference Person (HRP),a person in the household in full-time employment, or who earns more or is older than other household residents. If the respondent was not working at the time of the interview they were asked about their previous occupation.	Managerial & professional occupations Intermediate occupations Routine & manual occupations	
Economic activity	In employment Unemployed Retired Other	Categorical
Household income	Household income	Continuous
Health behaviours Physical activity (complying with the CMO physical activity guidelines. These encompass two different options: 1) Vigorous intensity which makes a person breathe much harder than normal, feel warmer, perspire, and increases heart rate. Additionally, vigorous intensity can be achieved by exercising 75 minutes per week. 2) Moderate intensity which makes a person feel warmer, breathing becomes hard and the heart rate increase. Moderate activity can be completed by exercising 150 minutes per week or 30 minutes 5 times a week or in several bouts of 10 minutes adding up to 150 minutes. The examples of moderate activity are brisk walking. . These can be summarized as moderate to vigorous physical activity (MVPA) (Public Health England, 2019)	Meets physical activity guidelines Active but does not meet guidelines Inactive	Categorical

Five a day fruit and vegetable consumption (derived variable in the HSE 2008 dataset only where participants have been divided into meeting or not meeting guidelines)	Meeting recommendations Not meeting recommendations	Binary
Smoking status	Never smoked cigarettes at all Used to smoke cigarettes occasionally Used to smoke cigarettes regularly Current cigarette smoker	Categorical
Alcohol consumption	Not at all in the last 12 months/Non-drinker Almost every day Five or six days a week Three or four days a week Once or twice a week Once every couple of months Once or twice a year	Categorical
Psychological Mental wellbeing (General health questionnaire GHQ-12)	Have you recently: Been able to concentrate on what you're doing? Lost much sleep over worry? Felt that you are playing a useful part in things? Felt capable of making decisions about things? Felt constantly under strain? Felt you couldn't overcome your difficulties? Been able to enjoy your normal day-to-day activities? Been able to face up to your problems? Been losing confidence in yourself? Been thinking of yourself as a worthless person? Been feeling reasonably happy, all things considered? Likert scale responses for the questions 1 'Better than usual' 2 'Same as usual 3 'Less than usual' 4 'Much less than usual'	Categorical variable Recoded to 0-2 No mental-ill health 3 + mental ill health
What is your quality of life today? (ED-5Q descriptive)	Mobility (walking about) I have no problems in walking about I have some problems in walking about I am confined to bed Looking after myself I have no problems with self-care I have some problems with washing or dressing myself I am unable to wash or dress myself	Categorical

	Doing usual activities I have no problems with performing my usual activities I have some problems with performing my usual activities I am unable to perform my usual activities Having pain or discomfort I have no pain or discomfort I have moderate pain or discomfort I have extreme pain or discomfort Feeling worried I am not anxious or depressed I am moderately anxious or depressed I am extremely anxious or depressed	
Self-assessed general health today	Very good/good Fair Bad/very bad	Categorical
Limiting longstanding illness over last 12 months	Limiting long-lasting illness Non-limiting long-lasting illness No long-lasting illness	Categorical

Notes: The self-assessed health variable was included in the HSE as three categories: very good/good, fair and bad/very bad. The fair and bad/very bad categories only included a few responses both in the 2008 and 2012 dataset (bad/very bad only 13 individuals 2008 and only 10 in 2012). It is common practice to dichotomize the general health variable into two categories as 'good' and 'less than good'. Longstanding illness can be a physical or mental health illness that may have lasted or is expected to last for a period of 12 months or more. It tends to reduce a person's ability to do day-to-day work.

Table 4. 3

List of variables coded in the HSE (2008 and 2012) and recoded for analysis in the multiple regression model

Variable	Variable coded in the HSE 2008 and 2012	Recoded variable	Coding of the recoded variable
Sex	1=Male 2=Female	Gender	Reference category 0=Male 1=Female
Ethnicity	1=White-British 2=White-Irish 3=Any other White background 4=Mixed-White and Black Caribbean 5=Mixed-White and Asian 6=Any other mixed background 7=Asian or Asian British-Indian 8=Asian or Asian British-Pakistani 9=Asian or Asian British-Bangladeshi 10=Black or Black British-Caribbean 11=Black or Black British-African 12=Any Other Black and Black British Background 13=Chinese	Ethnicity	Reference category 0=White 1=Asian 2=Black 3=Other
Marital status	1=Single and never married 2=Married and living with husband or wife 3=Civil Partner in a legally recognized civil partnership 4=Married and separated from husband or wife 5=Divorced 6=Widowed	Maritalst	Reference category 0= Unmarried (1,4,5,6) 1= Married or cohabiting (2 and 3)
Has children	1=0 2=1 3=2 4=3 5=4 6=5	Child	Reference category 0=No children 1=Has children

Economic status	1=In employment 2=Unemployed 3=Retired	Econoact	Reference category 0=Not employed (2 & 3) 1=Employed (1)
Social class (NS-SEC 3)	1=Managerial & Professional 2=Intermediate 3=Routine & Manual 4=Other	Ncsec3	Reference category 0=Managerial & professional 1=Intermediate 2=Routine & manual 3=Other
Physical activity	1=Meeting Guidelines 2=Lower but Active 3=Inactive	Physiacti	Reference category 0=Not meeting MVPA guidelines (2 and 3) 1=Meeting MVPA guidelines
Five a day fruits and vegetables (only in 2008)	1=None 2=Less than 1 portion 3= less than 3 portions 4=3 less than 4 portions 5=4 less than 5 portions 6=5 less than 6 portions 7= less than 7 portions 8= less than 8 portions 9=8 portions or more	Fiveaday	Reference category 0=Not meeting guidelines 1=Meeting guidelines
Cigarette smoking status (cigsta3)	1=Current Smoker 2=Ex-regular smoker 3=Never smoked	Smoker	Reference category 0=Non-smoker (2 and 3) 1=Smoker
Alcohol consumption (dnoft3)	1=Almost every day 2=Five or six days a week 3=Three or four days a week 4=Once or twice a week 5=Once or twice a month 6=Once every couple of months 7=Once or twice a year 8= Not at all in the last 12 months/Non-drinkers		Reference category 0=Do not drink 1=Drinker

General health (genhelf2)	1=Good/Very Good 2=Fair 3=Bad/Very Bad	GENHealth	Reference category 0=Good/Very Good 1=Fair/Bad/Very Bad
Limiting longstanding illness (longill)	1=Yes 2=No	Longstanding Illness	Reference category 0= No 1=Yes
GHQ 12 score (GHQ12score)	1=0 2=1 3=2 4=3 5=4 6=5 7=6 8=7 9=8 10=9 11=10 12=11	GHQ12 Variable	Reference category 0-2 = No mental ill health 3+ = Mental ill health

4.4.4 Statistical analysis

Both descriptive and inferential statistics were computed using SPSS version 22 (IBM, Chicago, IL). First, the sample of university students from the HSE 2008 and 2012 datasets was identified using the variable 'Highest Educational Qualification – Students' and students below 17 years of age were dropped (Joint Survey Unit, 2008 and 2012).

The Univariate analyses included frequencies of the key variables, measures of central tendency and measures of dispersion (Bryman, 2015). This was followed by the estimation of the prevalence of sedentary behaviour utilizing the Chi Square test for independence and binary logistic regressions were computed to estimate the odds ratios (prevalence ratios). The outcome variable for the logistic regression was sedentary behaviour that was dichotomized (1 when the individual was sitting for more than 8 hours per day, 0 otherwise that is sitting for less than 8 hours per day).

In the next stage, bivariate analyses were conducted to examine the relationship between total sedentary time per day in minutes and various potential predictors (Field, 2013). This was followed by the estimation of multiple regression models to analyse the relationship between the dependent and independent variables. Estimates from regression models provided information about the direction and the strength of the statistical association between a dependent variable (y) and a series of independent variables (x). Regression models also provide a measure of the quantitative effect that changes in an independent/explanatory variable (x) have on the dependent variable (y), thus going beyond the estimated statistical correlation (Dancey & Reidy, 2004). The outcome variable of Study 1 was a continuous variable, therefore the most appropriate regression technique in this analysis was multiple linear regression (Field, 2013).

Linear regression was used to examine the relationship between a single independent variable, such as the age of the individual (x), and the continuous dependent variable, sedentary behaviour, in minutes per day (y) (Dancey & Reidy, 2004). The value of y for any given individual is denoted as *i* and it is written as y^i and x for that individual is denoted as x^i. The coefficient for the intercept of the relationship between x and y is denoted by β^o.

The error term for an individual *i* was denoted as ε^i , this is known as an idiosyncratic error term (Marasinghe, 2008). In multiple linear regression models, more independent variables were added, for example:

$$x_1^i\ (age), x_2^i\ (income), x_3^i\ (gender)\ and\ \ x_4^i\ (ethnicity).\ _1$$

In addition, the corresponding β_s was added, this included β_1 , β_2, $\beta_3\ and\ \beta_4$. The multiple regression model's equation used in Study 1 was as follows:

$$y_{i=}\ \ \beta_0 + \ \beta_1\, x_{1i} \ + \ \beta_2\ x_{2i} \ + \ \beta_3\, x_{3i} \ + \ \beta_4 x_{4i} \ + \ \varepsilon_i \qquad \text{(Equation 1)}$$

The software SPSS 22 (IBM Corp, 2015) was programmed to assume that the data came from a simple random sample, where every participant had an equal chance of being selected. This meant that in the sampling every *n* th number of randomly selected participants could be included in the analysis. Statistical benefits of simple random sampling are that the observations of a given variable are independent and every participant has an equal chance of selection (West, 2008). When stratification and clustering are utilized in the sampling procedure, participants cannot be selected independently of each other and parameter estimates might be affected. The main parameter estimate that is likely to be affected is the standard error, a statistic that

provides a measure of dispersion. On the other hand, clustering of samples that also require weighting of the estimates may increase the size of the standard errors (Best & Wolf, 2014). Authors, such as Johnson and Elliot (1998) believe that in multiple linear regression analysis it is often acceptable to use unweighted datasets. However, Osborne (2013) advocates that using unweighted data can result in incorrect parameter estimates and errors. Keeping these arguments in mind it was considered pragmatic to compute the multiple linear regression models with both the unweighted dataset and the complex sample design adjustment for both 2008 and 2012 datasets. The rationale for adjusting for the complex sampling design was to ensure that any bias that may have occurred because of non-response was taken into consideration. The HSE dataset needed adjustment so that the sample could be considered a random sample. The procedure used was adjusted for clustering, stratification and weighting. In the dataset either the variable 'area' or 'PSU' described the primary sampling unit, strata was denoted by variable 'cluster'. To adjust for sampling weight and non-response weighting the variable 'wt_int' was used.

Study 1 data analysis followed four steps:

1. Descriptive statistics were conducted.
2. Simple linear regression models were computed to analyse the associations between each independent variable separately and the dependent variable.
3. Finally, multiple linear regression models were computed to assess the predictive strengths and statistical associations of the demographic, lifestyle choices and psychological and physical wellbeing of university students' sedentary behaviour.
4. In the next stage the models were adjusted for the complex sampling design to ensure that the sample was made into a simple unclustered random sample. After

the adjustment, multiple linear regression models were built in the complex sample module of the SPSS software. This step was undertaken as a check and to analyse preferred estimates.

4.4.5 Data quality

In the HSE not all respondents selected to be included in the survey agreed to participate (Brick & William, 2013). The individual interview response rate for the HSE was 58.0% in 2008 and 56.0% in 2012. HSE data are weighted to resemble the general population of England by using data from the UK Census (for HSE 2008, 2001 data were used and 2011 Census data for HSE 2012).

4.5 Methods employed for Study 2

Study 2 consisted of a cross-sectional primary study in which data were collected from a sample of university students at a London university. The rationale for conducting a primary study is ensure that data about the complete breadth of socio-ecological correlates of sedentary behaviour can be collected (Owen et al., 2011). Moreover, the questionnaire has been designed in a manner that data about sedentary behaviour in different domains can be collected (Marshall et al., 2010). The advantage of primary research is that the questionnaire was designed specific to the research objectives (Gratton & Jones, 2009).

4.5.1 Context of research site for Study 2

Study 2 was undertaken at a university on the east side of London, referred to as University X for confidentiality. This university had approximately 10,000 students from 120 different nationalities, and 65.0% of the students belonged to the Black and other minority ethnic groups (University X, 2015). Study 2 aimed to explore sedentary

behaviour among university students and to establish if there were ethnicity-related differences in sedentary behaviour.

The university had three campuses located within the same borough. The borough was identified as one of the most deprived areas in London (London Datastore, 2017). Previous research has shown that social inequalities in health and lower life expectancy are evident in areas of high deprivation (Marmot Review, 2010). Life expectancy in the study setting has been identified as lower than other more affluent areas in London (London Datastore, 2017). University X was also in a socially deprived area that had less infrastructure to support healthy lifestyles. At the time of data collection there were no cycle lanes or cycles that could be hired for riding, and more takeaway outlets in this area compared to more affluent areas of London (Ogilvie & Goodman, 2012). This provided an interesting environmental and neighbourhood context in the socio-ecological model (Owen et al., 2011).

4.6 Research methodology

Study 2 extended the analyses conducted in Study 1 by including the full breadth of socio-ecological correlates of sedentary behaviour: individual-level, interpersonal, perceived environmental, organizational setting and policy related characteristics (Owen et al., 2011). The questionnaire of the study was designed to collect information about students' sedentary time in their different sitting domains (Appendix 3). The questionnaire included closed-ended questions, which can be completed and coded more quickly than open-ended questions (Bowling, 2005). The questionnaire contained well-established questions that have been used in previous studies (Vaus, 2013). Validated tools and questions included those of the Marshall Sitting Questionnaire **(**Marshall et al., 2010); the Euroqol 5D Questionnaire (Brooks et al., 2003); the New

Zealand Physical Activity Questionnaire-Short Form (Maddison et al., 2007); the General Health Questionnaire 12 (GHQ-12) (to measure mental health) (Hamer et al., 2009); and the Perceived Environment Questionnaire (Ogilive et al., 2008).

The questionnaire started with questions about the intrapersonal and interpersonal characteristics outlined by the socio-ecological model of sedentary behaviour, such as age; gender; ethnicity; income; mode of study (full-time or part-time); year of study; degree type (undergraduate or postgraduate degree); and residence arrangements. The interpersonal characteristics were marital status and number of children (Owen et al., 2011).

4.6a Marshall Sitting Questionnaire

Several questionnaires are available to measure sedentary behaviour; for this study the Marshall Sitting Questionnaire was most appropriate (Marshall et al., 2010). This questionnaire asked about the time spent sitting during five different domains: sitting while travelling to and from places, at work, watching television, using a computer at home, and leisure-time other than TV viewing over the last 7 days (Marshall et al., 2010). After personal communication with the authors an additional category to measure sitting while studying at university was added.[1] Data from the Marshall Sitting Questionnaire was used to create estimates of total weekday and weekend sitting time by summing the time reported in each of the domains. The questionnaire started with the question 'please tell us about the time you spend sitting on a weekday and weekend. It will be useful if can tell is about your sitting time in different settings' followed by the response options of sitting time in six different settings: sitting while travelling to

[1] I contacted the authors of the questionnaire to ask if an additional category about 'sitting while at university' could be added. The authors, Alison Marshall and Jacqueline Kerr, responded that this appears to be a suitable addition in my study's context (Personal Communication, 2014).

and from places, at work, watching television, using a computer at home, sitting at university and leisure-time other than TV viewing over the last 7 days.

Marshall et al. (2010) concluded that the Marshall Sitting Questionnaire was a valid and reliable questionnaire to measure sedentary time; it was also appropriate for Study 2 because it was short, and respondents could complete it quickly. An alternative measure of sedentary behaviour, the Medical Research Council's Sedentary Behaviour Questionnaire (SIT-Q-7) (Wijndaele et al., 2014), was discounted as it was lengthy and contained twenty questions with further sub-questions.

4.6b Euroqol 5D

Euroqol 5D (EQ-5D) (Brooks et al., 2003) was included in the questionnaire to measure the health-related quality of life. The conceptual basis of EQ-5D questionnaire is that it has a holistic view of health and includes both a positive (wellbeing) and negative (illness) definition of health. It includes the medical definition of health and also encompasses the physical, emotional and social functioning. The EQ-5D measures five health dimensions: mobility, self-care, ability to complete usual activities, pain, and anxiety. Alternative scales to measure quality of life, such as the Short Form-6 (SF-6D) (Ware, 2000) and the Health Utility Index 2 and 3 (Furlong et al., 2001), consist of longer volumes of questions which can overwhelm respondents (Bowling & Ebrahim, 2005) so were not used. Moreover, the use of EQ-5D aids comparison with the HSE (2008 and 2012) which also used to measure health-related quality of life (Brooks et al., 2003).

4.6c General Health Questionnaire 12

Goldberg (1970) developed the General Health Questionnaire (GHQ) to measure current mental health and since its development it has been used in different studies. The original questionnaire was as a 60-item instrument but there are shortened versions of the questionnaires including GHQ-30, GHQ-28, GHQ-20, and GHQ-12. The GHQ-12 as selected to be included in the Study 2 questionnaire because it was considered a brief, simple, easy to complete questionnaire as it only contained twelve questions on mental health that the respondents could complete quickly (Hardy et al., 1999), whereas other versions of the tool (GHQ-60, GHQ-30, and GHQ-28) take much longer to complete (Rosenberg et al., 1983). In addition, the GHQ-12 was used in HSE 2008 and 2012, so using GHQ-12 aided comparison with the previous analysis based on data representative of the population in England (Joint Survey Unit, 2008 and 2012). The twelve questions included in the GHQ-12 ask around mental health, anxiety and depression and completion of daily activities. For example, questions ask the respondent whether they have recently 'Been feeling unhappy and depressed?' and 'Been able to enjoy your normal day-to-day activities?'

4.6d Questions on smoking and alcohol intake

Three questions about smoking and alcohol included in Study 2's questionnaire were similar to those used in the HSE. The questions ask about the respondents' smoking status to establish whether they are non-smokers, ex-smokers or current smokers. The question was phrased as 'May I just check, have you ever smoked a cigarette, a cigar or a pipe?' with a response option of Yes or No. If respondents smoked, they were asked to select the number of cigarettes they smoked per day.

To collect data about respondents' alcohol intake the first question was used to identify if the person had ever consumed an alcohol drink. The question was adapted from research by Bowling and Ebrahim (2005). If the respondents consumed alcohol questions about the type and number of units consumed was asked. In addition, the number of units of alcohol they consumed per day during the last week was recorded.

4.6e Cambridge University Five-a-day Community Evaluation Tool

The HSE included an extensive list of questions about dietary intake, including questions to ascertain whether respondents complied with the recommended five-a-day intake. Given the length of this HSE item, the Cambridge University five-a-day community evaluation tool (FACET) (Ashfield-Watt et al., 2007) was used instead as it was shorter and can assess the fruit and vegetable intakes in an adult. Respondents had to indicate on a five-point scale how often they consumed certain fruit and vegetables during the previous day (Ashfield-Watt et al., 2007).

4.6f New Zealand Physical Activity Questionnaire

To measure physical activity the New Zealand Physical Activity Questionnaire Short Form (NZPAQ-SF) (Maddison et al., 2007) was used. The NZPAQ-SF is a seven-item questionnaire that measures the frequency, intensity and duration of physical activity undertaken by an individual in the last seven days. The NZPAQ-SF includes seven questions in which the participants are asked to recall the frequency they performed brisk walking, moderate, vigorous and a combination of both. Then the participants record the duration (time) they performed the activity. In some terms the NZPQ-SF is similar to the condensed version of the International Physical Activity Questionnaire-Long form, the International Physical Activity Questionnaire-Short Form (IPAQ-SF) but there are some significant differences: 1) unlike the NZPQ-SF the IPAQ-SF does

not measure the frequency of physical activity; 2) the order in which questions about physical are asked is reverse in NZPQ-SF compared with IPAQ-SF; 3) the NZPQ-SF does not include a question about sedentary behaviour and 4) the IPAQ-SF has been reported in research to overestimate respondents' physical activity levels (Lee et al., 2011).

In laboratory tests, the NZPAQ-SF has been reported to be a valid measure of physical activity (Maddison et al., 2007). The International Physical Activity Questionnaire-Long Form is also a valid measure of physical activity but was not used for Study 2 because it consisted of twenty-seven questions about physical activity so is much longer than the NZPAQ-SF.

4.6 g Questions about the University Setting

The built environment where one resides as well as the neighbourhood environment impacts health. Owen et al.'s (2011) socio-ecological model emphasizes the need to understand the behaviour setting for where sedentary behaviour occurs because some settings may encourage sedentary behaviour, whereas others may discourage it. It was thought important to understand students' physical setting to assess if it encourages sedentary behaviour or discourages it. In Study 2 questions about the university setting were developed, including questions about the classroom size, facilities for exercise and university environment, and whether physical activity is promoted at university (for example, whether 'the use of stairs rather than lifts is promoted'. Previous literature was consulted to design questions about the physical setting of the university that may influence students' behaviour and physical activity (Greaney et al., 2009; Deliens et al., 2015).

4.6 h Perceived Neighbourhood Environment

Environmental factors—the perceptions that people have about their neighbourhood environment—may contribute towards people's sedentariness (Owen et al., 2011). In a UK study of health status in a deprived urban area a questionnaire was used to measure the perceived neighbourhood environment (Ogilive et al., 2008). This questionnaire has UK appropriate terminology and has been considered the most appropriate to be used in the UK (Ogilive et al., 2008). The neighbourhood scale developed by Ogilive et al. (2008) assessed the perceptions of local environment such as aesthetics, green space, access to amenities, convenience of routes, traffic, road safety and personal safety. The questions were closed ended and consisted of statements asking respondents about their local area, such as in your local area 'it is pleasant to walk' and 'there are convenient routes for cycling.' The responses were in the form of a Likert scale varying from Agree to Disagree.

Alternative measures of perceived neighbourhood environment were considered for use in this study but were discounted because they were either not validated for use in the UK (Neighbourhood Environment Walkability Scale; Saleans et al., 2003) or were too lengthy (Spittaels et al., 2009). Therefore, the Ogilive et al. (2008) questionnaire was considered feasible for Study 2.

4.6 i Social Capital Questions

Socio-cultural factors encompass social capital, meaning the resources individuals accumulate by connecting with other people or their social networks (Coleman, 1988). Questions from the Office of National Statistics Social Capital Harmonized Questionnaire to measure social capital were considered appropriate for the study and

were used (Green & Fletcher, 2003). The dimensions of social networks, social support and reciprocity were measured. Social networks and social support questions included questions about the types and number of exchanges with relatives, friends and neighbours. Reciprocity measured peoples' willingness to co-operate for mutual benefit that included questions on how people would help the other person if someone needed money or medicine. Questions were also included about civic participation such as measuring individual involvement in local affairs (Green & Fletcher, 2003).

4.6 j Policy-related factors

The socio-ecological model of sedentary behaviour recognizes the importance of policy-related factors (Owen et al., 2011). There was no specific UK government policy to reduce sedentary time. To assess students' awareness of sedentary behaviour policy, two questions were asked in this study to establish if respondents were aware of any government or university policy about sedentary behaviour. The questions were phrased as 'are you aware of any United Kingdom government and University policy about reducing sitting time or sedentary behaviour.'

4.6.1 Piloting the questionnaire

The questionnaire developed for Study 2 was piloted amongst eight university students at University X on 05/03/2015. A participatory pilot survey strategy was employed, in which the questionnaire was pilot tested with the eight respondents; respondents reported their feedback of the questionnaire and the resulting feedback was used to amend the survey questionnaire (Converse & Presser, 1986). Students reported that the participant information sheet was easy to understand and was self-explanatory. On average, students took 20 minutes to complete the survey. The feedback was recorded on printed sheets of paper. The students were asked to answer the following questions,

adapted from Bowden et al. (2002), to provide feedback about the pilot survey:

1. What do you think of the questionnaire in general?

2. Did you find any question to be strange?

3. How appropriate are the response categories to the questions?

4. Do you think any question should not be asked in the survey?

5. Do you think more questions should be added to the survey?

6. What changes do you think can be made to improve the survey?

7. Do you think any questions seem to be asking the same thing?

The students reported that they were content with the length of the questions and that most were relevant and easy to answer. However, they recommended including a category of 'council housing' in the accommodation question and 'only living with children' in a question asking about who respondents live with. The students also stated a preference for the question about hours of sedentary behaviour to be in the form of rows, rather than a table, to avoid confusion.

4.6.2 Dissemination of the questionnaire

Compared to paper surveys, online questionnaires are cheaper, as the cost of emailing the web link of the survey is low, and they can be distributed quickly to the respondents and have lower data entry errors (Wright, 2005; Bryman, 2015). Previous research using postal questionnaires has shown a low response rate as the residential addresses may vary because university students tend to stay at or near university during term time

and move to different accommodation when term finishes (Steward-Brown et al., 2000).

Although university students are common users of the internet and it may be considered that they would respond better to online surveys compared to paper-based surveys, research demonstrates the contrary. University students have a lower response rate to email or online surveys compared with paper-based surveys (Nulty et al., 2008; Saleh & Bista, 2017). However, the previous research recommends that the use of email reminders and incentives can improve response rates. In Study 2, to enhance the response rate of the study students were reminded about the survey by using advertisements. The leaflets and brochures publicizing the study were placed in different locations in the university and electronic leaflets were advertised on the virtual learning environment and social media websites of the university.

4.6.3 Sampling strategy

University X maintained a list of its students' email addresses but as this is confidential information it was not possible for the researcher to access it. In the absence of a sampling frame required for selecting a random sample, a convenience sampling approach was adopted (Bowling & Ebrahim, 2005). Convenience sampling is a non-probability sampling technique that would include any respondent available and willing to participate in the study provided they met the participant inclusion criteria (Bowling & Ebrahim, 2005). Previous studies that employed similar convenience sampling strategies were able to report characteristics and behaviours of students at the various universities where data were collected but results could not be further generalized because they were not a random sample (Steptoe & Wardle, 1991; Buckworth & Nigg,

2004; Rouse & Biddle, 2010; Fountaine et al., 2011; Fotheringham et al., 2011; El Ansari et al., 2011).

4.6.4 Ethical approval

Ethical approval for Study 2 was confirmed from Lancaster University and University X.

4.6.5 Sample size estimation

A statistician at Lancaster University was consulted for sample size calculation. Results from the analysis of Study 1 were utilized to estimate the required sample size for Study 2. For sample size estimation, the mean sedentary time in group one (Black students) was 413 minutes per day and mean sedentary time in group two (White students) was 340 minutes per day (SD 142 minutes per day). The designated parameters used by the statistician were as follows: effect size = 0.15, power = 0.80, p = 0.05 (Field, 2013). The required sample size was estimated to be 330 university students (Table 4.4). Previous studies on sedentary behaviour amongst university students have used sample sizes of between 86 and 736 university students (Buckworth & Nigg, 2004; Rouse & Biddle, 2010; Fountaine et al., 2011; Moulin & Irwin, 2017).

Table 4. 4

Sample Size Estimation

Estimated sample size for two-sample comparison of means	
Test Ho: m1 = m2, where m1 is the mean in population 1 and m2 is the mean in population 2	
Assumptions:	
alpha =	0.0500 (two-sided)
power =	0.8000
m1 =	413
m2 =	340
sd1 =	133
sd2 =	142
n2/n1 =	10.00 (as the HSE 2012 dataset has 10 times as many Whites as Blacks)
Sample size (413, 340), sd1(133) sd2(142) power (.8) ratio (10)	
Total sample size of 330.	

Notes: Alpha or α is the significance level and is the probability of rejecting the null hypothesis when it is true. Power statistical power is the probability of detecting a predefined clinical significance, ideally it is kept at 80%. M is the mean sedentary time spent per day in minutes. SD is the standard deviation of the mean sedentary time. N2/N1 is the ratio of White students to Black students.

4.6.6 Procedure for inviting participants

To contact potential respondents at University X the study was publicized using posters displayed in communal areas at the university, such as halls of residence, student cafés, student dining areas, and the university reception area. Moreover, the study was publicized in the university students' magazine and on the virtual learning environment. The university media and management team did not agree to send an invitation email to the students to participate in the study. However, the study was publicised on the university's social media pages, such as its Facebook and Twitter accounts; the social media posts were shared several times during the recruitment of the students so they could be reminded about the study. No face-to-face recruitment was carried out for this study.

The students were invited to visit a webpage to learn more about the study before agreeing to take part. Participants accessing the webpage were informed that participation in the study was voluntary. Students had a chance to win one of the two advertised Amazon vouchers if they participated in the survey. If after reading the participant information sheet the respondents were willing to take part in the study, they were asked to 'click' on the link for the questionnaire, which opened the portal for the web-based software tool Bristol Online Surveys (BOS, 2015). The BOS serves as an online platform to develop, disseminate, and analyse surveys, and over 300 organizations including 130 universities subscribe to it (BOS, 2018). Lancaster University maintains access and membership of BOS, therefore, PhD in Public Health students were able to utilize this service free of charge. The BOS website was used for data collection and the data were stored on encrypted servers of BOS hosted by University of Bristol (BOS, 2018). The questionnaire was designed in a manner to

ensure that the respondents completed the entire questionnaire. The questionnaire was only stored and considered complete when students pressed the final finish button at the end of the questionnaire.

4.6.7 Data cleaning

Data from completed questionnaires on the BOS platform were downloaded on an Excel spreadsheet. The data were first checked for duplication. The majority (86.0%) of the students provided their email addresses at the end of the questionnaire because they were willing to participate in a draw which gave them a chance to win one of the two advertised Amazon vouchers. The survey was designed in a manner that respondents who filled in the questionnaire could not proceed without filling in the mandatory questions. The Marshall Sitting Questionnaire contained response options that the respondents had to complete by entering the number of hours they sat in each domain (Marshall et al., 2010). 32 respondents either misunderstood this component of the questionnaire or were not keen to complete it and entered zero in most of the categories; accordingly, these respondents were excluded from the analysis. Two of the respondents only filled zero in most of the categories and in one of them reported that they had been sitting for either two or three hours per day; these were deemed unrealistic and were not included in the analysis. This data cleaning was in line with previous studies about sedentary behaviour where if respondents entered zero in the responses they were removed from the analysis (Gyimah, 2001; Moulin & Irwin, 2017).

4.6.8 Outcome variable (sedentary behaviour)

Total sedentary time is the dependent variable for Study 2. At present there is no quantified limit for total time that should be spent being sedentary per day, therefore it was considered logical to categorize sedentary time as a continuous variable. Similarly,

in previous studies examining correlates of sedentary behaviour, sedentary time has been operationalised as a continuous variable (Rouse & Biddle, 2010; Jefferis et al., 2018).

4.6.9 Independent variables

The independent variables in this study were chosen based on the characteristics identified by the socio-ecological model of sedentary behaviour (Owen et al., 2011) (Table 4.5).

Table 4. 5

Independent variables for Study 2

Independent variables	Categories	Level of measurement	Source
1. **Intrapersonal characteristics**			
I. Age, gender, ethnicity, marital status, number of children, socio-economic status, income general health, quality of life and general wellbeing, as used in the HSE/ Study 1 (Table 1).			HSE 2008 and 2012
Employment	Only studying at university and not working Studying at university part-time and working part-time Studying at university part-time and working full-time Studying at university full-time and working part-time Studying at university full-time and working full-time	Categorical	Self-developed
Mode of study	Full-time student on campus Part-time student on campus Distance-learning student full-time Distance learning part-time	Categorical	Self-developed
Study type	Undergraduate Postgraduate	Dichotomous	Self-developed
2. Health Behaviour			
Physical activity	Meeting guidelines Not meeting guidelines	A categorical variable recoded to a binary variable	Madisson et al. (2007)
Smoking a. Smoking status	Never smoked cigarettes at all Used to smoke cigarettes occasionally Used to smoke cigarettes regularly Current cigarette smoker	Categorical	HSE (2008 and 2012)
b. Banded smoking status	Light smokers, under 10 a day Moderate smokers, 10 to under 20 a day Heavy smokers, 20 or more a day Don't know number smoked a day Non-smoker	Categorical	HSE (2008 and 2012)

Alcohol consumption			
a. Do you drink alcohol?	Yes/No	Dichotomous	HSE (2008 and 2012)
b. How many units of alcohol do you have on a typical day when you are drinking?	1-2 3-4 5-6 7-8 9 +	Continuous	HSE (2008 and 2012)
c. How many alcohol-free days do you have per week?	1 2 3 4 5 6 7	Categorical	HSE (2008 and 2012)
How often do you have five or more units on one occasion?	Never Less than monthly Monthly Weekly Daily or almost daily	Categorical	NHS (2015)

3. <u>Neighbourhood environment</u>	In my local area… It is pleasant to walk There is a lot of traffic noise There is a park within walking distance The roads are dangerous for cyclists People are likely to be attacked There is convenient public transport There are convenient routes for cycling There is little green space It is safe to walk after dark The nearest shops are too far to walk to There is little traffic There are no convenient routes for walking It is safe to cross the road The surroundings are unattractive Response as Likert Scale with responses 'Strongly Agree', 'Agree', 'Neither agree nor disagree' 'Disagree', 'Strongly Disagree'	Categorical	Ogilive (2012)
4. <u>Social capital</u> a. Personal contact with your relatives, friends and neighbours	Meet up with relatives Speak to relatives on the phone Write to relatives (including letters, texting, email, and internet). Meet up with friends. Speak to friends on the phone Write to friends (including letters, texting, email and internet) Speak to neighbours The responses consist of 'most days', 'once or twice a week', 'once or twice a month', 'less than a month'.	Categorical	Office of National Statistics (2013)
b. Thinking now about your relatives, friends, and neighbours outside your home, can you tell me around how many people could you ask for the following kinds of help?	To go to the shop for groceries if you are unwell To lend you money to see you through the next few day To give you advice and support in a crisis The responses consist of 'none,' 'one or two', 'more than two', 'would not ask', 'don't know'.	Categorical	Office of National Statistics (2013)

c. Voluntary participation (Unpaid help to groups and individuals)	During the last 12 months have you given any unpaid help to any groups, clubs or organizations in any of the ways shown? Select one option from below: Unpaid help to groups and individuals Raising or handling money/taking part in sponsoring events. Leading the group/ member of a committee Organizing or helping to run an activity or event Visiting people Befriending or mentoring people Giving advice/information/counselling Secretarial, admin or clerical work Providing transport/driving Representing Campaigning Other practical help (e.g. helping at school, religious group, shopping)	Categorical	Office of National Statistics (2013)
5. <u>Behavioural setting</u> **(**at your university)	At my university: The use of stairs rather than lifts is promoted. There are facilities for exercise There is time at university to exercise There is a green space for walking The use of cycles is encouraged There are convenient routes for cycling The lecture rooms are spacious It is safe to walk after dark There are convenient routes for walking Response as Likert Scale with responses 'Strongly Agree', 'Agree', 'Neither agree nor disagree', 'Disagree', 'Strongly Disagree'	Categorical	Adapted from Owen et al. (2011)
6. <u>Policy-related factors</u>	Do you know of any national or local government policy in the United Kingdom about sedentary behaviour? Do you know of any policy in your university about sedentary behaviour? Response as 'Yes' and 'No'	Binary	Self-developed

4.6.10 Data analysis

The data analysis of Study 2 was undertaken in a comparable manner to Study 1. First the descriptive statistics of the respondents were reported followed by the estimation of prevalence of sedentary behaviour amongst the university students. This was followed by multiple linear regression analysis to examine the relationship between the independent variables outlined by the socio-ecological model of sedentary behaviour: 1) intrapersonal 2) interpersonal 3) perceived environment 4) behaviour setting and 5) policy-related factors and the outcome variable, sedentary time.

4.7 Conclusion

The methodology chapter started with justifying the reason for selecting a quantitative methodology to conduct the studies in the thesis. This was followed by a detailed discussion of the methods utilized in Study 1 and Study 2. The data analysis methods that were considered most appropriate for the studies were also reported. The next two chapters report the findings of Study 1 and Study 2.

Chapter 5

Results Study 1

5 Introduction

This chapter contains the results of the descriptive and inferential statistics from Study 1. Study 1 utilized the HSE dataset for 2008 and 2012 to understand the intrapersonal and interpersonal determinants of sedentary behaviour outlined by the socio-ecological model of sedentary behaviour (Owen et al., 2011).

5.1 Participant characteristics HSE 2008 and 2012

Tables 5.1-5.5 compare the demographic, health and health behaviour profiles of the student sample with those of the full HSE population. The student sample in both years was younger than the full sample. The mean age of the student sample for both years was 23.6 years (standard deviation =10.04, 2008 and SD=9.8, 2012). In contrast, the general population sample was older with a mean age of 35.4 years in the 2008 sample and 40.0 years in the 2012 sample, respectively. In both years, around 83.0% of the full sample identified themselves as being of White ethnic background compared to 71.0% of students in 2008 and 65.0% in 2012, reflecting greater ethnic diversity in the student population.

The socio-demographic and interpersonal profile of the student sample also differed from the HSE full sample. In the 2008 sample, most students were single (84.7% compared with 26.8% in the full sample); had fewer children (32.4% compared to 52.7%) and were not in employment (88.1% compared to 45.3%) (Tables 5.2 and 5.3). A similar pattern of differences in the socio-demographic profile and interpersonal

factors was observed between the student sample and full HSE sample in 2012 (Table 5.2 and 5.3).

The proportion of students and full sample reporting physical activity compliance increased between the 2008 and 2012 surveys (Table 5.4). General health and mental wellbeing profiles of the student sample and full HSE sample remained stable between the 2008 and 2012 surveys. Although the student sample reported to be in good general health (87.0-88.0%), their mental health (43.8-46.0%) was worse than the full sample (37.0-38.6%) (Table 5.5).

Table 5. 1

Characteristics of the student sample and complete sample (ethnicity), HSE 2008 and 2012.

	Student HSE 2008	Full Sample 2008	Student HSE 2012	Full Sample 2012
Ethnicity	Proportion (N)	Proportion (N)	Proportion (N)	Proportion (N)
White – British	70.7 % (531)	83.1 % (18,801)	64.8 % (323)	82.7% (8,522)
White – Irish	0.4 % (3)	1.1 % (237)	-0	-
Any other White background	5.2 % (39)	3.7 % (837)	7.5 % (34)	4.7 % (82)
Mixed - White and Black Caribbean	0.5 % (4)	0.8 % (171)	0.8 % (3)	0.5 % (55)
Mixed - White and Black African	0.3 % (2)	0.3 % (67)	1.1 % (4)	0.2 % (20)
Mixed - White and Asian	0.4 % (3)	0.4 % (89)	1.1 % (4)	0.6 % (60)
Any other mixed background	1.7 % (13)	0.7 % (150)	0.6 % (2)	0.5 % (56)
Asian or Asian British – Indian	3.6 % (27)	2.5 % (553)	3.6 % (15)	2.6% (268)
Asian or Asian British – Pakistani	2.8 % (21)	1.8 % (411)	7.0 % (29)	2.2% (224)
Asian or Asian British – Bangladeshi	2.4 % (18)	0.7 % (164)	0.8 % (4)	0.8 % (86)
Any other Asian/Asian British background	2.9 % (22)	0.9 % (213)	0.8 % (11)	1 % (100)
Black or Black British – Caribbean	1.1 % (8)	1.1 % (239)	0 %	0 % (0)
Black or Black British – African	4.1 % (31)	1.6 % (369)	6.4 % (29)	1.7% (172)
Any other Black/Black British background	0.4 % (3)	0.2 % (40)	0.8 % (3)	0.5 % (50)
Chinese	1.3 % (10)	0.3 % (76)	-	-

Source: HSE 2008 and 2012

Table 5. 2

Characteristics of the student sample and complete sample (gender, age, marital status and children), HSE 2008 and 2012.

	Student HSE 2008	Full Sample 2008	Student HSE 2012	Full Sample 2012
Sex	Proportion (N)	Proportion (N)	Proportion (N)	Proportion (N)
Male	43.7 % (328)	46.4 % (10,490)	47.9 % (226)	45.7 % (4,723)
Female	56.3 % (423)	53.6% (12,129)	52.1 % (246)	54.3 % (5,610)
Age				
16-34	86.6 % (650)	25.6 % (3,868)	88.5 % (430)	24.4 % (2,025)
35-54	11.2 % (84)	34.5 % (5,210)	9.5 % (35)	33.7 % (2,795)
55+	2.3 % (17)	39.9 % (6,020)	2.0 % (7)	41.9% (34,700)
Marital Status	Proportion (N)	Proportion (N)	Proportion (N)	Proportion (N)
Single (never married)	84.7 % (636)	26.8 % (4,052)	86.6 % (423)	27.2 % (2,255)
Married/ Cohabiting	11.9 % (89)	35.5 % (8,024)	9.5 % (35)	53.1 % (4,402)
Previously married	3.5 % (26)	13.4 % (3,021)	3.9 % (14)	19.7 % (1,630)
Has children				
Yes	32.4 % (243)	52.7 % (11,926)	32.4 % (154)	60.7 % (6,272)
No	67.6 % (508)	47.3 % (10,693)	67.6 % (303)	39.3 % (4,061)

Source: HSE 2008 and 2012 Sample

Table 5.3

Sample characteristics (economic status) of the student sample and complete sample, HSE 2008 and 2012

	Student sample 2008	**Full HSE 2008**	**Student sample 2012**	**Full HSE 2012**
Economic Status	Proportion (N)	Proportion (N)	Proportion (N)	Proportion (N)
In employment	11.5 % (86)	54.6 % (8218)	5.3 % (22)	52.3 % (4,321)
Unemployed	35.8 % (269)	4.4 % (669)	35.5 % (153)	5.3 % (435)
Retired	0.40 % (3)	25.3 % (3,801)	1.4 % (5)	27.1 % (2,240)
Other economically inactive	51.9 % (390)	15.6 % (2,354)	57.3 % (290)	84.6 % (1,269)
Social class				
Professional & managerial	13.0 % (98)	32.5 % (4,887)	14.1 % (48)	33.7 % (2,703)
Intermediate occupations	9.3 % (70)	21.7 % (3,260)	10.2 % (38)	24.7 % (2,011)
Routine & manual	43.5 % (327)	40 % (6,023)	39.9 % (159)	37.6 % (3,064)
Other	33.7 % (748)	5.8 % (873)	35.7 % (201)	4.5 % (366)

Source HSE 2008 and 2012 Dataset Database

Table 5. 4

Characteristics of the student sample and complete sample (health behaviours), HSE 2008 and 2012.

	Student sample 2008	Full HSE 2008	Student sample 2012	Full Sample 2012
Physical Activity	Proportion (N)	Proportion (N)	Proportion (N)	Proportion (N)
Confirming to reaching either guideline	46.3 % (346)	33.9 % (5,099)	72.4 % (134)	58.7 % (4,799)
Generally active (but not reaching the recommended physical activity guidelines)	39.1% (294)	41.2% (6198)	11.8% (42)	17.1% (1394)
Inactive	53.7 % (404)	24.9 % (3,747)	27.6 % (335)	24.9 % (1,979)
Cigarette smoking status				
Current cigarette smoker	15.8 % (119)	21.1 % (3,158)	17.5 % (72)	18.9 % (1,556)
Ex-regular cigarette smoker	8.9 % (67)	26.4 % (3,958)	7.4 % (29)	26.1 % (2,148)
Non-smoker	73.2% (550)	52.5 % (7,871)	75.1 % (336)	54.9 % (4,511)
Alcohol intake				
Almost every day	2.7 % (20)	8.2 % (1862)	1.2 % (4)	9.4 % (771)
Five or six days a week	2.1 % (16)	3.1 % (699)	1.8 % (6)	4.8 % (397)
Three or four days a week	11.9 % (89)	9.8 % (2,212)	12.2 % (45)	14.6 % (1,202)
Once or twice a week	32.6 % (245)	17.8 % (4,036)	29.9 % (116)	25.1 % (2,064)
Once or twice a month	22.1 % (166)	8.5 % (1,923)	16.4 % (85)	12.8 % (1,047)
Once every couple of months	6.0 % (45)	4.6 % (1,049)	10.1 % (49)	8.1 % (663)
Once or twice a year	4.7 % (35)	5.4 % (1,222)	5.4 % (30)	8.2 % (677)
Not at all in the last 12 months/Non-drinker	16 % (120)	13.2 % (1,986)	23 % (103)	16.9 % (1,388)

Source: HSE 2008 and 2012 Dataset

Table 5. 5

Characteristics of the student sample and complete sample (general health and mental wellbeing), HSE 2008 and 2012.

	Student sample 2008	**Full HSE 2008**	**Student Sample 2012**	**Full Sample 2012**
General Health	Proportion (N)	Proportion (N)	Proportion (N)	Proportion (N)
Good	88 % (661)	80.9 % (18,288)	87.4 % (420)	78.0 % (8,054)
Fair	10.3 % (77)	14.0 % (3,171)	9.8 % (41)	15.8 % (1,634)
Bad/very bad	1.7 % (13)	5.1 % (1,153)	2.8 % (11)	6.2 % (642)
GHQ 12				
Optimal mental health	54.0% (390)	63.0 % (9,883)	56.2 % (229)	61.5 % (4,620)
Less than optimal mental health	31.0% (224)	23.5 % (3,685)	27.6 % (116)	23.6 % (1,773)
Mental ill health	15.0% (108)	13.5 % (2,112)	16.2 % (70)	15.0% (1,125)
Limiting longstanding illness				
No limiting illness	77.1 % (579)	63.7 % (14,411)	90.5 % (383)	63.7 % (6,576)
Limiting longstanding illness	22.9 % (172)	36.3 % (8,201)	9.5 % (88)	36.3 % (3,748)
Health related quality of life				
No problems	71.0 % (533)	63.7 % (14,405)	71.4 % (304)	56.2 % (4,096)
Some problems	28.0 % (218)	34.9 % (7,896)	28.6 % (126)	43.8 % (3,198)

Source: HSE 2008 and 2012 dataset

5.2 Research question 1: prevalence of sedentary behaviour

Research Question 1: What is the prevalence of sedentary behaviour amongst university students in England and how does it compare to that of the general population?

The mean sedentary time reported by students in 2008 and 2012 was similar at 5.8 (± 1.45) hours per day in 2008 and 5.7 (± 1.43) hours per day in 2012. If adults stay awake for 16 hours during the day (Wallmann-Sperlich et al., 2013), these results suggest that students spent 35.0% of their waking time sitting. In 2008 and 2012 the mean sedentary time spent by the general population sample was 5.7 (± 1.43) hours and 5.6 (± 1.41) hours, respectively. This implied that, according to HSE data, sedentary behaviour patterns of students were very similar to those of the general population in England. However, in the HSE individuals were only asked to report their time spent sitting while watching television or sitting for any other purpose besides work, hence it was not a complete portrayal of the sedentary pursuits.

The estimation of the prevalence of sedentary time is difficult because there is no consensus regarding the optimal cut off point for classifying sedentary behaviour in previous research. The prevalence of sedentary behaviour was measured as the proportion of students who reported sitting eight or more hours per day (Leitzmann et al., 2017; Harvey et al., 2013).

The prevalence of sedentary behaviour was 30.4% and 20.2% in the HSE student sample in 2008 and 2012, respectively (Table 5.5). When categorized by age the prevalence of sedentary behaviour was highest (32.2%) in the youngest age band (16-34 years) in both the 2008 and 2012 samples and broadly it decreased significantly with increasing age in both years. The prevalence of sedentary behaviour was significantly

lower in married and cohabiting students in 2008 (13.5%, $p<0.05$) and 2012 (PR 16.8%, $p<0.05$) compared with single students. Students with children were less sedentary than students without children in both 2008 (18.9%, $p<0.05$) and 2012 (18.9%, $p<0.05$). Employed students were significantly less sedentary than unemployed students 2008 (15.1 %, $p<0.05$) 2012 (18.8%, $p<0.05$).

The prevalence of sedentary behaviour was broadly similar between alcohol drinkers and non-drinkers in 2008 and 2012. Smokers and non-smokers in 2008 had broadly similar prevalence of sedentary behaviour, but in 2012 the prevalence of sedentary behaviour was 37.8% in students who smoked compared to 42.0% in non-smokers and this difference was statistically significant (Table 5.6).

The prevalence of sedentary behaviour was significantly higher in students with mental ill health compared to students with optimal mental wellbeing in both the 2008 and 2012 sample 37.8% and 25.5% respectively.

5.3 Research question 2: Prevalence in ethnic minorities

Research Question 2: Does the prevalence of sedentary behaviour in students and the general population vary by ethnic group?

The prevalence of sedentary behaviour was broadly similar between ethnic groups in the 2008 student sample, whereas in the 2012 student sample, Black students 26.9% were significantly more sedentary than White students (19.1%, $p<0.05$) (Table 5.6).

Table 5. 6

Prevalence (%) of sedentary behaviour according to socio-demographic, economic, health behaviour and mental health variables of students in the 2008 and 2012 HSE student sample

	2008					2012				
Sex	**N**	**%**	*PR*	**P-value**	**CI**	**N**	**%**	*PR*	**P-value**	**CI**
Male	328	34.1%	1			226	25.1%	1		
Female	423	27.4%	0.77	0.04*	0.53-0.99	246	20.2%	0.06	0.08	0.69-1.69
Age Group										
16-34 years	650	32.2%	1			420	31.5%	1		
35-54 years	84	16.7%	0.42	0.04*	0.23-0.76	35	16.3%	0.38	0.01**	1.11-1.19
55 years and older	17	29.4%	0.88	0.81	0.31-2.51	17	18.4%	0.51	0.51	0.07-5.35
Ethnicity										
White	613	31.6%	1			363	19.1%	1		
Asian	88	25.0%	0.87	0.68	0.43-1.73	53	18.5%	0.67	0.20	0.43-1.91
Black	42	28.6%	0.72	0.21	0.43-1.21	43	26.9%	1.85	0.02*	1.52-3.70
Other	10	27.1%	0.80	0.52	0.42-1.56	13	16.7%	1.3	0.10	0.09-7.02
Marital Status										
Single	662	32.6%	1			437	21.1%	1		
Married and Cohabiting	89	13.5%	0.61	0.01**	0.45-0.81	35	16.8%	0.34	0.03*	1.15-1.98
Children										
No children	508	35.8%	1			397	23.9%-	1		
Has children	243	18.9%	0.42	0.00***	0.29-0.61	75	18.9%	0.54	0.00***	0.26-0.89
Employment status										
Not Employed	662	32.3%	1			451	20.8%	**1**		
Employed	86	15.1%	0.37	0.02*	0.20-0.69	21	18.8%	0.28	0.00***	1.04-1.61
Social Class (based on HRP)[1]										
Professional and managerial	98	24.5%	1			48	22.2%	1		
Intermediate	70	37.1%	1.79	0.08	0.93-3.49	38	20.5%	4.71	0.01*	1.43-2.28
Routine and Manual	327	29.1%	1.25	0.40	0.75-2.08	159	16.8%	2.62	0.01*	1.36-1.78
Other	253	32.4%	1.46	0.16	0.86-2.46	201	35.0%	3.63	0.00***	4.41-6.56
Income										
Lowest <14,918	168	36.4%	1			146	26.2%	1		
Middle Tertile 14,918-31,871	105	25.1%	0.59	0.01**	0.41-0.87	104	18.2%	0.83	0.56	0.51-2.37

Highest >31,871	75	20.4%	0.46	0.00***	0.29-0.73	75	17.6%	0.67	0.23	0.45-2.46
Item not applicable	403					116	--			
Physical activity										
Non-Compliance to MVPA guidelines	395	56.1%	1			134	24.7%	1		
Compliance to MVPA guidelines	368	43.9%	0.87	0.41	0.64-1.20	335	18.1%	1.14	0.44	0.40-0.98
Smoking										
Smokers	119	30.0%	1			118	37.8%	1		
Non-smokers	617	31.1%	0.95	0.81	0.81-1.45	319	42.0%	0.92	0.04*	0.39-1.18
Drinkers										
Drinkers	119	30.8%	1			335	37.6%	1		
Non-drinkers	617	30.5%	0.01	0.95	0.66-1.55	103	28.4%	0.75	0.04*	0.20-0.55
General health										
Very good/Good	661	29.5%	1			310	19.2%	1		
Bad/Fair	91	36.5%	0.33	0.17	1.05-2.72	35	26.7%	0.93	1.61	0.95-2.71
GHQ 12										
Optimal mental health	614	28.4%	1			339	20.2%	1		
Mental ill health	137	37.8%	1.86	0.03*	1.05-2.22	133	25.5%	1.80	0.01*	1.10-1.97
Limiting longstanding illness										
No limiting Illness	579	29.4%	1			383	19.1%	1		
Limiting longstanding Illness	172	33.7%	0.20	1.22	0.85-1.76	83	20.5%	1.07	0.82	0.78-1.70
Health related quality of life										
No problems	712	33.9%	1			304	18.1%	1		
Some problems	32	28.9%	0.96	0.53	0.83-1.10	126	24.2%	0.71	0.14	0.40-1.20

Notes: N is the frequency, P is prevalence of sedentary behaviour in the diverse groups, Odds ratio denoted as PR, p-value is the statistical significance and confidence interval (CI). Household reference person in the HSE (2008 and 2012) is the main person on whose occupational status the social class of the household is calculated.

5.4 Simple linear regression models

The relationship between each independent variable and total sedentary time per day in minutes was examined. The results of the bivariate analyses are presented in Table 5.7 and most of the statistically significant results are reported (Pallant, 2016).

There was a negative association between age and sedentary behaviour ($p < 0.05$); being married and sedentary behaviour ($p < 0.05$); having children and sedentary behaviour ($p < 0.05$) and employment and sedentary time ($p < 0.05$). There was a negative association between compliance with the physical activity recommendations by the CMO and sedentary behaviour ($p < 0.05$). In the 2008 sample of university students only there was negative statistically significant association between heath related quality of life and sedentary behaviour ($p < 0.05$).

There was a positive statistically significant association between sedentary time and ethnicity (other (2008 and 2012) and Black (only 2012) students). There was a positive association between mental ill health and sedentary time in the 2008 HSE sample ($p<0.05$). There was a positive association between limiting longstanding illness and sedentary behaviour in the HSE 2012 student sample ($p<0.05$).

Table 5. 7

Simple linear regressions between each independent variable and total sedentary time in minutes per day (the outcome variable) using data from the 2008 and 2012 HSE student sample

	2008				2012			
	N	**Total daily sitting time**	**β coef**	**P-value**	**N**	**Total daily sitting time**	**β coef**	**P-value**
Gender								
Male	328	356.1	Ref		226	344.8	Ref	
Female	423	337.1	-0.07	0.06	246	343.5	0.05	0.95
Age								
Age last birthday	751	373.2	-0.086	0.00***	472	390.4	-2.29	0.00***
Ethnicity								
White	613	345.6	Ref		363	340.1	Ref	
Asian	88	336.8	-0.020	0.59	53	328.5	-0.03	0.58
Black	42	353.3	0.013	0.73	43	412.6	0.13	0.01**
Other	10	356.6	0.019	0.00***	13	370.0	0.03	0.03*
Marital Status								
Single	662	345.3	Ref		437	352.1	Ref	
Married and Cohabiting	89	281.7	-0.017	0.00***	35	267.8	-0.17	0.00***
Children								
No children	508	362.1	Ref		397	364.4	Ref	
Has Children	243	312.1	-0.168	0.00***	75	302.5	-0.20	0.00***
Employment status								
Not Employed	508	349.4	Ref		448	349.1	Ref	
Employed	243	316.1	-0.076	0.04**	24	255.6	-0.14	0.01**
Social Class								
Professional & managerial	98	326.4	Ref		48	322.9	Ref	
Intermediate	70	367.4	0.086	0.06	38	365.1	0.08	0.16
Routine & manual	327	341.7	0.053	0.35	159	343.4	0.07	0.33
Other	253	352.1	0.088	0.11	201	351.7	0.09	0.18
Physical activity								
Non-Compliance to MVPA guidelines	404	354.6	Ref		134	349.1	Ref	
Compliance to MVPA guidelines	346	329.1	-0.67	0.07	335	255.6	-0.14	0.01**

Alcohol consumption								
Drinkers	616	353.9	Ref		335	346.4	Ref	
Non-drinkers	120	345.5	0.022	0.55	137	338.8	0.02	0.68
Smoking								
Smokers	119	346.7	Ref		153	344.8	Ref	
Non-smokers	617	335.7	0.030	0.41	319	343.3	0.02	0.73
General Health								
Very good/good	661	343.6	Ref		420	342.7	Ref	
Fair	77	358.5	0.034	0.36	41	333.6	0.10	0.67
Bad/very bad	13	365.8	0.030	0.41	11	432.4	0.06	0.05
GHQ 12								
Optimal mental health	390	328.9	Ref		339	342.7	Ref	
Mental ill health	332	364.9	0.108	0.00***	133	382.4	0.06	0.23
Limiting longstanding illness								
No limiting illness	579	341.7	Ref		383	350.4	Ref	
Limiting longstanding illness	172	359.1	0.052	0.153	88	284.4	0.13	0.01*
Health related quality of life								
EQ mean	751	341.3	-0.08	0.03**	472	341.2	-0.03	0.52

5.5 Multiple linear regression analysis

Research Question 3: What is the relationship between students' intrapersonal and interpersonal characteristics and sedentary behaviour? Multiple linear regression models were computed to examine the associations between mean sedentary time and the independent variables, categorized broadly as intrapersonal (1) socio-demographic factors 2) health behaviours and 3) mental and physical wellbeing, and interpersonal (personal relationships) characteristics. All the independent variables were entered in the model simultaneously to estimate the predictive power of each one over and above other independent variables (Pallant, 2016).

As discussed in chapter 3, the HSE was collected using a complex sampling design, therefore the design effects were taken into consideration in the analysis. In the following section, findings from the 2008 dataset were reported using, firstly the unweighted dataset, followed by the dataset with the complex sampling design adjustment. The same was repeated for the 2012 dataset.

5.5.1 Standard multiple linear regression model (fully adjusted for all independent variables using the 2008 HSE sample unweighted dataset)

The results of the multiple linear regression model were presented in Table 5.8. In the fully adjusted model, there was a negative association between being a female and sedentary behaviour ($p<0.05$); being married, having children, being employed and sedentary behaviour ($p < 0.05$). Higher income was negatively associated with sedentary time ($p<0.05$). Complying with physical activity recommendations of the CMO was negatively associated with sedentary time ($p<0.05$). There was a positive association between mental ill health and sedentary time ($p<0.05$). The R^2 (R Squared) indicated that 11.0% of the variance of sedentary behaviour was accounted for by the independent variables.

Table 5. 8

Results from multiple linear regressions using the 2008 dataset (reported here socio-demographic factors, health behaviours and mental and physical wellbeing)

Multiple Regression Model	Standardized Coefficients		p-value
	β coef	Std. Error	
N=751			
(Intercept)	495.2	59.1	0.00
Women	-31.3	0.71	0.02*
Age	-0.76	0.04	0.34
Asian	-16.2	0.01	0.45
Black	-42.6	0.08	0.28
Other	-35.9	0.00	0.33
Married or cohabiting	-38.7	0.01	0.04*
Has child(ren)	-43.8	0.14	0.02*
Employed	-42.3	0.05	0.00***
Social class intermediate	17.3	0.05	0.61
Social class routine & manual	5.52	0.14	0.27
Social class other	-6.72	0.26	0.67
Middle income	-42.6	0.05	0.04
High Income	-36.3	0.14	0.03*
Meets physical activity guidelines	-21.9	0.15	0.01**
Five-a-day	1.44	0.05	0.90
Non-smokers	11.2	0.04	0.59
Do not drink	23.6	0.15	0.23
General health	-22.5	0.08	0.41
Mental ill health	41.5	0.26	0.01*
Longstanding illness	21.8	0.07	0.13
Health related quality of life[2]	-77.6	0.06	0.11

*Notes: Multiple linear regression from the HSE 2008 data. The first column displays the Beta coefficients; the second column reports standard errors; and the third column displays p values: *p<0.05, **p<0.01, ***p<0.001. R2 = 11.0%, which indicates that 11% of the variance of the outcome variable sedentary time in minutes per day is explained by the independent variables.*

5.5.2 Multiple linear regression analysis with complex sample design adjustment for 2008 dataset.

Multiple linear regression models were re-estimated after adjusting for the complex sampling design. The results of the model were similar to those estimated without the complex sampling adjustment, except for the standard errors, which were generally larger. The R^2 indicated 16.4% of variance in the sedentary behaviour was accounted for by the independent variables.

Table 5. 9

Multiple linear regression output with the adjustment of complex sampling design using the HSE (2008) dataset

N=751 Parameter	Beta	Std. Error	p-value
(Intercept)	495.2	68.0	0.00
Women	-31,3	14.0	0.02*
Age	-0.76	0.74	0.34
Asian	-16.2	29.4	0.45
Black	42.6	36.7	0.28
Other	-35.9	41.8	0.33
Married or Cohabiting	-38.7	25.5	0.04*
Has child(ren)	-43.8	13.3	0.02*
Employed	-42.3	17.2	0.00***
Social Class Intermediate	17.3	26.0	0.61
Social Class Routine & Manual	5.52	21.3	0.27
Social Class Other	-6.72	22.4	0.67
Middle income	-42.6	15.7	0.04*
High Income	-36.3	17.2	0.03*
Meets physical activity guidelines	-21.9	13.1	0.01**
Five-a-day	1.44	14.2	0.90
Non-Smokers	11.2	16.3	0.59
Do not Drink	23.6	24.0	0.23
General Health	-22.5	21.6	0.41
Mental Ill Health	41.5	19.0	0.01*
Longstanding Illness	21.8	15.8	0.13
Heath Related Quality of Life[9]	-77.6	59.5	0.11

Notes: This adjustment of the complex sampling design allows accounting for the complexity of the sample thus taking in consideration both clustering and stratification and should produce more reliable estimates especially the standard errors. R2 16.4% even after adjustment of complex sampling design indicates that 16.4% of variance in the dependent variable is caused by the independent variables

**p<0.05, **p<0.01, ***p<0.001.*

5.6 Standard multiple linear regression model (fully adjusted for all independent variables using the 2012 HSE sample unweighted dataset)

The regression models were repeated for the 2012 dataset (Table 5.10). As in the 2008 sample, there was a negative association between having children and sedentary behaviour ($p < 0.05$). Similar to the bivariate analysis (Table 5.6) there was a negative association between being employed and sedentary behaviour ($p < 0.05$). As reported in the descriptive statistics (Table 5.5), the prevalence of sedentary behaviour was significantly lower in White students compared with

Black students similarly, in the multiple linear regression model there was a positive association between Black ethnicity and sedentary behaviour ($p < 0.05$). There was a positive association between intermediate-level occupations and sedentary behaviour ($p < 0.05$). It was interesting to observe in the multiple linear regression model that after adjusting for other independent variables there was a positive association between smoking and sedentary behaviour ($p < 0.05$). The R^2 indicated 9.0% of variance in the sedentary behaviour was accounted for by the independent variables in the analysis.

Table 5. 10

Results from multiple linear regressions on the contribution of intrapersonal and interpersonal characteristics on the dependent variable 'total sedentary time'

N=472 Parameter	**Beta**	**Std. Error**	**P value**
(Intercept)	325.7	47.5	0.00
Women	-18.0	16.5	0.189
Age	-1.15	0.97	0.30
Asian	18.8	29.6	0.56
Black	82.4	30.6	0.01**
Other	70.7	66.5	0.34
Married or cohabiting	-4.73	35.3	0.90
Has children	-43.6	22.2	0.004*
Employed	-90.8	24.9	0.01**
Social class intermediate	77.0	34.4	0.03*
Social class routine & manual	35.0	28.4	0.24
Other	58.9	26.8	0.06
Physical activity	8.1	21.9	0.66
Non-smoker	57.1	22.0	0.01**
Does not drink	-23.0	18.1	0.21
General health	-26.8	25.3	0.47
Mental ill health	12.1	26.5	0.60
Longstanding illness	-26.9	22.0	0.23
Middle income	-31.3	22.5	0.20
High income	-39.9	24.9	0.14
Health related quality of life	-101.1	80.8	0.07

*Notes: This table displays the results of the multiple linear regression model computed using the HSE 2012 data. The first column displays the standardized beta coefficients; the second column is about the standard error of the beta coefficients and the third column is the p value. The p values can be considered as*p<0.05, **p<0.01, ***p<0.001. The R^2 9.0%, which indicates that 9.0% of the variance of the outcome variable sedentary time in minutes per day is because of the independent variables. The R^2 of 9.0% indicates that this model is a good fit.*

5.6.1 Multiple linear regression analysis with complex sample design adjustment for 2012 dataset

The results of this analysis were similar to those described for the unweighted multiple linear regression analysis for the 2012 sample (Table 5.9) except that the standard errors were slightly larger than when the design effect was not adjusted (Table 5.10). The R^2 indicated 11.0% of variance in the sedentary behaviour was accounted for by the independent variables.

Table 5. 11

Multiple linear regression output with the adjustment of complex sampling design, HSE (2012) dataset

N=472 **Parameter**	**Beta**	**Std. Error**	**P value**
(Intercept)	325.7	51.4	0.00
Women	-18.0	17.7	0.189
Age	-1.15	1.09	0.30
Asian	18.8	31.9	0.56
Black	82.4	31.1	0.01**
Other	70.7	74.0	0.34
Married or cohabiting	-4.73	35.8	0.90
Has children	-43.6	23.3	0.00***
Employed	-90.8	35.8	0.01**
Social class intermediate	77.0	36.4	0.03*
Social class routine & manual	35.0	28.7	0.24
Other	58.9	30.8	0.06
Physical activity	8.1	23.9	0.66
Non-smoker	57.1	22.2	0.01**
Does not drink	-23.0	18.8	0.21
General health	-26.8	28.9	0.47
Mental ill health	12.1	28.9	0.60
Longstanding illness	-26.9	26.8	0.23
Middle income	-31.3	24.5	0.20
High income	-39.9	27.1	0.14
Health related quality of life	-101.1	82.8	0.07

Notes: This adjustment of the complex sampling design allows accounting for the complexity of the sample, thus taking into consideration both clustering and stratification, and should produce more reliable estimates. This adjustment in turn should ease problems related to missing data and potential related bias. For a more detailed discussion about the adjustment for the complex sampling design, see methodology and discussion chapters. R^2 11.0% even after adjustment of complex sampling design indicates that 11.0% of variance in the dependent variable is caused by the independent variables.

*R^2 11.0 %, *p<0.05, **p<0.01, ***p<0.001.*

5.7 Merged analyses: fully adjusted model with 2008 and 2012 unweighted data

Regression models were repeated on a merged 2008 and 2012 dataset to increase the sample size and the power of the study (Bryman, 2012). The results of the analysis were very similar to those from the 2008 data (Table 5.3): women and students who were married, had a child or children, were employed, complied with physical activity guidelines or were in good mental health demonstrated a negative association with sedentary time per day. The only exception was health-related quality of life as this was not statistically significant in the multiple linear regression analysis models but was significant in the merged analysis: respondents who identified as having a better quality of life demonstrated a negative association with sedentary time ($p < 0.05$) (Table 5.7).

Increasing the sample size by merging the two datasets reduced the standard error. However, combining the two waves of data collected four years apart may have resulted in losing the context in which the data were collected because of some of the political, economic or cultural changes that may have happened in these years. The most notable policy changes were the significant increase in student fees implemented in 2012 (Higher Education Funding Council, 2016), which may have explained the decrease in the number of students observed in the 2012 HSE sample compared with the 2008 sample. In addition, the implementation of a smoking ban in public places in 2007 may have had an influence on sedentary behaviour (Department of Health, 2007). It may also be possible that the Olympic Games hosted in London in 2012 may have had an influence on physical activity levels among the respondents. This is because physical activity compliance improved not only in the student sample but also in the complete sample in the 2012 dataset (Table 5.12).

Table 5. 12

Results from multiple linear regressions on the contribution of intrapersonal characteristics on the dependent variable time spent sitting per day; Beta = standardized beta; SE B (standard error of B), p = sig p value using the HSE Merged 2008 and 2012

N=1101 Parameter	Beta	Std. Error	P value
(Constant)	511.4	41.5	0.000
Women	-0.08	8.3	0.004*
Age	-0.05	0.55	0.173
Asian	-0.03	15.5	0.310
Black	0.01	18.0	0.728
Other	-0.00	24.2	0.945
Married or cohabiting	-0.10	15.7	0.007
Has children	-0.11	8.6	0.000***
Employed	-0.10	12.4	0.000***
Social class intermediate	0.04	16.7	0.214
Social class routine & manual	0.01	12.8	0.778
Social class other	-0.02	14.4	0.609
Meets physical activity guidelines	-0.09	7.9	0.002**
Non-smoker	0.03	10.5	0.003**
Does not drink	0.06	14.0	0.058
General health	-0.02	13.4	0.391
GHQ 12 variable	0.08	10.0	0.004**
Longstanding illness	0.05	9.9	0.057
Middle income	-0.07	8.9	0.20
High income	0.04	0.10	0.12
Heath related quality of life	-0.09	32.6	0.004**

*Notes: The p values can be considered as*p<0.05, **p<0.01, ***p<0.001. The R^2 11.9%, which indicates that 11.9% of the variance of the outcome variable sedentary time in minutes per day is because of the independent variables. The R^2 of 11.9% indicates that this model is a good fit.*

5.8 Conclusion

Study 1 addressed Research Questions 1 to 3 by examining the prevalence of sedentary behaviour and its intrapersonal correlates in the student population in the HSE. The results of the analysis with and without design adjustment were substantively the same except for larger standard errors when design adjustment was conducted. It was logical to consider the results with the complex

sample adjustment as the conclusive results of this chapter (Tables 5.9 and 5.11).

In the 2008 HSE sample, the estimated coefficients: gender, marital status, children, employment status, physical activity compliance, and mental wellbeing presented a statistically significant association with sedentary behaviour. In the 2012 HSE sample, the estimated coefficients of ethnicity, children and employment presented a statistically significant association with sedentary behaviour ($p < 0.05$).

The HSE is a nationally representative sample and helpful in identifying prevalence and some of the correlates of sedentary behaviour in students in England. However, the HSE did not include the full range of variables outlined in the socio-ecological model. Therefore, Study 2 was carried out as an empirical study that integrated the full breadth of the socio-ecological model of sedentary behaviour. The result of the data collected amongst university students at a university in London are reported in the next chapter

Chapter 6

Results Study 2

6 Introduction

Study 2 was a cross-sectional primary study among university students at a university in London. The aim was to understand the prevalence of total and domain-specific sedentary behaviour among university students. It extended the analyses in Study 1 by exploring total and domain-specific sedentary behaviour and including a broader range of variables from the socio-ecological model of sedentary behaviour in the analyses (Owen et al., 2011): 1) intrapersonal; 2) interpersonal; 3) perceived environment; 4) behavioural setting and 5) policy-related factors.

The following sections report the completion rate of Study 2 along with a comparison of the socio-demographic profile and other characteristics of the student sample and complete student population at the London university. In the last section the socio-ecological correlates of sedentary behaviour that were statistically significant with sedentary behaviour are reported (Owen et al., 2011).

6.1 Completion rate and participants' characteristics compared with the complete university student sample

In total, 374 students completed the online survey for Study 2, giving a completion rate of 59.7%.[3] The rationale for considering the completion rate instead of response rate was because University X did not allow the survey to be disseminated to the students using their University email

[3]Completion rate $=$ No of completed survey/No of respondents who entered the survey

addresses, therefore it cannot be concluded with confidence that all 12,896 students enrolled at university between the years 2016/17 during fieldwork were invited to participate in the survey (Bryman, 2015). Instead the study was advertised on different platforms, such as the virtual learning environment and university social media websites. Printed leaflets that included bar codes that could direct the student to the participant information sheets and questionnaires were advertised in the university foyer, cafeterias, student lounges, grounds, library and elevators.

During data cleaning, 32 respondents were removed because they reported zero in all the components of the section asking about daily sedentary behaviour. Two respondents recorded zero in most categories of the questionnaire and in one component they reported to sit for two hours per day; these were also considered unrealistic values, so they were removed from the analysis.

Limited socio-demographic data were available from the university about its complete population of registered students as there was only access to data about gender, age and ethnicity. Chi-square analyses indicated that participants in the Study 2 student sample and complete student population were independent, with significant differences detected in age, gender and ethnicity (Table 6.1). The student sample had fewer males (21.8%; Confidence Interval CI 23.5-25.4%) compared to the complete population (37.3%; CI 36.4-38.1%) (X^2 34.0, P<0.00). The student sample on average was older, only 57.6% (CI 52.3-62.8%) of the sample identified as in the 17-29 age range, compared with 70.1% (CI 69.8-71.4%) of the complete university population (X^2 26.6, P<0.00). The student sample had more students from ethnic minorities, 38.8% (CI 33.8-44.1%) compared to the complete population, 32.2% (CI 31.3-33.0) (Tindell, 2017). The most probable reason that the two samples were different is because institutional constraints prevented the recruitment of a random sample of students at University X. Previous research demonstrates responses are typically higher for women than for men and for older individuals than for younger (Curtin et al., 2000).

Table 6. 1

Student sample and complete student population at University X, London 2016-17

	Study 2 students % (N)	Complete student population %	Chi Square test
Gender			
Male	21. 8 % (74)	37.3% (4,800)	X^2 34.0 *
Female	78.2 % (266)	62.7% (8,096)	
Age Groups			
17-29 years	57.6% (196)	70.1% (9,097)	X^2 34.0*
30 and above	42.4% (144)	29.9% (3,787)	
Ethnicity			
White	38.8% (132)	32.2% (4,148)	X^2 6.71*
Ethnic minority students	61.2 % (208)	67.8% (8,748)	

Notes: Source of data: Complete sample from the University Registry (Tindell, 2017).
*Stars indicate statistical significance for chi-squared (P < 0.05). The values are either % (N) *P < 0.05, **P < 0.01, ***p < 0.001*

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6.2 Participants' characteristics compared with the 2008 and 2012 HSE student sample

The socio-demographic profile of the student sample in Study 2 was compared with that of the students in the nationally representative 2008 and 2012 HSE samples. Study 2's student sample had a higher proportion of female students (78.2%) compared to both waves of the HSE (56.3% in 2008; 56.1% in 2012). Study 2's student sample were older than the HSE student sample: 70.5% reported themselves as being in the 17-34 years category compared with 86.5 % of the 2008 HSE and 85.7% of the 2012 HSE. There was a higher proportion of ethnic minority students at University X in London as 60.6% students identified themselves to be from ethnic minority backgrounds compared with only 29.3% in the 2008 and 35.2% in 2012 HSE sample. This is reflective of a general demographic change in England; in the 2011 Census a fifth of the population belonged to ethnic minorities with the highest percentage of ethnic minorities residing in London

(Office of National Statistics, 2011).

A higher proportion of students in Study 2 were married (33.4%) compared to the HSE 2008 (15.4%) and HSE 2012 (13.4%). However, a similar proportion of students in both studies had children: Study 2 (34.9%) and HSE 2008 (32.4%), HSE 2012 (32.4%). A higher proportion of Study 2's sample was employed alongside their studies (51.0%) compared to students in the HSE 2008 (11.5%) and HSE 2012 (5.5%). More students were employed in professional and managerial jobs in Study 2 (26.0%) compared to HSE 2008 (13.0%) and HSE 2012 (14.1%). Almost half of the students in Study 2 (47.5%) and Study 1 (HSE 40.0% 2008 and 44.2% 2012) reported as earning less than £14,918 per annum.

6.2.1 Health behaviours of respondents in Study 2

Compliance to physical activity recommendations was comparable in Study 2 (56.2%) and the HSE 2008 student sample (53.7%); a higher proportion of students were physically active in the 2012 HSE population (72.4%). Equal proportions of students smoked in both samples of Study 1 and Study 2. However, fewer students (64.4%) in Study 2's sample drank alcohol in the last twelve months compared to HSE 2008 (83.7%) and 2012 (77.0%) sample. A higher proportion of students in Study 2 (80.6%) ate five pieces of fruit and vegetables per day compared to Study 1 (20.6% in 2008, no data for 2012). It is possible that students in the Study 2 sample adopted healthier behaviours because they were older and/or more ethnically diverse; for example, in some religions, it is forbidden to consume alcohol (Michalak et al., 2007).

6.2.2 Respondents' general health and mental wellbeing

In Study 2, a larger proportion of students (35.8%) identified as being in either bad,[4] or fair general health as opposed to students in both waves of the HSE (12.0%, 2008; 12.6%, 2012). A larger proportion of students in Study 2 (41.6%) identified as having some problems in their health-related quality of life compared to students in the HSE student sample (28.0%, 2008; 28.6%, 2012). Students in Study 2 and the HSE 2012 sample reported broadly similar patterns in terms of their mental wellbeing and limiting longstanding illness.

6.2.3 Comparison of the participants' characteristics of Study 2 and HSE 2008 and 2012

Respondents in Study 2 were older, a larger proportion were in the age bracket 35 and above compared with respondents in Study 1. Respondents in Study 2 reported to make healthier choices by eating fruits and vegetables and drinking less alcohol compared to HSE 2008 and 2012 students. Despite better health habits, however, respondents in Study 2 reported worse general health, mental wellbeing and health-related quality of life compared to students in the HSE samples. Differences between the respondents in both studies may be because the students in Study 2 were from an urban university and the HSE sample was drawn from all over England. In addition, a higher percentage of students had children and were in employment than students in the HSE, so they were combining their studies with other commitments, which would be likely to lead to increased stress.

[16] In the HSE 2008 and 2012 for the health question asking about respondents' general health the term 'bad' health instead of 'poor' health was used as a response category. To maintain consistency with the HSE in Study 2's questionnaire the same response item was used.

6.3 Prevalence of sedentary behaviour

Research question 4: What is the prevalence of sedentary behaviour among university students at a university in London and are there any differences by ethnic groups?

Study 1 revealed that students in England spent around six (± 1.4) hours/day sitting whereas in Study 2 students at the London university spent on average 11.7 ± 3.3 hours/day sitting. Therefore, students in Study 2 spent more time in sedentary pursuits compared to students in Study 1's HSE student sample. The prevalence of sedentary behaviour was measured as the proportion of students who reported sitting for eight or more hours per day (Chau et al. 2013; Harvey et al., 2013). In Study 2, the prevalence of behaviour was 80.5% (Table 6.10), higher than for students in the HSE 2008 (30.4%) and 2012 (20.2%) in Study 1.

Among ethnic groups Black (88.6%) and Other (90.0%) university students had a higher prevalence of sedentary behaviour compared to White university students (81.0%); however, the results were not statistically significant. This supports the findings of Study 1, in which the prevalence of sedentary behaviour among Black university students in England was higher than White students but the results were statistically significant.

Surprisingly, the prevalence of sedentary behaviour was higher in students complying with physical activity recommendations (88.3%, $p<0.05$) compared to non-compliers (79.6%). However, among students who drank alcohol the prevalence of sedentary behaviour was significantly lower amongst those who did not drink alcohol in the last 12 months (71.1%, $p<0.05$). compared with students who drank alcohol in the last 12 months (85.4%).

Students who identified as having a good health related quality of life (76.5%, $p<0.05$) were significantly less sedentary than those students who identified as having a poor health related quality of life (85.9%).

In terms of environment, sedentary behaviour was significantly lower in students who resided in an urban area (81.5%, $p<0.05$) compared to a rural area (90.7%). Students who thought their neighbourhood was convenient for cycling (68.0%, $p<0.05$) had significantly less prevalence of sedentary behaviour than those who thought it was not convenient (83.9%).

Students who thought there was a university policy about sedentary behaviour (68.8%, $p<0.05$) had significantly lower sedentary behaviour than those who thought there was no such policy (83.0 %).

Table 6. 2

Prevalence of sedentary behaviour amongst university students (Prevalence is a sitting time >than 8 hours/ day)

	Frequency(N)	Prevalence	Odds Ratio	P value	Confidence Interval
Gender					
Male	74	87.8%	1		
Female	266	78.2%	0.32	0.02*	0.13- 0.86
Age group					
17-29 years	196	80.0%	1	0.33	0.67-3.3
30-39 years	77	81.4%	1.49	0.54	0.53-3.2
40-49 years	51	80.5%	1.32	0.59	0.48-3.57
55 years and older	16	82.4%	1.31		
Ethnicity					
White	132	81.0%	1		
Asian	41	80.5%	1.06	0.91	0.37-3.08
Black	127	88.6%	0.55	0.08	0.28-1.06
Other	40	90.0%	1.33	0.63	0.42-4.20
Marital Status					
Single	224	76.1%	1		
Married or cohabiting	116	72.0%	1.94	0.06	0.97-3.86
Children					
No children	219	80.8%	1		
Has children	121	79.3%	0.82	0.50	0.45-1.49
Employment status					
Not employed	173	81.4%	1		
Employed	167	79.2%	1.31	0.37	0.73-2.37
Social Class[5](based on HRP)					
Professional & managerial	91	83.5%	1		
Intermediate	77	83.1%	0.92	0.86	0.36-2.30

Routine & manual	116	79.3%	0.75	0.48	0.33-1.67
Other	56	73.2%	0.42	0.47	0.17-0.99
Income					
Lowest <16,918	216	80.1%	1		
Middle tertile 16,918-35,035	70	74.3%	0.87	0.70	0.43-1.76
Highest >35,035	53	88.7%	2.43	0.10	0.83-7.18
Physical activity					
Non-compliance to MVPA Guidelines	152	79.6%	1		
Compliance to MVPA guidelines	188	88.3%	1.93	0.03*	1.07-3.50
Smoking					
Smokers	68	85.3%	1		
Non-smokers	272	79.0%	0.67	0.33	0.30-1.50
Drinkers					
Drinkers	219	85.4%	1		
Non-drinkers	121	71.1%	0.47	0.01**	0.26-0.85
General health					
Very good/good	217	78.8%	1		
Bad/Fair	123	82.9%	0.53	1.71	0.88-3.29
GHQ 12					
Optimal mental health	178	77.0%	1		
Mental ill health	162	82.0%	1.12	0.57	0.62-2.02
Limiting longstanding illness					
No limiting illness	297	78.5%	1		
Limiting longstanding illness	43	90.0%	1.93	0.23	0.66-5.64
Health related quality of life					
No problems	198	76.5%	1		
Some problems	142	85.9%	1.02	0.60	0.95-1.09
Area of residence					
Rural	107	90.7%	1		
Urban	233	81.5%	0.46	0.04*	0.22-095
Neighbourhood environment Pleasantness for walking					
Neutral	43	79.0%	1		
Agree	268	80.6%	0.83	0.68	0.33-2.07

Disagree	28	78.6%	0.95	0.94	0.24-3.71
Attractiveness					
Neutral	68	69.1%	1		
Agree	234	83.3%	2.35	0.01*	1.22-4.55
Disagree	36	83.3%	2.14	0.09	0.72-6.36
Proximity to park					
Neutral	76	81.6%	1		
Agree	193	83.1%	0.98	0.61	0.47-2.03
Disagree	71	78.8%	1.14	0.81	0.46-2.84
Traffic noise					
Neutral	45	80.8%	1		
Agree	214	77.8%	1.26	0.69	0.46-3.41
Disagree	29	79.3%	2.19	0.91	1.06-4.54
Road safety for cyclists					
Neutral	24	83.3%	1		
Agree	26	79.0%	0.98	0.61	0.34-2.80
Disagree	290	86.3%	1.01	0.34	0.47-2.16
Convenient public transport					
Neutral	81	82.7%	1		
Agree	172	81.4%	1.12	0.75	0.54-2.33
Disagree	87	75.9%	0.92	0.83	0.41-2.07
Convenient for cycling					
Neutral	122	83.6%	1		
Agree	75	68.0%	0.41	0.02*	0.19-0.87
Disagree	143	83.9%	1.13	0.76	0.54-2.32
Green space					
Neutral	108	78.7%	1		
Agree	155	78.7%	0.99	0.98	0.51-1.91
Disagree	290	86.3%	1.01	0.34	0.47-2.16
Likelihood of attack					
Neutral	33	75.8%	1		
Agree	284	81.0%	1.18	0..73	0.46-3.02
Disagree	23	78.3%	2.33	0.33	0.42-12.7
Safety walking after dark					
Neutral	70	77.1%	1		
Agree	55	85.5%	0.97	0.97	0.34-2.80

Disagree	215	80.0%	1.00	0.98	0.47-2.16
Proximity to the shops					
Neutral	111	85.7%	1		
Agree	133	79.3%	1.64	0.19	0.78-3.48
Disagree	215	80.0%	1.00	0.98	0.47-2.16
Traffic volume					
Neutral	52	76.9%	1		
Agree	39	75.0%	1.26	0.65	0.46-3.41
Disagree	248	82.3%	2.19	0.03*	1.06-4.54
Routes for walking					
Neutral	76	77.6%	1		
Agree	99	75.8%	1.11	0.77	0.52-2.37
Disagree	165	84.2%	1.78	0.22	0.86-3.71
Safety crossing the road					
Neutral	64	81.3%	1		
Agree	44	79.5%	0.97	0.96	0.34-2.80
Disagree	232	80.2%	1.01	0.98	0.47-2.16
Road Safety for cyclists					
Neutral	24	83.3%	1		
Agree	26	79.0%	1.04	0.95	0.34-3.16
Disagree	290	86.3%	2.40	0.34	0.39-14.4
Environment at the university					
Use of stairs promoted					
Neutral	111	82.9%	1		
Agree	128	78.1%	1.53	0.28	0.70-3.33
Disagree	101	80.2%	0.99	0.98	0.51-1.95
Facilities for exercise					
Neutral	101	85.7%	1		
Agree	190	78.4%	1.08	0.81	0.56-2.07
Disagree	49	81.2%	1.45	0.46	0.53-3.95
Time to exercise					
Neutral	56	71.4%	1		
Agree	233	83.3%	1.77	0.12	0.86-3.63
Disagree	51	76.5%	2.27	0.13	0.79-6.50
Green space					
Neutral	73	76.7%	1		

Agree	181	81.8%	1.59	0.18	0.81-3.12
Disagree	86	80.2%	3.43	0.01**	1.33-8.81
Use of cycle encouraged					
Neutral	79	81.0%	1		
Agree	167	81.4%	1.12		0.54-2.34
Disagree	94	77.7%	1.04	0.93	0.46-2.34
Convenient routes for cycling					
Neutral	129	83.7%	1		
Agree	127	79.5%	0.92	0.82	0.46-1.85
Disagree	84	76.2%	0.68	0.32	0.32-1.44
Lecture rooms					
Neutral	139	82.7%	1		
Agree	118	78.8%	0.92	0.81	0.48-1.79
Disagree	83	78.3%	1.23	0.60	0.56-2.67
Safe to walk after dark					
Neutral	70	80.7%	1		
Agree	215	79.3%	1.17	0.65	0.58-2.37
Disagree	55	81.7%	2.28	0.14	0.76-6.85
Convenient routes for walking					
Neutral	119	77.1%	1		
Agree	150	80.0%	0.94	0.84	0.48-1.82
Disagree	71	85.5%	0.97	0.95	0.43-2.20
UK policy about SB					
No	272	82.0%	1		
Yes	68	73.5%	0.51	0.12	0.26-0.99
University policy about SB					
No	275	83.0%	1		
Yes	64	68.8%	0.42	0.01**	0.22-0.79

6.4 Prevalence of domain-specific sedentary behaviour in the student sample

The prevalence of domain-specific sedentary behaviour was reported as sedentary time spent by students in different contexts. The mean sedentary times spent by students in six different contexts on weekdays and weekends were reported below (Table 6.3). Sitting at university was the most predominant sedentary behaviour among students during the weekdays, followed by sitting to use the computer at home. Students also spent approximately one or one and a half hours in the following activities: television viewing, sitting at work, and leisure time sitting. The least time was spent sitting while travelling to either work/university that is less than an hour (0.91 hours). During the weekend the predominant sedentary behaviour was sitting to use the computer (3.22 hours), and the second most prevalent behaviour was sitting for leisure time activities (2.61 hours).

Table 6. 3

Domain-Specific Sitting of the university students (reported in mean sedentary time in hours)

Domain	Mean sitting in hours each weekday	Mean sitting in hours weekend each day
Sitting at university	4.3 ± 2.5	0.9 ± 0.8
Sitting using computer	2.7 ± 1.8	3.2 ± 2.1
Sitting at work	2.0 ± 1.6	1.5 ± 1.2
Sitting for leisure without television viewing	1.8 ± 1.4	2.6 ± 2.8
Sitting watching television	1.5 ± 1.2	2.0 ± 1.5
Sitting during transport	0.9±0.8	1.6 ± 1.3

Notes: Domain is the context where sedentary behaviour was occurring, mean time of sedentary behaviour was reported separately for weekdays and the weekend.

6.5 Socio-ecological correlates of sedentary time

Research Question 5: Do socio-ecological characteristics correlate with total sedentary time among university students and do they vary by ethnic group?

One of the aims of this study was to examine the correlates of socio-ecological characteristics with total sedentary time amongst all university students and ethnic minority students. Simple linear regression and multiple linear regression models were computed to examine the associations between total sedentary time and the independent variables categorized by the socio-ecological model of sedentary behaviour 1) intrapersonal factors (psychological factors; health behaviours; socio-economic factors;) 2) interpersonal (social relationships; social networks); 3) perceived environment; 4) behaviour setting; and 5) policy-related factors. First, results of the simple linear regression models were reported, followed by the results of the multiple linear regression models.

6.5.1 Simple linear regression analysis

There was a negative association between being a female and sedentary behaviour ($p < 0.05$); employment and sedentary behaviour ($p < 0.05$); higher income and sedentary time ($p < 0.05$); and alcohol consumption and sedentary behaviour ($p<0.05$). In terms of the environmental correlates there was a negative association between living in an urban area and sedentary behaviour ($p<0.05$). Respondents who perceived that their neighbourhood was convenient for cycling and had a close proximity to shops reported a negative association with sedentary behaviour ($p<0.05$).

Table 6. 4

Bivariate Analysis

	N	Beta	P value
Gender			
Male	74	Ref	
Female	266	-82.5	0.00***
Age group			
17-29 years	196	Ref	
30-39 years	77	21.2	0.54
40-49 years	51	13.8	0.72
55 years and older	16	-3.67	0.93
Ethnicity			
White	132	Ref	
Asian	41	-59.3	0.13
Black	127	-24.6	0.37
Other	40	25.8	0.52
Marital status			
Single	224	Ref	
Married or cohabiting	116	45.6	0.07
Children			
No children	219	Ref	
Has children	121	-15.8	0.53
Employment status			
Not Employed	173	Ref	
Employed	167	-49.3	0.04*
Social class[6](students' own occupation)			
Professional & managerial	91	Ref	
Intermediate	77	-14.3	0.67
Routine & manual	116	-55.8	0.07
Other	56	-72.8	0.05
Income			
Lowest <14,918	216	Ref	
Middle tertile 14,918-31,871	70	-65.7	0.03*
Highest >31,871	53	0.59	0.99
Physical activity			
Non-compliance to MVPA guidelines	152	Ref	
Compliance to MVPA guidelines	188	43.9	0.07
Smoking			
Smokers	68	Ref	
Non-smokers	272	-35.4	0.23
Drinkers			
Drinkers	219	Ref	
Non-drinkers	121	-75.7	0.02*
Five-a-day			
Less than 5 a day	66	Ref	
More than 5 a day	274	-6.26	0.84
General health			
Very good/good	217	Ref	
Bad/fair	123	32.1	0.21
GHQ 12			
Optimal mental health	178	Ref	
Mental ill health	162	2.98	0.90
Limiting longstanding illness			
No limiting Illness	297	Ref	

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Limiting longstanding Illness	43	28.7	0.43
Environmental			
Rural	107	Ref	
Urban	233	-62.6	0.02**
Neighbourhood environment			
Attractiveness			
Neutral	68	Ref	
Agree	234	-18.8	0.60
Disagree	36	30.4	0.57
Proximity to park			
Neutral	76	Ref	
Agree	193	-2.27	0.94
Disagree	71	-0.62	0.97
Traffic noise			
Neutral	45	Ref	
Agree	214	9.8	0.78
Disagree	29	62.4	0.23
Road safety for cyclists			
Neutral	24	Ref	
Agree	26	1.68	0.97
Disagree	290	4.89	0.88
Convenient public transport			
Neutral	81	Ref	
Agree	172	1.2	0.97
Disagree	87	-42.7	0.21
Convenient for cycling			
Neutral	122	Ref	
Agree	75	-0.94	0.03*
Disagree	143	-33.7	0.21
Green space			
Neutral	108	Ref	
Agree	155	4.57	0.87
Disagree	77	26.2	0.43
Likelihood of attack			
Neutral	33	Ref	
Agree	284	19.95	0.63
Disagree	23	-1.36	0.98
Safety walking after dark			
Neutral	70	Ref	
Agree	55	8.03	0.84
Disagree	215	8.38	0.77
Proximity to the shops			
Neutral	111	Ref	
Agree	133	-14.2	0.62
Disagree	96	-64.1	0.04*
Traffic volume			
Neutral	52	Ref	
Agree	39	-59.3	0.20
Disagree	248	-5.1	0.88
Routes for walking			
Neutral	76	Ref	
Agree	99	-26.1	0.44
Disagree	165	21.6	0.48
Safety crossing the road			
Neutral	64	Ref	
Agree	44	1.68	0.97
Environment at the university			
Use of stairs promoted			
Neutral	111	Ref	
Agree	128	-36.8	0.20

Disagree	101	10.8	0.72
Facilities for exercise			
Neutral	101	Ref	
Agree	190	-26.8	0.49
Disagree	49	-40.4	0.14
Time to exercise			
Neutral	56	Ref	
Agree	233	10.5	0.81
Disagree	51	1.15	0.97
Green space			
Neutral	73	Ref	
Agree	181	4.57	0.87
Disagree	86	26.2	043
Use of cycle encouraged			
Neutral	79	Ref	
Agree	167	-10.2	0.76
Disagree	94	-2.38	0.93
Convenient routes for cycling			
Neutral	129	Ref	
Agree	127	-27.6	0.38
Disagree	71	-10.4	0.70
UK policy about SB			
No	272	Ref	
Yes	68	-45.9	0.13
University policy about SB			
No	275	Ref	
Yes	64	63.4	0.40

6.5.2 Multiple linear regression models

The comprehensive model in which all the variables were included simultaneously was considered the most appropriate model for this analysis. With the use of the simple linear regression model there were seven variables that were statistically significant but when the comprehensive model using multiple linear regression was computed that included the variables outlined by the socio-ecological model of sedentary behaviour adjusted for each other (Owen et al., 2011), only five variables were statistically significantly correlated with the outcome variable, total sedentary minutes per day.

Similar to the findings in the HSE (2008) and bivariate analysis of Study 2 there was a negative association between being a female and sedentary behaviour ($p < 0.05$); and being employed and sedentary behaviour ($p < 0.05$). Higher income ($p < 0.05$); being employed in a routine occupation ($p < 0.05$); and residing in an urban area ($p < 0.05$) were negatively associated with sedentary behaviour. The R^2 (R Squared) indicated that 20.2% of variance of sedentary behaviour was explained by the independent variables.

Examining the p-values, the variables that were most strongly statistically significantly associated with sedentary behaviour were gender and income (Field, 2015). The other three variables that were statistically significantly associated with sedentary behaviour were social class; being employed; and residing in an urban area and their p values were less than 0.05.

Table 6.5

Socio-ecological correlates of sedentary behaviour

Multiple Linear Regression Model N=340	Standardized Coefficients		Sig.
	Beta	Std. Error	
1(Constant)	707.607	178.274	0.00
Women	-94.878	0.17	0.00***
Asian	11.225	0.01	0.81
Black	7.083	0.01	0.85
Mixed/Other	22.536	0.08	0.59
Age group 30-39 years	16.792	0.02	0.65
Age group 40-49 years	-17.325	0.06	0.72
Age group 55 years and above	-36.534	0.05	0.47
Married or cohabiting	46.685	0.13	0.12
Has child(ren)	-14.113	0.04	0.83
Employed	-75.851	0.03	0.01**
Social class intermediate	-30.801	0.04	0.39
Social class routine & manual	-65.030	0.15	0.04*
Social class other	-44.031	0.06	0.28
Income middle 14,918-31,871	-98.542	0.04	0.00***
Income High >31,871	-63.698	0.01	0.09
Undergraduate student	12.558	0.04	0.74
Physically active	36.826	0.05	0.15
Smokers	-32.334	0.08	0.34
Drinkers	-47.624	0.01	0.11
Eats five -a-day	9.790	0.03	0.77
General health	9.677	0.04	0.72
Mental wellbeing	-1.322	0.01	0.95
Health related quality of life	42.398	0.04	0.12
Child lives with student	-5.376	0.01	0.93
Urban area	-52.036	0.09	0.04*
Speak to relatives on phone	15.981	0.02	0.19
Meet up with relatives	-20.481	0.03	0.17
Write to friends	12.594	0.06	0.31
Speak to friends on the phone	13.90	0.03	0.33
Meet up with friends	5.974	0.01	0.66
Write to friends	-19.234	0.02	0.13
Shop for you when unwell	-137.9	0.13	0.41
Someone to lend money when needed	90.615	0.11	0.58
Advice when in need	30.276	0.05	0.10
Participation in voluntary work	28.397	0.06	0.30
Neighbourhood environment	4.296	0.01	0.11
Perception of university environment disagree	83.429	0.10	0.60
Perception of university environment neutral	83.133	0.12	0.60
Perception of university environment agree	74.859	0.19	0.63
Perception of university environment strongly agree	82.850	0.17	0.60
UK policy about SB	-54.426	0.07	0.20
University policy about SB	-37.756	0.08	0.39

*Notes: The R2 is 20.2% which indicates that 20.2% of the variance in the outcome variable sedentary time in minutes per day is because of the independent variables P 0.00***, 0.01**, 0.05**

6.5.3 Correlates of sedentary behaviour in ethnic minority students compared to White students

To fully answer the research question five the next step was to analyse the correlates of sedentary behaviour amongst white students. A multiple linear regression analysis was computed to assess if there was any difference in the correlates of sedentary behaviour among White students compared to ethnic minority students. To examine the associations a sub-group analysis was carried out and the sample was divided into two groups 1) White and 2) Ethnic minority students.

In the fully adjusted model, for White students the only statistically significant association identified was a negative association between intermediate social class and sedentary behaviour (Table 6.7). The R^2 indicated 30.5% of variance of sedentary behaviour was explained by the independent variables.

In the fully adjusted model for ethnic minority students three independent variables were statistically significantly correlated with the outcome variable total sedentary minutes per day. Among ethnic minority students, there was a negative association between being a woman and sedentary behaviour ($p < 0.05$); between being in employment and sedentary behaviour ($p < 0.05$); and between being in middle-income and sedentary behaviour ($p < 0.05$) (Table 6.6). The R^2 (R Squared) indicated 27.5% of variance of sedentary behaviour was explained by the independent variables in this model.

The correlates of sedentary behaviour in White students differed from those in ethnic minority students but it was interesting to note that when a comparison was made between the two groups the most significant differences were because of income, employment and social class.

Table 6. 6

Socio-ecological correlates of sedentary behaviour in ethnic minority students

Ethnic minority N 207	Standardized coefficients		Sig
	Beta	Std. Error	
(Constant)	972.840	298.084	0.00
Women	-109.615	0.18	0.01**
Age group 30-39 years	-13.556	0.03	0.81
Age group 55 years and above	-2.680	0.04	0.96
Married & cohabiting	78.848	0.16	0.06
Has child(ren)	-16.580	0.04	0.84
Employed	-126.21	0.27	0.00***
Social class intermediate	-38.809	0.08	0.30
Social class routine & manual	-19.753	0.03	0.72
Middle-income 14,918-31,871	-86.806	0.14	0.04*
High-income >31,871	-76.282	0.09	0.21
Undergraduate student	0.095	0.00	0.99
Physical activity	42.358	0.09	0.24
Smokers	-20.544	0.03	0.69
Drinkers	-54.799	0.12	0.11
Five-a-day	23.400	0.04	0.59
Mental wellbeing	-7.602	.016	0.82
Health related quality of life	46.253	0.09	0.20
Child lives with student	-15.008	0.03	0.86
Urban area	-62.810	0.12	0.09
Meet up with relatives	97.683	0.10	0.27
Write to friends	10.305	0.00	0.91
Speak to friend on the phone	-16.115	0.02	0.82
Speak to relatives on the phone	127.43	0.01	0.15
Write to friends	-86.389	0.06	0.42
Speak to neighbours	8.952	0.07	0.92
Shop for you when unwell	149.16	0.51	0.22
Someone to lend money when needed	111.26	0.31	0.36
Advice when in need	-32.944	0.17	0.17
Participation in voluntary work	48.681	0.94	0.19
Neighbourhood environment	4.823	0.11	0.14
Perception of university environment disagree	73.363	0.09	0.75
Perception of university environment neutral	9.962	0.02	0.96
Perception of university environment agree	18.848	0.04	0.93
United Kingdom policy about SB	74.23	0.04	0.15
University policy about SB	79.09	0.09	0.38

*Notes: The R2 is 27.5% which indicates that 27.5% of the variance in the outcome variable sedentary time in minutes per day is because of the independent variables P 0.000***, 0.01**, 0.05**

Table 6. 7

Socio-ecological correlates of sedentary behaviour in White students

White students N143	Standardized Coefficients Beta	Std. Error	Sig
(Constant)	857.7	300.303	0.00
Women	-20.29	0.05	0.66
Age group 30-49	-56.06	0.01	0.36
Age group 55 and above	139.5	0.23	0.06
Married or cohabiting	78.57	0.18	0.13
Has child(ren)	7.785	0.16	0.94
Employed	-30.98	0.07	0.53
Social class intermediate	-163.6	0.38	0.00***
Social class routine	-10.02	0.02	0.87
Middle-income 14,918-31,871	-60.66	0.03	0.24
High-income >31,871	-2.886	0.06	0.95
Undergraduate student	2.321	0.05	0.97
Physically active	6.700	0.01	0.89
Smokers	-87.89	0.19	0.06
Drinkers	16.60	0.02	0.84
Five-a-day	-49.80	0.01	0.32
Mental wellbeing	11.23	0.02	0.78
Health related quality of life	44.14	0.11	0.31
Child lives with student	-91.44	0.16	0.46
Urban Area	-93.54	0.22	.038
Meet up with relatives	234.2	0.27	.012
Write to friends	28.37	0.17	.763
Speak to relatives on the phone	-10.04	0.14	.887
Speak to friend on the phone	371.4	0.17	.031
Write to friends	108.0	0.14	.210
Speak to neighbours	-46.22	0.06	.576
Shop for you when unwell	-79.22	0.23	.546
Someone to lend you money when needed	100.0	0.30	.425
Advice when in need	-6.478	0.18	.865
Participation in voluntary work	16.78	0.04	.727
Neighbourhood environment	-1.582	0.27	.780
Perception of university environment disagree	39.00	0.06	.864
Perception of university environment neutral	129.1	0.32	.563
Perception of university environment agree	63.0	0.14	.771
Perception of university environment strongly agree	75.4	0.11	.742
United Kingdom policy about SB	41.0	0.79	.610
University policy about SB	73.8	0.12	.431

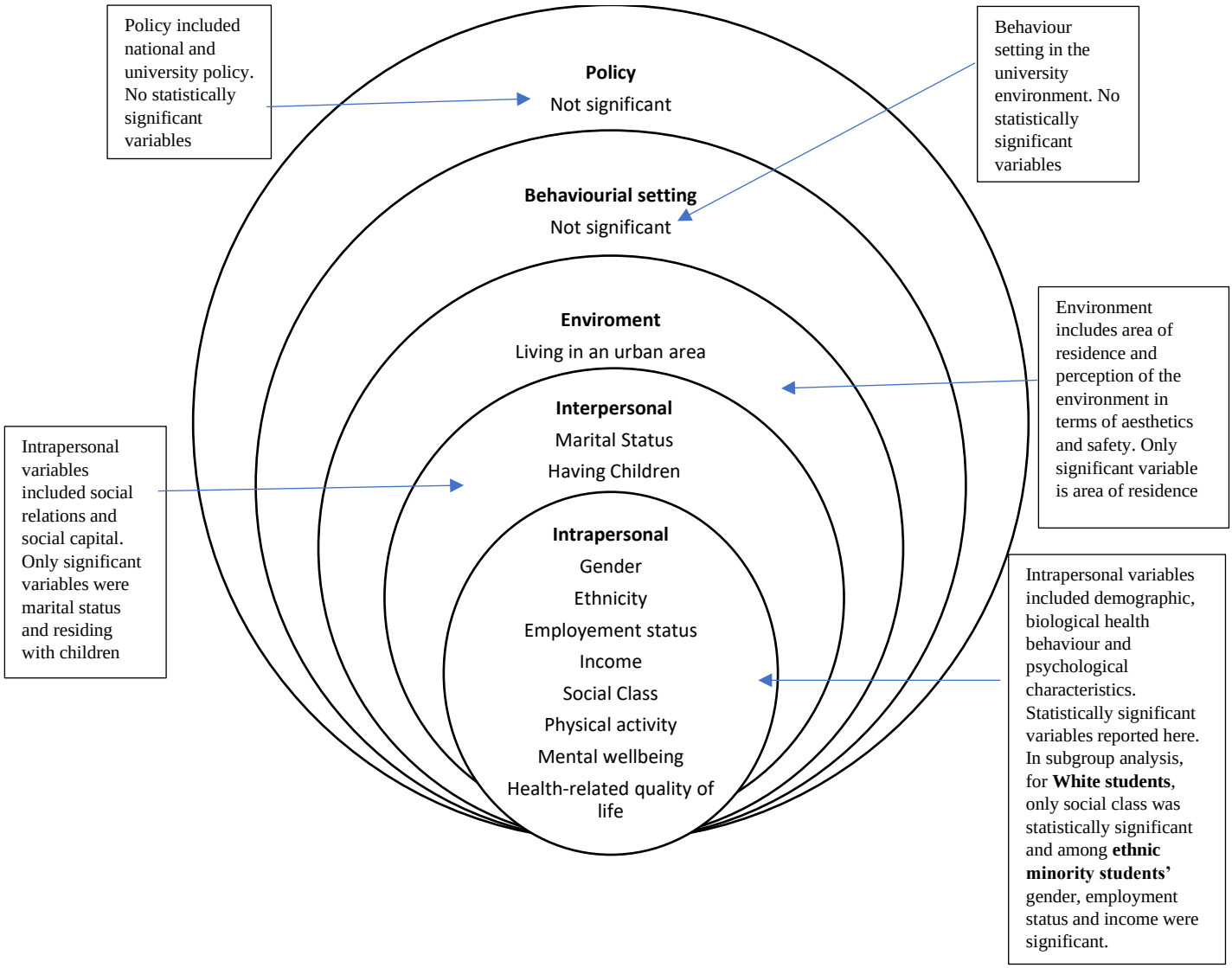

Figure 4: Depiction of the socio-ecological correlates of sedentary behaviour in Study 1 and Study 2

6.6 Correlates of domain-specific sedentary behaviour

Research Question 6: What are the correlates of domain-specific sedentary behaviour amongst university students? To examine the socio-ecological correlates of domain-specific sedentary behaviour multiple linear regression models were computed with each of the six domains of sedentary behaviours as the outcome variable and the set of socio-ecological correlates identified by the theoretical framework as the independent variables. Only statistically significant correlates of the different domains of sedentary behaviour were reported in Table 6.8.

Women were significantly less sedentary than men at home ($p< 0.05$) or sitting using the computer ($p<0.05$). Students who identified as having social support ($p<0.05$) were significantly more sedentary than students without social support. Asian students spent ($p<0.05$) significantly more time sitting for leisure than White students. The only significant correlate for students who sat to watch television, was mental wellbeing: students with mental ill health ($p<0.05$) spent more time watching television than students with optimal mental wellbeing. Older students particularly in the age group 40-54 years spent more time sitting when they were travelling compared with younger students of 17 to 29 years.

Table 6. 8

Domain-specific sedentary behaviour

Domain-Specific Correlates	Dependent variables					
	Sitting at University	Sitting using the computer	Sitting at work	Sitting for leisure	Sitting to watch TV	Sitting while travelling
Interpersonal factors - socio-demographic related variables	X	Women (Beta -51.9, p 0 .00)	Women (73.9, p 0.00***)	Asian (Beta 166.3, p 0.02*)	Mental ill health (Beta 19.3, p 0.04*)	Age group 40-54 (Beta 26.3, p 0.01**)
Health related variables	X	X	X	X	X	X
Interpersonal factors - social capital	Someone to shop when unwell (Beta 79.1, p 0.03*) Someone to lend money (Beta 88.0, p 0.01**)	X	X	X	X	X
Behaviour setting - perceived environment	X	X	X	X	X	X
Policy-related factors	X	X	X			X

6.7 Conclusion

The results of Study 2 provide a deeper understanding of the sedentary behaviour patterns of university students in England. The data clearly indicate that students spend around a half of their time in sedentary pursuits because their mean sedentary time per 24-hour day was 11.4 hours. Among the ethnic variations in sedentary behaviour, Black students sat more compared to White students. Similarly, students who identified to be in the Other group spent more time sitting than White students.

Similar to the findings in the HSE (2008) and bivariate analysis of Study 2 there was a negative association between being a female and sedentary behaviour ($p < 0.05$); and being employed and sedentary behaviour ($p < 0.05$). Higher income ($p < 0.05$); and residing in an urban area ($p < 0.05$) were negatively associated with sedentary behaviour.

In Study 2, when the multiple linear regression models were computed with sedentary behaviour in minutes per day as an outcome variable with a battery of independent variables from the socio-ecological model, similar to the findings in the 2008 and 2012 regression models there was a negative association between being a female, being employed and having higher income and sedentary behaviour. There was a negative association between being in a routine occupation and/or residing in an urban area and sedentary behaviour. The R^2 (R Squared) indicated that 20.2% of variance of sedentary behaviour was explained by the independent variables.

Some interesting findings were apparent in the correlates of domain-specific sedentary behaviour: Asian students were significantly more sedentary than White students during leisure time; and older students were significantly more sedentary during travel compared to younger students, suggesting that younger students may be using more

active means of transport, such as walking or cycling. In addition, students who identified to have social support were more sedentary than those without social support.

Chapter 7

Discussion

7 Discussion

Prolonged sitting is recognized as an important public health concern as it has been associated with increased risk of obesity, diabetes, heart disease, cancer and early mortality (Katzmarzyk et al., 2009; Patel et al., 2010; Wilmot et al., 2012; George et al., 2013). Before sedentary behaviour can be addressed by use of well-designed public health interventions it is important to understand its prevalence, patterning and the contexts in which it occurs in different population groups. An important population is university students as they are an under-researched population in relation to sedentary behaviour in comparison to other population groups, such as office workers, primary and secondary school children (Thorp et al., 2012; Deliens et al., 2015). University students may be considered an important group as they are the future leaders, decision-makers or policymakers that may help to influence the social, cultural and health norms of the population (Leslie et al., 1999). In addition, Keating et al. (2005) suggest that habits formed at university tend to last later in life, while the best predictor of future behaviour is past behaviour (Varplanken et al., 2004). It is important to therefore understand and examine the patterns and correlates of sedentary behaviour in the student population to inform the design of interventions that may help in reducing it amongst university students. The socio-ecological model was the most appropriate model to examine sedentary behaviour among university students because it holistically considers the multiple characteristics that can influence sedentary behaviour and also takes into consideration its domain-specific nature (Owen et al., 2011).

There were two studies included in this thesis: Study 1 was an analysis of nationally representative data from the HSE from the years 2008 and 2012. Study 2 was a cross-sectional primary study carried out at a London-based university in England. This second study collected data about domain-specific sedentary behaviour and used the socio-ecological model to understand the correlates of sedentary behaviour among university students. In addition, both studies examined its prevalence among university students.

Data analysed in this thesis provided information regarding the relationships between socio-ecological factors and sedentary behaviour. The findings of Study 1 and 2 add to sedentary behaviour literature regarding the prevalence and correlates of sedentary behaviour among university students. The uniqueness of this study was a focus on the prevalence of sedentary behaviour among students, with a specific focus on ethnic minorities, and the application of the socio-ecological model of sedentary behaviour to assess the impact of broader intrapersonal, socio-cultural, perceived environmental, behavioural setting and policy-related factors on sedentary behaviour among university students (Owen et al., 2011).

7.1 Aims and research questions

The aim of this study was to understand the prevalence of sedentary behaviour and identify socio-ecological correlates of sedentary time amongst university students. The research questions it sought to address were as follows:

Study 1:

1. What is the prevalence of sedentary behaviour amongst university students in England and how does it compare to that of the general population?

2. Does the prevalence of sedentary behaviour in students and the general population vary by ethnic group?

3. What is the relationship between intrapersonal and interpersonal characteristics and their sedentary behaviour?

Study 2:

4. What is the prevalence of sedentary behaviour among university students at a university in London and are there any differences by ethnic group?

5. Do socio-ecological characteristics correlate with total sedentary time among university students?

6. What are the socio-ecological correlates of domain-specific sedentary behaviour amongst university students?

7.1.1 Prevalence of sedentary behaviour in students in England and the general population

In Study 1, secondary analysis of a nationally representative sample of students was carried out; in the HSE, sedentary behaviour was reported as the time spent sitting watching television or sitting for any other reason during leisure time. The mean sedentary time spent by students in both the HSE 2008 and 2012 sample was around 5.7 hours per day, which was similar to the general population in the HSE at 5.3 hours per day (Health and Social Care Information Centre, 2017).

The prevalence of sedentary behaviour amongst university students in Study 1 was similar to that reported amongst university students in the US, Argentina and Canada of between 5.0 to 7.0 hours per day (Buckworth & Nigg 2004; Fountaine et al. 2011;

Farinola & Bazan 2011; Quartiroli & Maeda, 2014). It also is similar to the findings of a current meta-analysis by Castro and colleagues (2020) in which students were reported to sit on average for 7.29 hours per day.

Study 1 reported that 30.4 % of the university students in England sat for eight or more hours per day. The only comparable study of adults in a multi-ethnic population survey in Singapore was similar at 37.0% almost equivalent to that observed in HSE 2008 sample (Win et al., 2015).

It is important to consider that the estimation of prevalence of sedentary behaviour is debatable as there is no consensus on any specific cut-off points or limits of sedentary behaviour. Some authors, such as Leitzmann et al. (2017), suggest that the prevalence of sedentary behaviour is the mean or median time spent sitting per day (Leitzmann et al., 2017). However, the epidemiological definition of prevalence describes it as a percentage and should be considered as the proportion of time individuals were sitting (Bhopal, 2009). To ensure that a thorough understanding of sedentary time is achieved for both Study 1 and Study 2, both the mean sedentary time and the proportion of sedentary time was reported. Future studies should also endeavour to report both the mean and proportion of time students spent in sedentary pursuits.

A common shortcoming of Study 1 and prevalence studies among university students and the general population mentioned in this section is that they do not examine the multiple contexts in which sedentary behaviour occurs. It is important to recognise that there are many contexts in which sitting occurs, for example, sitting during transport, at work, using the computer and leisure time (Marshall et al., 2010).

7.1.2 Intrapersonal correlates of total sedentary time

The socio-ecological model of sedentary behaviour was used as a theoretical framework to analyse and conceptualize the correlates of sedentary behaviour (Owen et al., 2011). In Study 1 the HSE (2008 and 2012) only contained variables about intrapersonal and a few interpersonal characteristics therefore these were the only factors examined.

In previous research among university students in the US and UK male university students were more sedentary than female students (Buggworth & Nigg, 2004; Rouse & Biddle, 2010; Fountaine et al., 2011). Similarly, a national survey in England also found that men in the general population were more sedentary than women (British Heart Foundation, 2015). This is similar to findings of studies in Europe (Loyen et al., 2016; Van Nassau et al., 2017; Loyen et al., 2017), however, two systematic literature reviews on the correlates of sedentary behaviour in the general population (Rhodes et al., 2012; O'Donoghue et al., 2016) and one in university students report less consistent and inconclusive results (Castro et al., 2018).

In Study 1, there was a positive association between being a Black student (HSE,2012) and sedentary behaviour. Brodersen et al. (2007) reports a similar trend where Black adolescents in the UK were more sedentary than White adolescents. Similarly, previous US studies found African American students were more sedentary than White students (Crespo et al., 2000; Cohen et al., 2013). The reasons for higher sedentary behaviour patterns among Black ethnic minorities are not clear. In a systematic review examining sedentary behaviour and physical activity patterns in ethnic minorities in Europe, Langøien et al. (2017) reported that some ethnic minorities hesitated in participating in physical activity because of cultural reasons. These revolved around dressing up; abiding by religious practices, for example, when participating in physical activity

Muslim women reported a lack of women only facilities within European countries for exercise, and difficulty in finding clothing that was modest for exercise purposes (Langøien et al., 2017). Additionally, for some first-generation immigrants, fluency in the native language served as a hindrance in understanding the opportunities that were available for physical activity participation (Langøien et al., 2017).

In the HSE (2008), marital status was negatively associated with sedentary behaviour. The finding that married individuals were less sedentary than single respondents is consistent with the existing hypothesis that marriage may protect people from unhealthy behaviour (Robert & Wood, 2007). This was supported by Canadian research in which single adults were reported to be more sedentary compared to their married counterparts (Huffman & Szafron, 2017). Studies in the US (King et al., 2010) and Hong Kong (Xie et al., 2013) also report that single individuals spend more time in sedentary pursuits compared with married individuals.

In both HSE 2008 and 2012, there was a negative association between having children and sedentary behaviour. Munir et al. (2015) report that women that have children are less sedentary than women without children. Households with dependent children report, on average, less time in sedentary pursuits (Van Uffelen et al., 2012; Huffman & Szafron, 2017). In another study it was reported that respondents without children reported a longer time sitting using the computer, watching television and sitting and talking to friends (Kozo et al., 2012). In terms of physical activity however, respondents with children participate less in physical activity because of family commitments (Salmon et al., 2004).

In both HSE 2008 and 2012, there was a negative association between being in employment and sedentary time. The same was reported in a systematic review of

studies examining the correlates of sedentary behaviour, by Rhodes et al. (2012) and O'Donoghue et al. (2016). Oliveira et al. (2011) speculate that being employed increases an individual's social connectivity, that potentially leads to less sedentary time and more leisure time physical activity. Koyanagi et al. (2018) report in their study there is a likelihood that among unemployed respondents some either had mental health issues or physical health problems making them more sedentary than employed respondents.

In Study 1, higher income was negatively associated with sedentary time. This contradicts research in the US, UK and Australia among the general population where respondents with higher income report more sedentary time compared to their low-income counterparts (Kozo et al., 2012; Stamatakis et al., 2014). It could be speculated that individuals with a higher income may have occupations that require them to sit for more hours (Bauman et al., 2017), and there is a difference in the health behaviours of students compared with the general population. This finding also indicated the need for more specific domain-specific sedentary behaviour research.

In the HSE (2008) there was a negative relationship between physical activity and sedentary behaviour. This is supported by previous research where an inverse association between physical activity and sedentary behaviour was reported (Vandelanotte et al., 2009; Ballard et al., 2009; Van Ufflen et al., 2012). The inverse relationship is also reported by a systematic review in the general population (Rhodes et al., 2012) and university students (Castro et al., 2018). This finding refutes the displacement hypothesis that states a symmetrical, zero-sum relationship in which if one spends time in sedentary behaviour, less time is spent in physical activity (Fountaine et al., 2011). There is also speculation that respondents who comply with

physical activity guidelines may be more educated and in occupations that may require more sitting per day therefore, despite following the physical activity recommendations they may still be sedentary (Shuval et al., 2017).

In the HSE (2012) sample a negative statistically significant association was found between sedentary behaviour and smoking. This contradicts previous studies. For example, a study in the US that analysed data from the National Health and Nutrition Examination Survey from 1999 to 2006 reported that current smokers were more sedentary than non-smokers and never smokers (Kaufmann et al., 2012). Another study in the US reported a positive link between smoking and sedentary behaviour (King et al., 2010). Although the finding in the HSE (2012) sample about smoking and sedentary behaviour differs from previous research, as previously mentioned, one possible explanation could be the smoking ban introduced in the UK in 2007, which disallowed smoking indoors in public places, resulting in people smoking outdoors mostly while standing (Department of Health, 2007).

Poor mental wellbeing was statistically significantly associated with sedentary behaviour in the HSE (2008) sample only. Previous studies reported that watching excessive television is linked with depression (Sanchez-Villegas et al., 2008; Atkin et al., 2012). These findings were confirmed by a meta-analysis (Zhai et al., 2014) and a systematic review (Teychenne et al., 2010). In the absence of longitudinal research, it is difficult to ascertain the direction of the relationship between sedentary behaviour and mental ill-health. Several hypotheses and biological explanations have been postulated: screen-based activities may lead to a disruption in sleep that may increase a person's anxiety levels (Dworak et al., 2007); and playing video or computer games may increase the activity in the brain (Wang et al., 2006). Some other metabolic

diseases could also be linked with sedentary behaviour, for example, people who sit more may develop Type 2 Diabetes that is linked with poor mental health (Mommersteeg et al., 2012). When examined from another perspective Teychenne et al. (2015) hypothesized that poor mental health could be responsible for people spending more time in sedentary pursuits. There is evidence for both sides of the relationship, clearly indicating that poor mental health and sedentary behaviour are associated, but to understand the direction of causality longitudinal research is required.

Previous studies among university students have only examined age and gender as a correlate of sedentary time (Buckworth & Nigg, 2004; Rouse & Biddle, 2010). Study 1 was the first study to examine the intrapersonal and some of the interpersonal correlates of sedentary behaviour.

7.1.3 Prevalence of sedentary behaviour among university students in Study 2

Study 2 was a cross-sectional primary study in which data were collected from a sample of students enrolled at a London university, and sedentary behaviour was measured in six distinct domains: sitting for leisure, at university, sitting to watch television, sitting during travel, sitting at work and sitting using the computer. Study 2 expanded the information gathered in Study 1 because it collected data about the different domains of sedentary behaviour, unlike Study 1 in which only time spent watching television and sitting for any other reason was measured. The average time spent in sedentary pursuits by participants in Study 2 was 11.5 hours per day. This is comparable with findings by Moulin and Irwin (2017) who, after examining domain-specific sedentary behaviour among Canadian university students, reported a prevalence of 11.9 hours per day. The findings were also parallel with the study by Peterson et al. (2018) who used device based methods to assess students' sedentary behaviour and reported that students

spent on average 10 hours per day in sedentary behaviour, which was similar to the findings of a recent meta-analysis by Castro et al. (2020) who reported that students sit on average for 9.82 hours per day. In a UK based study Rouse and Biddle (2010) conducted an ecological momentary assessment gathering information about university students' sedentary time and reported they spent 7.8 hours per day in sedentary pursuits, ranging from using technology, social activities, and studying. Studying was reported as the most predominant activity. As would be expected the most time in both Study 2 and Rouse and Biddle's (2010) sample was spent studying or sitting at university.

It was pertinent to mention that the time spent in sedentary pursuits among university students in Study 2 was higher than that in Study 1. Study 2 included detailed and probing questions about sedentary behaviour in different domains, whereas Study 1 only included two questions about sitting to watch television and sitting for any other purpose. Therefore, the patterns of sedentary behaviour amongst respondents in Study 2 and Study 1 cannot be compared because different measurement methods have been utilized. These measurement effects were also reported in literature on measuring self-reported health from a simple Likert scale questionnaire with options to select a scale, as opposed to asking if people have a specific illness. Respondents that completed the questionnaire about a specific illness identified worse self-reported health and illness compared with respondents filling in the Likert scale because when the specific illnesses were listed, people could relate and identify their problems. Instead, with a Likert scale the respondents could only identify the scale of the problem rather than the issue (Lee et al., 2002). This has important implications on the measurement of sedentary behaviour in Study 2 because it was measured in different domains that were clearly mentioned to the respondents so that a complete understanding of their sedentary pursuits could be identified. In addition, the profile of students in Study 2

differed from the HSE (2008 and 2012) sample and this may have affected the results of sedentary behaviour.

Using a detailed domain-specific questionnaire, the Sedentary Behaviour Questionnaire, with a sample of 842 respondents, Rosenberg et al. (2010) found that adults in the general population sit for 9.4 hours, office workers for an average of 10 hours, and university students for approximately 11.4 hours. More time spent in sedentary pursuits per day is associated with an increase in all-cause mortality (Loyen et al., 2016).

Studies that examined sedentary behaviour patterns among office workers using a similar type of questionnaire that asked about domain-specific sedentary behaviour in Study 2, the Marshall et al. (2010) sitting questionnaire, report that respondents sit on average for 10.3 hours per day (Chau et al., 2011). When data among office workers was collected using accelerometers, it was found that respondents sit for approximately 11.0-11.3 hours per day (Hagstromer et al., 2010; Parry & Straker, 2013).

7.1.4. Socio-ecological correlates of total sedentary time among university students

As previously mentioned, Study 1 was a nationally representative sample and Study 2 was an empirical study at a university in London. Akin to Study 1, there was negative association between being a female and sedentary behaviour, and higher income was negatively associated with sedentary time. Similarly, there was a negative association between employment and sedentary behaviour. Furthermore, in Study 2, students who were employed in professional occupations were more sedentary than those in routine and manual occupations but there was no association in Study 1. In previous research exploring the type of occupation a similar trend to Study 2 was observed that

respondents who were in professional occupations sat for a longer time than those in non-professional occupations (Jans et al., 2007; Stamatakis et al., 2014; DeCocker et al., 2014).

In Study 2, there was a negative association between residing in an urban area and sedentary behaviour. Previous studies reporting the relationship between area of residence and sedentary time have mainly been conducted in Australia. Uijtdewilligen et al. (2014) report that women residing in urban localities in Australia were less sedentary than those in rural areas. There is still a paucity of research within the UK that reports the relationship between sedentary behaviour and areas of residence. The studies carried out in Australia cannot be directly applicable to the UK because of geographical and structural differences. Evidence suggests that there was greater car use for commuting in Australia than in the UK. In Australia most of the population used motorized transport. In the 2011 census: 78.0% Australians used cars for their day-to-day journeys, 12.0% used public transport, 5.0% used bicycles and 5.0% did not commute because they worked at home (Australian Government, 2018). In contrast, in the UK 65.0% of commuting journeys were in cars, 10.0% on public transport and the remaining 25.0% people walked (National Travel Survey, 2016).

The socio-ecological model of sedentary behaviour was used as the theoretical framework to underpin this research study and both modifiable and non-modifiable correlates of sedentary behaviour were examined as encouraged by the model so that interventions that focus on the modifiable correlates to reduce sedentary behaviour can be developed (Owen et al., 2011). To summarize, in Study 2, the main findings were that men were more sedentary than women, students that were earning in the lower income bracket were more sedentary compared with students in the high-income

categories. Unemployed students were more sedentary than students in employment, students in professional occupations were more sedentary than those in non-professional occupations, and respondents living in a rural area were more sedentary than those living in an urban area.

7.1.5. Correlates of domain-specific sedentary behaviour amongst university students

One of the objectives of this thesis was to examine the correlates of domain-specific sedentary behaviour among students. There was a positive association between being a male and sitting using the computer at home, compared to female students. Comparable results were reported in previous study by Buckworth and Nigg (2004) in the US where male university students spent more time using the computer compared to female university students. The gender differences in engagement in different sedentary activities has been previously reported in studies carried out in Canada among the general population, where men have been reported to watch more television, use computers more often and play more video games compared to females; and women were reported to spend more sedentary time sitting and chatting or for communication purposes (Liwander et al., 2013).

There was a positive association between social capital and sitting at university. In a UK study higher social capital was associated with lower sedentary time in deprived London neighbourhoods (Watts et al., 2017). However, in contrast, a study carried out in Belgian and Dutch adults reported an inverse relationship between social capital and total sedentary time (Van Nassau et al., 2017).

Parallel to the relationship reported in Study 1 there was a significant relationship between television viewing time and poor mental wellbeing. As mentioned earlier, this

was in concordance with previous research where a negative relationship between poor mental health and sedentary behaviour was reported (Rhodes et al., 2012).

7.2 Differences between Study 1 and Study 2's sample

Study 1 was a nationally representative sample and Study 2 was a cross-sectional primary study at a university in London. There were demographic differences in the respondents of Study 1 compared with Study 2. The average age of respondents in Study 1 was lower compared with Study 2; a difference of 10 years in the mean age of the two samples. There was a higher proportion of ethnic minority students in Study 2 compared with Study 1. A substantial proportion of students in Study 2 were married and employed, mostly in managerial and professional positions, compared with Study 1 where most respondents were single and employed in lower socio-economic occupations.

Besides the demographic difference there were differences in health behaviours. A higher proportion of students in Study 2 self-reported compliance with five-a-day fruit and vegetable consumption guidelines compared with respondents in Study 1 (HSE, 2008). In addition, respondents in Study 2 reported a lower consumption of alcohol compared with Study 1 participants. Despite the healthy behaviours, a higher percentage of respondents in Study 2 identified themselves as having poor mental wellbeing, general health and health status compared with Study 1's respondents. The findings reported above match with the changing demographics of students, especially in urban areas in England, and reflect the higher levels of stress that current students in higher education in England report (National Union of Students, 2018).

7.3 How the socio-ecological model of sedentary behaviour has informed this thesis.

The socio-ecological model was the most suitable model to examine the correlates of sedentary behaviour among university students for two main reasons. First, it was the most appropriate and holistic model for behaviour research because it provided a framework for examining the modifiable and non-modifiable correlates of sedentary behaviour. In addition, it focused not only on intrapersonal characteristics but considered social, environmental contexts, such as the perceived physical environment, neighbourhood and behavioural settings, and the policy-related factors. Second, to the author's best knowledge to date no study in the UK has applied the socio-ecological model of sedentary behaviour to investigate correlates of sedentary behaviour among university students. Application of this model may assist in the future development of more comprehensive interventions that may target the multiple levels of influence on sedentary behaviour. Successful worksite interventions for the reduction of sedentary behaviour have been carried out targeting individuals' skills and knowledge, encouraging the social support networks, working on building the institutional capacity and environmental changes that help in reducing sedentary behaviour (Plotnikoff & Karunamuni, 2012; Sallis et al., 2008; Healy et al. 2016). Chu et al. (2016) in a meta-analysis reviewed interventions in the workplace and reported that multi-component interventions that target multiple levels of influence of sedentary behaviour outlined by the socio-ecological model demonstrate the most successful reduction in sedentary time. Moreover, interventions to reduce sedentary behaviour should be evidence-based so that they can be translated into practice effectively (Healy et al. 2016; Biddle & Bennie, 2017).

Multiple linear regression models showed that the independent predicators of sedentary behaviour among students were; gender, ethnicity, marital status, having children, employment status, participation in physical activity, smoking status and mental wellbeing. These findings suggest that the intrapersonal and interpersonal factors in the socio-ecological model of sedentary behaviour have more influence on university students' sedentary behaviour compared to perceived environment, behaviour setting and policy-related factors. Essiet et al. (2017) applied the socio-ecological model of physical activity to investigate correlates of physical activity among Nigerian university students and reported similar findings, stating that intrapersonal and interpersonal factors in the model had more influence on physical activity among students compared to the perceived environmental, behaviour setting and policy-related factors.

7.4 Strengths and limitations

7.4.1 Strengths

The HSE was a large nationally represented sample of adults from England; one of the strengths of Study 1 was that its analysed data on a sub-sample of university students from this dataset that provided a better understanding of sedentary behaviour patterns among university students in England. In addition, the data in Study 1 was collected using the technique of stratified random sampling that resulted in providing a representative sample of students. Both Study 1 and Study 2 utilized a cross-sectional study design to collect data as it is the most appropriate to collect data about prevalence of a condition or a behaviour (Bowling, 2005; Bryman, 2015). Both Study 1 and Study 2 utilized pre-existing validated questionnaires to collect data about heath behaviours which aids comparison with other studies (Biemer & Lyberg, 2003).

One of the strengths of Study 2 was the measurement of domain-specific sedentary time. Compared to two previous studies among university students that measure domain-specific sedentary time among university students, by Moulin and Irwin, (2017) in Canada and Peterson et al. (2018) in the US, Study 2 has a larger sample. The shortcoming of the study by Moulin and Irwin (2017) was that it measured sleep to be a part of sedentary behaviour although, as discussed in the literature review section of this thesis, it was not classified as a sedentary pursuit by the sedentary behaviour Research Network (2012). Study 2's strength was that it measured domains of sedentary behaviour accurately and did not consider sleeping to be a part of sedentary behaviour.

Another strength of Study 2 was that it collected data about the socio-ecological correlates of sedentary behaviour among university students, helping to understand the multiple factors that influence sedentary behaviour in this population group.

7.4.2 Limitations of this thesis

The design of the study has implications for the validity and generalizability of the results. Study 1 and Study 2 were cross-sectional studies that assessed the prevalence and correlates of sedentary behaviour amongst university students in England. Although cross-sectional studies are useful when examining prevalence of studies and exploring the correlates, they cannot investigate causality (Mann, 2003).

In Study 2 convenience sampling was used to recruit the respondents from the London-based university. Unlike random sampling non-random convenience sampling strategy tends to collect data from respondents who are available and willing to participate in a study, but it does not cover the entire university population. This means that data from Study 2 may help to understand the health behaviour patterns of students at the university, but the findings cannot be extrapolated to the wider university student

population (Etikan et al., 2016). In Study 2, the choice of a convenience sampling strategy was made because of institutional constraints.

The data for sedentary behaviour in both Study 1 and Study 2 were collected using self-completion methods with use of a questionnaires. In Study 1, the measurement of sedentary behaviour, in the HSE, was limited to time outside of work hours. It is important that national surveys focus on sedentary behaviour during work as well. Another limitation was that no wearable devices, such as electronic devices (pedometers or accelerometers) were utilized to examine sedentary behaviour patterns amongst university students. The reason these devices could not be used were because of lack of resources and funding and scope of the thesis did not allow for the use of wearable devices for data collection of sedentary behaviour.

7.4.3 Social desirability bias

Health behaviours examined in the studies of this thesis, such as smoking, alcohol intake, physical activity and sedentary behaviours, can be considered as sensitive and respondents may not be comfortable in sharing this information (Grimm, 2010; Leitzmann et al., 2018). This may result in an external form of bias known as social desirability bias (Althubaiti, 2016); in this case respondents may either over-report or underreport. The chances of socially desirability bias can be reduced by employing techniques that do not require the presence of an interviewer or using trained interviewers (Buckworth & Nigg, 2004; Grimm, 2010). The possibility of social desirability bias was minimized in Study 2 because respondents completed an online survey and did not meet the researcher. However, as the HSE questionnaire was interviewer administered in Study 1 there was a possibility of social desirability bias among the respondents (Bryman, 2015; Grimm, 2010).

7.4.4 Recall bias

Self-report in the case of sedentary behaviour could result in recall bias as there was a possibility the respondents could underestimate the time spent sitting because sitting was considered socially undesirable (Moulin & Irwin, 2017). However, as warranted by the socio-ecological model of sedentary behaviour to mitigate this potential bias sedentary behaviour prevalence was collected in certain contexts, such as sitting to watch television both during the weekday and weekend (Owen et al., 2011; Leitzmann et al., 2018). In Study 1, when data were collected for the HSE 2008 and 2012 respondents were asked to report their sitting time when watching television or during any other activity, which potentially could have assisted respondents in remembering their sitting time. The propensity of recall bias was further mitigated in Study 2 when respondents were asked to report domain-specific sedentary time. In Study 2, the respondents reported their sitting time in different domains, such as sitting while travelling, sitting at work, sitting at university, sitting while viewing television, sitting using the computer and sitting for leisure (not including television viewing) (Marshall et al., 2010; Leitzmann et al., 2018). This ensured that respondents could report the time they would have spent while sitting in different contexts. The recall period could have an influence on recall bias. Stull et al. (2009) posits the longer the recall periods in surveys the more the chances of inaccuracies in the reported estimates. It has been reported that when respondents were asked to recall an event that happened during the last year compared to the last month, they were more likely to make an error (Kjellsson et al., 2014). Cherpitel et al. (2017) in their study tried to understand recall periods using alcohol as an example and reported that respondents were more accurately able to remember alcohol intake in the last three days compared to a week. In most of the questions in Study 1 and Study 2 respondents were asked to report about their recent

behaviours either on the day or the last seven days, minimizing the potential of recall bias that could occur because of a prolonged recall period.

7.5 Implications of this study

Owen et al. (2010) and O'Donoghue et al. (2017) emphasise the importance of sedentary behaviour in public health because it is associated with various detrimental health risks (Katzmarzyk & Lee, 2012). Given this, the findings of this study have important implications for public health professionals, researchers and university health and wellbeing teams. The high proportion of time spent by students in sedentary pursuits that was observed in both Study 1 and Study 2, parallels findings from research conducted amongst university students and office workers. These findings suggest the need for universities within England to introduce interventions to reduce sedentary behaviour among university students, over which, intrapersonal, interpersonal and environmental factors have an influence. When developing interventions among university students to reduce sedentary behaviour there should be a focus on developing multi-component interventions. Chu et al. (2016) undertook a meta-analysis of interventions in the workplace and found consistent evidence that particularly multi-component interventions or interventions that target environmental factors resulted in the most significant reduction in sedentary behaviour among office workers. Among university students, multi-component interventions like the ones in workplaces should be developed that encourage students to spend more time standing compared to sitting, for example, standing breaks between lectures could be introduced. There may also be a potential to place sit and stand desks in classrooms and libraries and have standing meetings with lecturers (Biddle et al., 2011).

Study 1 and Study 2 are of public health significance because of the rising trends in obesity and diseases associated with sedentary behaviour within the UK. This thesis provides an understanding about the prevalence of sedentary behaviour amongst university students, a relatively important but under-researched population subgroup. This was an important subgroup because their health behaviours may not only shape their current and future health, but university students mostly serve as agents of change as they often take up important roles within society.

7.6 Contribution to sedentary behaviour research

This study contributes to the literature on sedentary behaviour in several ways. First, it provides a better understanding on the prevalence of sedentary behaviour using a representative sample of university students in England from the HSE. Secondly, it collects novel information about different contexts in which university students spend their time. Third, it examines the whole breadth of socio-ecological correlates of sedentary behaviour among university students. Finally, it is the first study analysing sedentary behaviour among ethnic minority university students.

This study reinforces previous findings that university students tend to sit more than adults in the general population and their sedentary patterns are akin to office workers (Smith et al., 2010). Occupational sedentary behaviour is given a lot of importance in public health and given that university students sit as much as office workers they should be given similar attention in public health.

This is also the first study employing the socio-ecological model of sedentary behaviour to examine the intrapersonal correlates of sedentary behaviour amongst a sample of

university students in England from the HSE dataset. It has applied the socio-ecological model of sedentary behaviour to assess the impact of broader intrapersonal, environmental, behaviour setting and policy-related factors on sedentary behaviour among university students providing us with an understanding on the factors that are most important in terms of students' sedentary behaviour (Owen et al., 2011). The evidence provided by this study can help inform policy makers devise more targeted strategies/interventions to reduce sedentary behaviour among students, including minority group students. The evidence from this study can be used at the London-based university to inform public health interventions to reduce sedentary behaviour amongst students.

Chapter 8

Conclusion

8 Conclusion

The results of this thesis provide important insights about the patterns of sedentary behaviour among university students, an under-researched yet highly relevant population subgroup. The findings clearly suggest that when domain-specific sedentary behaviour is considered, students appear to spend a substantial proportion of their time sitting (Moulin & Irwin, 2017; Patterson et al., 2019; Castro et al., 2020).

The socio-ecological correlates of sedentary behaviour examined in this study provide a greater understanding of the factors associated with sedentary behaviour among university students and can be utilized to make specific multicomponent interventions at universities to improve students' health. This research, therefore, provides a baseline for future research and makes a meaningful contribution to the study of sedentary behaviour among university students.

8.1 Recommendations for future research

It will be useful to investigate further the sedentary behaviours of university students using measures, such as accelerometers that can provide a device-based assessment of patterns of sedentary activities in the students, which may not have the risk of recall or social desirability bias.

The socio-ecological model of sedentary behaviour provided a good framework to understand the correlates of sedentary behaviour amongst university students. This framework can be utilized to design interventions and health education material in order

to reduce sedentary behaviour patterns amongst students at university. Although the intrapersonal and interpersonal correlates were statistically significant with sedentary behaviour further research with a larger sample may help in identifying more correlates of sedentary behaviour.

The intrapersonal and interpersonal factors amongst university students were most commonly associated with sedentary behaviour. Identification of these correlates assists in identifying the target population amongst which interventions or health promotion strategies can be utilized to reduce the patterns of sedentary behaviour.

Studies 1 and 2 were cross-sectional studies identifying factors associated with sedentary behaviour but longitudinal studies are needed to establish a causal relationship between intrapersonal and interpersonal factors outlined by the socio-ecological model and sedentary behaviour.

Before interventions can be designed and implemented to address sedentary behaviour among students it is important to understand the barriers students experience in being more active and the facilitating factors that are conducive to being less sedentary. The barriers and facilitators to being less sedentary can best be explored using qualitative research methods as they can help understand the factors that are responsible for either increase or decrease in sedentary behaviour of students. The clarity of reasons of sedentary behaviour may help in designing relevant interventions. For example, the current study revealed that Black students are more sedentary than White students, so conducting qualitative research with Black and other ethnic minority students would enable an understanding of the factors in the different characteristics of the socio-ecological model that may combine to create a more sedentary lifestyle.

Study 2 identified that students spent the most time sitting at university hence it is an important setting to reduce sedentary behaviour. Universities should emphasize collecting more data about the health and health behaviour of their students. Universities also need to reflect on the design and culture of their campuses to identify opportunities to create environments that actively encourage more standing and physical activity. For example, a change in social norms can be for instance, making it permissible for the students to stand during lectures, seminars or meetings. There is a need to regularly collect data about students' health behaviour so a change in behaviour trends can be identified. Furthermore, there should be more focus on studies that can be translated into practice, such as intervention studies that can assist in reducing sedentary behaviour amongst university students.

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Appendix-1

Table of the included studies with quality assessment

	Article	Study design	Quality score	No. of participants	Sedentary time assessment methods	Reported sedentary time outcome measure
1.	Banks et al. (2010)	Cross-sectional	0.95	91,266	Questionnaire: IPAQ-long form	Minutes per week sitting time
2.	Bauman et al. (2011)	Cross-sectional	0.86	16,766	Questionnaire: IPAQ-short	Minutes per day sitting time
3.	Bennie et al. (2013)	Cross-sectional	0.91	27,637	Questionnaire: IPAQ-short	Minutes per day sitting time
4.	Bennet et al. (2005)	Cross-sectional	0.81	486	Questionnaire: Unspecified	Hours per day sitting time
5.	Buckworth and Nigg, (2004)	Cross-sectional	0.83	493	Questionnaire; Three questions about sitting time used in previous studies	Hours per week sitting time
6.	Chau, (2011)	Cross-sectional	0.91	10,785	Questionnaire; Unspecified	Minutes per day sitting time
7.	Clemes et al. (2014)	Cross-sectional	0.77	170	Accelerometer: Actigraph	Minutes per day sitting time
8.	Conroy et al. (2013)	Cross-sectional	0.86	128	Accelerometer: Actigraph	Hours per week sitting time
9.	Crespo, (2011)	Cross-sectional	0.95	1,313	Accelerometer: Actigraph	Minutes per day sitting time
10.	Deliens et al. (2013)	Longitudinal	0.86	202	Questionnaire Screen time and reading	Hours per day sitting time
11.	De Cocker et al. (2014)	Cross-sectional	0.91	1,843	Workforce sitting questionnaire	Hours per day sitting time
12.	Ding et al. (2012)	Cross-sectional	0.68	287	Questionnaire GPAQ-Questionnaire	Hours per week sitting time
13.	Dunston et al. (2010)	Cross-sectional	0.80	8,800	Questionnaire Television Viewing time	Hours per day sitting time
14.	Epton, (2014)	Randomised Controlled Trial	0.90	1,445	Questionnaire: IPAQ-short	Hours per week sitting time
15.	Farinola and Bazan, (2011)	Cross-sectional	0.91	425	Questionnaire: GPAQ	Hours sitting per day

16.	Fountaine et al. (2011)	Cross-sectional	0.82	736	Questionnaire: Unspecified and self-developed	Minutes per day sitting time
17.	Gerovasili et al. (2015)	Cross-sectional	0.86	19,978	Questionnaire: IPAQ-short	Minutes per day sitting time
18.	Healy, (2008)	Cross-sectional	0.95	169	Accelerometer: Actigraph	Minutes per day sitting time
19.	Hamer, (2009)	Cross-sectional	0.81	3,920	Questionnaire: TV viewing time	Percentage sitting more than 4 hours per day
20.	Hawker, (2012)	Cross-sectional	0.63	215	Questionnaire: IPAQ-Short	Minutes per weekday sitting time
21.	Loyen et al. (2016)	Cross-sectional	0.95	26,617	Questionnaire: IPAQ-short	Minutes per day sitting time and percentage sitting more than 7.5 hours per day
22.	Lakerveld et al. (2015)	Cross-sectional	0.95	6,037	Questionnaire; Marshall	Minutes per day sitting time
23.	Maher et al. (2014)	Cross-sectional	0.86	128	Ecological momentary assessment Actigraph	Hours per day sitting time
24.	Moulin and Irwin, (2017)	Cross-sectional	0.86	102	Questionnaire: SIT-Q	Hours per day sitting time
25.	Milton et al. (2015)	Cross-sectional	0.95	65,970	Questionnaire: IPAQ-short	Minutes per day sitting time and percentage sitting more than 7.5 hours per day
26.	Ortega et al. (2013)	Longitudinal	0.91	321	Accelerometer: Actigraph	Minutes per day sitting time
27.	Parry, (2013)	Cross-sectional	0.90	50	Accelerometer: Actigraph	Minutes per day sitting time
28.	Peterson, (2018)	Cross-sectional	0.95	94	Accelerometer: Actigraph	Hours per day sitting time
29.	Proper et al. (2007)	Cross-sectional	0.86	2,650	Questionnaire: IPAQ-long form	Minutes per week sitting time
30.	Rouse and Biddle (2010)	Cross-sectional	0.82	84	Ecological Momentary assessment	Minutes per day sitting time

31.	Sjostrom et al. (2006)	Cross-sectional	0.91	1,000	Questionnaire: IPAQ-short	Percentage sitting more than 6 hours per day
32.	Sugiyama et al. (2010)	Cross-sectional	0.68	1,408	Questionnaire: Unspecified	Minutes per day sitting time
33.	Stamatakis et al. (2014)-	Cross-sectional	0.91	2,289	Questionnaire	Hours per day sitting time
34.	Thorp et al. (2014)	Cross-sectional	0.92	193	Accelerometer: Actigraph	Minutes per day sitting time
35.	Quartiroli and Maeda, (2014)	Cross-sectional	0.82	875	Questionnaire: IPAQ-short	Hours per week sitting time
36.	Uijtdewilligen et al. (2014)	Longitudinal	0.84	11,676	Questionnaire: IPAQ-Short	Hours per day sitting time
37.	Van Dyck, (2010)	Cross-sectional	0.95	1,200	Accelerometer: Actigraph	Minutes per day sitting time
38.	Van Dyck (2015)	Cross-sectional	0.91	5,712	Accelerometer: Actigraph	Minutes per day sitting time
39.	Van Uffelen et al. (2012)	Cross-sectional	0.90	19,938	Questionnaire: Not specific	Hours of sitting time per day
40.	Wallmann-Sperlich, (2013)	Cross-sectional	0.90	2,000	Questionnaire: GPAQ	Hours per day sitting time
41.	Watts et al. (2017)	Cross-sectional	0.75	4,107	Questionnaire: IPAQ-short	Hours per day sitting time
42.	Wijndaele (2010)	Longitudinal	0.86	1,867	Questionnaire: Unspecified	Hours sitting per day
43.	Wilson et al. (2014)	Cross-sectional	0.41	68	Questionnaire	Hours per day sitting time
44.	Xie, (2014)	Cross-sectional	0.95	3,016	Questionnaire; IPAQ-Short	Minutes per day sitting time

Total sum ((number of yes x 2 points) + (number of partial x 1)) / total possible sum (28 – (number of not applicable x 2)

Appendix-2

Research and Enterprise Services Division | Lancaster University

Applicant: Mahwish Hayee Shahid
Supervisor: Eugenio Zucchelli
Department: DHR

14 January 2015

Dear Mahwish and Eugenio,

Re: Prevalence and socio-ecological correlates of sedentary behaviour amongst university students in England

Thank you for submitting your research ethics application for the above project for review by the Faculty of Health and Medicine Research Ethics Committee (FHMREC). The application was recommended for approval by FHMREC, and on behalf of the Chair of the University Research Ethics Committee (UREC), I can confirm that approval has been granted for this research project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research to the Research Ethics Officer (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress);
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please contact the Research Ethics Officer, Debbie Knight (01542 592605 ethics@lancaster.ac.uk) if you have any queries or require further information.

Yours sincerely,

S.C. Taylor

Sarah Taylor
Secretary, University Research Ethics Committee

Cc Fiona Aiken, University Secretary, (Chair, UREC); Professor Roger Pickup (Chair, FHMREC)

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Appendix-3

Appendix 3: Socio-ecological Correlates of Sedentary behaviour questionnaire

All questions contained in this questionnaire are strictly confidential and your participation in this study is voluntary. If you have any questions, contact the researcher at this email address- m.hayeeshahid@lancs.ac.uk

Age	1. Can you identify which age group do you belong to? (Source HSE questionnaire, 2008) ☐under 17 (The survey will not progress) ☐ 17 ☐18-19 ☐ 20-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 50-64 ☐ 65 and above
Gender	1. Can you choose your gender? (Source HSE questionnaire, 2008) ☐ Male ☐ Female ☐ Prefer not to say

Marital status	1. Can you identify your marital status? (Source HSE questionnaire, 2008) ☐ Single ☐ Married ☐ Civil partnership ☐ Separated ☐ Divorced ☐ Widowed ☐ Cohabitees ☐ Prefer not to say

Ethnicity	1. To which ethnic group listed below do you think you belong? (Source HSE questionnaire, 2008
	a. White:
	☐ White – British
	☐ White – Irish
	☐ Any other White background
	b. Mixed:
	☐ Mixed - White and Black Caribbean
	☐ Mixed - White and Black African
	☐ Mixed - White and Asian
	☐ Any other mixed background
	c. Asian or Asian British:
	☐ Asian or Asian British – Indian
	☐ Asian or Asian British – Pakistani
	☐ Asian or Asian British – Bangladeshi
	☐ Any other Asian/Asian British background

d. Black or Black British:

☐ Black or Black British – Caribbean

☐ Black or Black British – African

☐ Any other Black/Black British background

e. Chinese or Other ethnic group:

☐ Chinese

☐ Any other

f. Prefer not to say

Income What is your monthly average household income? (Please write in the box below)

Employment

1. Are you employed (Self-developed)

☐ Yes

☐ No

2. Are you employed (Self-developed)

1. ☐ Full-time

2. ☐ Part-time

Residence

1. During term time, where do you live? (self-developed)

1. ☐ On university campus

2. ☐ Outside university campus

2. Is your accommodation (self-developed)

1. ☐ Privately rented property

2.☐ Privately owned property

3.☐ Do you live at home with parents

4. ☐ A campus/university provided accommodation

3. What is the location of your accommodation? (self-developed)

1.☐ Urban area

2.☐ Semi-urban

3.☐ Rural area

	4. During the university term-time who do you live with? (self-developed) 1.☐Alone 2.☐With parents 3.☐With partner 4.☐With friends 5.☐Other
Mode of study	1. How are you enrolled at the University of East London? (self-developed) (Please tick ONE option only) ☐Full-time student ☐Part-time student ☐Distance-learning student
Study type	1.Are you a/an (self-developed) (Please tick ONE option only)?

☐ Undergraduate student

☐ Postgraduate student

In this part of the questionnaire, we will ask you about your sitting time

Please tell us about the time you spend sitting on a weekday and weekend. It will be useful if can tell is about your sitting time in different settings—Marshall et al. (2010)

		Weekday	Weekend day	Weekday	Weekend day
	Sedentary pursuit	Hours	Minutes	Hours	Minutes
1	While travelling to and from places	Drop down menu with hours of activities	Drop down menu with minutes of activities		
2	While at university				
3	While at work				

Sedentary behaviour

4	While watching television				
5	While using a computer at home or to study				
6	In your leisure-time, NOT including television (e.g. visiting friends, movies, dining out, chatting with friends on the phone etc.)				

1. Do you regularly sit down for a period of more than 4 hours at a time? (self-developed)

1.☐Yes

2.☐No

Physical Activity

Questions from the New Zealand Physical Activity Questionnaire Short Form `

Please answer questions about your physical activity

Note; Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.

Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

1	During the last 7 days, on how many days did you walk for at least 10 minutes at a time? This includes at university, work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.	Days per week	
	How much time did you usually spend walking on one of those days?	No walking	
2		Hours per day	
		Minutes per day	

	3	During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? (Please note this does not include walking)	Days per week	
			No moderate physical activities	
	4	How much time did you usually spend doing moderate physical activities on one of those days?	Hours per day	
			Minutes per day	
	5	During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, running or fast bicycling?	Days per week	
			No vigorous physical activities	
	6	How much time did you usually spend doing vigorous physical activities on one of those days?	Hours per day	

			Minutes per day	

Smoking

The next questions are about drinking alcohol, including beer, wine, spirits and any other alcoholic drinks

1. Have you ever had an alcohol drink? (Bowling and Ebrahim, 2005)

☐ Yes

☐ No

2. How many units of alcohol do you have on a typical day when you are drinking? (source the National Health Service, 2014).

☐ 1-2

☐ 3-4

☐ 5-6

☐ 7-8

☐ 9 +

3. How many alcohol-free days do you have per week?

☐ 0

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

☐ 6

☐ 7

4. How often do you have five or more units on one occasion? (source the National Health Service, 2014)

☐ Never

☐ Less than monthly

☐ Monthly

☐ Weekly

☐ Daily or almost daily

Alcohol

Fruit and vegetable

Please select the number of portions of foods eaten for every row on a typical day (source Five-a-day community evaluation tool Ashfield-Watt et al., 2007)

NUMBER OF PORTIONS	1	2	3	4	5+
Fruit for breakfast, e.g. on cereal					

A glass of pure, unsweetened fruit juice					
Fruit as a between meal snack or juice (not squashes or fruit drink)					
Fruit as a starter to a meal					
Portions of vegetables with main meals (include baked beans and pulses as vegetables but not potatoes)					
A vegetable-based meal					
A bowlful of salad					
Fruit as a dessert, after a meal					

1. How do you rate your health? (Kaplan and Barol-Epe1, 2003)

General health	☐Very good ☐Good ☐Moderate ☐Bad ☐Very bad
Quality of Life	1. Do you have any long-standing illness, disability or infirmity? 1. ☐Yes 2. ☐ No 2. Does this illness or disability/do any of these illnesses or disabilities limit your activities in any way? 1. ☐Yes 2. ☐ No
Disability/Illness	Can you please take some time to describe your health today (Brooks et al., 2003) 1. Mobility (walking about) ☐I have no problems walking about ☐I have some problems walking about

☐I have a lot of problems walking about

2. Looking after myself

☐I have no problems washing or dressing myself

☐I have some problems washing or dressing myself

☐I have a lot of problems washing or dressing myself

3. Doing usual activities (for example, going to school, hobbies, sports, playing, doing things with family or friends)

☐I have no problems doing my usual activities

☐I have some problems doing my usual activities

☐I have a lot of problems doing my usual activities

4. Having pain or discomfort

1. ☐I have no pain or discomfort
2. ☐I have some pain or discomfort
3. ☐I have a lot of pain or discomfort

5. Feeling worried, sad or unhappy

1. ☐I am not worried, sad or unhappy

2. ☐I am a bit worried, sad or unhappy

3. ☐I am very worried, sad or unhappy

Neighbourhood environment

For each of the following statements about your local area, please tick one box to show how strongly you agree or disagree (Ogilvie et al., 2008).

In my local area…

1.It is pleasant to walk

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

2.There is a lot of traffic noise

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

3. There is a park within walking distance

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

4. The roads are dangerous for cyclists

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

5. There is convenient public transport

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

6. People are likely to be attacked

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

7. There are convenient routes for cycling

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

8. There is little green space

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

9. It is safe to walk after dark

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

10. The nearest shops are too far to walk to

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

11.There is little traffic

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

12. There are no convenient routes for walking

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

13.It is safe to cross the road

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

14. The surroundings are unattractive

☐Strongly agree

	☐Agree ☐Neither agree nor disagree ☐Disagree ☐Strongly disagree
Social Capital	1. Thinking about how often you personally contact your relatives, friends, and neighbours, but not counting the people you live with – how often do you do any of the following? (Office of National Statistics, 2014)

	Most days	Once a week or more	Once or twice a month	Less often than once a month	Never	Don't know
1. Meet up with relatives	☐	☐	☐	☐	☐	☐
2. Speak to relatives on the phone	☐	☐	☐	☐	☐	☐
3. Write to relatives (including letters, texting, email and internet)	☐	☐	☐	☐	☐	☐
4. Meet up with friends	☐	☐	☐	☐	☐	☐
5. Speak to friends on the phone	☐	☐	☐	☐	☐	☐
6. Write to friends (including letters, texting, email and internet)	☐	☐	☐	☐	☐	☐
7. Speak to neighbours	☐	☐	☐	☐	☐	☐

2. Thinking now about your relatives, friends, and neighbours outside your home, can you tell me around how many people could you ask for the following kinds of help? (Office of National Statistics, 2014)

[tick ONE only]

	None	One or two	More than two	Would not ask	Don't know
1. To go to the shop for groceries if you are unwell	☐	☐	☐	☐	☐
2. To lend you money to see you through the next few days	☐	☐	☐	☐	☐
3. To give you advice and support in a crisis	☐	☐	☐	☐	☐

3.Unpaid help to groups and individuals

During the last 12 months have you given any unpaid help to any groups, clubs or organisations in any of the ways shown? (Select One option) (Office of National Statistics, 2014)

☐Raising or handling money/taking part in sponsored events

☐Leading the group/ member of a committee

☐Organising or helping to run an activity or event

☐Visiting people

☐Befriending or mentoring people

☐Giving advice/information/counselling

☐Secretarial, admin or clerical work

☐Providing transport/driving

☐Representing

☐ Campaigning

☐ Other practical help (e.g. helping at school, religious group, shopping)

☐ Any other help

☐ None of the above

In this section you will be asked about your knowledge of policies related to sitting time (sedentary behaviour). Self-developed

Policy-Level factors	1. Are you aware of any United Kingdom government policy about reducing sitting time or sedentary behaviour? ☐ Yes ☐ No 2. Are you aware of any policy at your university, which focuses on reducing sitting time or sedentary behaviour? ☐ Yes ☐ No

Behaviour setting	In my university (adapted from Owen et al., 2011) 1. The use of stairs rather than lifts is promoted ☐Strongly agree ☐Agree ☐Neither agree nor disagree ☐Disagree ☐Strongly disagree 2. There are facilities for exercise

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

3. There is time at university to exercise

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

4. There is a green space for walking

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

5. The use of cycles is encouraged

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

6. There are convenient routes for cycling

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

☐Strongly disagree

7. The lecture rooms are spacious

☐Strongly agree

☐Agree

☐Neither agree nor disagree

☐Disagree

	☐Strongly disagree
	8. It is safe to walk after dark
	☐Strongly agree
	☐Agree
	☐Neither agree nor disagree
	☐Disagree
	☐Strongly disagree
	9. There are convenient routes for walking
	☐Strongly agree
	☐Agree
	☐Neither agree nor disagree
	☐Disagree
	☐Strongly disagree
Weather	1. How sedentary (the time you spend sitting) are you during summers? (Self-developed)
	☐More than usual
	☐Same as usual
	☐Less than usual

☐Much less than usual

2. How sedentary (the time you spend sitting) are you during winters?

☐More than usual

☐Same as usual

☐Less than usual

☐Much less than usual

Thank you for taking the time to fill this questionnaire

Appendix-4

Justification for the recoding of the variables:

Age was included as a continuous variable in the dataset, therefore, students above age 17 years were included in the analysis. Ethnicity was recoded from five broad categories (White, Asian, Black, Chinese and other) with each consisting of between two to six sub-categories to four main categories: White, Asian, Black and other, with White as the reference category (White=0; Asian=1; Black=2 and other=3). This is because there were only a few participants in some of the subcategories, for example, both the White Irish and Black categories The HSE contained of a single child-related variable with multiple categories including "no child" and, in the presence of children, the possibility of reporting from one up to five children. This was recoded into two separate variables, a first binary variable (0 = no child; 1= child) and a second binary variable (0=1-3 children; 1=more than 3 children). The rationale to code the children variable as a categorical variable was to understand if having more than three children affects sedentary behaviour, as previous research suggests that respondents with more than three children were less sedentary compared with those with fewer than three children (Rhodes et al., 2012).

In the HSE dataset the economic activity categories were included in four diverse groups 1) in employment, 2) unemployed, and 3) retired The third category only had three individuals in the 2008 sample and two respondents in the 2012 sample, therefore, it was deemed appropriate to collapse these categories to two distinct groups: employed

and unemployed (unemployed=0 and employed=1).

The social class variable which proxied the social class of the household reference person,[7] who may have been the head of the household, full-time employed or the person earning a higher income, was coded as four categories in the HSE (2008 and 2012). This variable was transformed as a dummy variable and the managerial and professional occupation was coded to be the reference category; the other three categories were intermediate, routine and manual and other. Household income, that is, the income of the entire family was coded as a continuous variable in the HSE (2008) and was included in the regression model without any changes.

The physical activity variable in HSE (2008) was coded in three categories: 1) following the CMO's guidelines,[8] 2) not following the CMO guidelines but still trying to be active, and 3) inactive. These were recoded into two categories: 1) meeting guidelines (1) and 2) not meeting guidelines (0) (CMO, 2011 & 2019). The HSE variable on cigarette smoking was coded into two categories: 1) smoker and 2) non-smoker. The alcohol intake variable in the HSE was coded as non-drinkers who had not consumed any alcohol in the last 12 months or never consumed alcohol, versus those who drank every day, instead of eight different categories in the HSE that had very few respondents in each category. The longstanding illness variable included in the dataset

[7]This was the social class of the Household Reference Person (HRP), this can be the person who is in full-time employment, earns more, or is older than the other person in the house. As per normal procedure, if the person was not working at the time of the interview they were asked about their previous occupation.

[8]A total of at least 30 minutes of moderate-intensity physical activity a day, on 5 days a week or more. The recommended levels of activity can be achieved either by doing all the daily activity in one session or through several shorter bouts of 10 mins or more. The activity can be lifestyle activity, structured exercise, sport, a combination of these activities, or 30 minutes of vigorous activity for 3 days a week.

had two categories, longstanding illness and no longstanding illness (the question includes examples of longstanding illnesses). This was recoded so that not having a longstanding illness was coded as 0 so that it could be the reference category, and having a longstanding illness was coded as 1.

The General Health Questionnaire (GHQ) was developed in England, this was a self-administered screening instrument used for identifying psychological distress. It was designed to cover four identifiable elements of distress: depression, anxiety, social impairment, and hypochondria. It was designed to be used in general population surveys or with medical patients. There were several forms of GHQ for example GHQ 60, 30, 28, 20 and 12, the HSE utilized GHQ-12 (Goldberg et al., 1997).

The HSE (2008 and 2012) coded the GHQ-12 in three different variables: continuous variable, categorical variable, and binary variable. The binary variable was coded as two categories Score 0-3 and Score 4 and above. The cut-off value of Score 4 did not include individuals who reported to have less than optimal mental wellbeing, which was coded as 3. Goldberg and colleagues (1997) reviewed seventeen studies, stating that a cut-off of 2/3 score was the most common score because 0-2 depicted no mental-ill health and a score of 3 and above suggested the presence of a mental disorder (Goldberg et al., 1997). Parallel to Goldberg's (1997) analysis the recoding of GHQ-12 was carried out as a binary variable with score 0-2 and score 3 and above.

Appendix-5

Mediation analysis

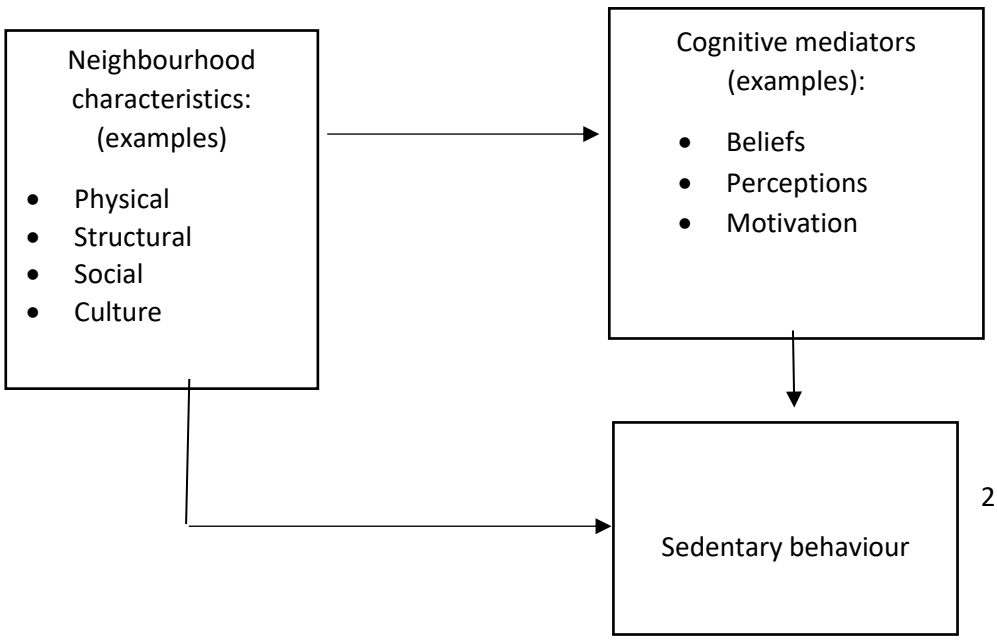
Kremers et al. (2006) neighbourhood characteristics model

The pathways through which the socio-ecological models influence health behaviour are dynamic and complex. The social-ecological models mentioned above propose five distinct characteristics that influence sedentary behaviour (Owen et al., 2011). Most of the research about sedentary behaviour examines the influence of independent variables on the outcome variable, sedentary behaviour only (O'Donoghue et al., 2016). However, the possibility of examination of indirect relationships (mediators) between independent variables and sedentary behaviour has been suggested (Zhao et al., 2010). A model that has been previously utilized in energy balance related behaviour and physical activity was one proposed by Kremer et al. (2006).

Kremer et al. (2006) model posit that health behaviours that could be energy balance related behaviours, physical activity or sedentary behaviour are influenced either directly without any intervening factors or indirectly through complex mediating pathways. In their publication, the authors state that the energy balance related behaviour can be influenced directly by the neighbourhood characteristics of the individual or alternately by the indirect pathways (mediated) through cognitive factors, such as individuals' psychological wellbeing, perceptions and beliefs (Kremers et al.,

2006). This model has been applied to physical activity research to examine both direct and indirect pathways in previous research. In this thesis, the model was applied to understand the direct and indirect pathways of sedentary behaviour. Swinburn et al. (1999) and Kremers et al. (2006) explain that four neighbourhood factors can possibly influence health behaviours, these include: 1) physical factors, such as buildings, roads or parks that have been constructed and can be changed; 2) structural factors, such as policies that influence how the neighbourhood was built. The policies about the built environment can influence sedentary behaviour; 3) social factors that may be relevant to the residents' neighbourhoods, such as crime, safety, noise, attractiveness of the neighbourhood and incivilities, and 4) cultural factors that may be cultural norms or religious practices (Swinburn et al., 1999; Kremers et al., 2006; Owen et al., 2011). Although the main aim of this thesis was to examine the direct correlates of sedentary behaviour, it was considered appropriate to utilize the Kremers et al. (2006) model to assess the indirect influence of mediating variables, such as cognitive factors on the relationship between neighbourhood characteristics measured in Study 2. This model was utilized to assess whether neighbourhood and/or individual characteristics are associated with sedentary behaviour through 'mediated' or 'indirect' pathways.

Model about mediating variables and health behaviours (Kremers et al., 2006)



Mediation

Most of the previous research on sedentary behaviour focused on relationships between two variables, independent variable 'X' and dependent variable 'Y'. In this case, X was a variable that represented the characteristic of the individual, for example, the perception of his neighbourhood, and Y was the outcome variable of the study, such as the sedentary behaviour of the individual (Figure 1) (Barron and Kenny, 2006). Mediation analysis was introduced by Baron and Kenny (1986) who provided a framework for the analysis of mediating variables, by which, β_a, β_b, β_c and β_c' pathways can be estimated using regression models. In research that has been carried out regarding sedentary behaviour and physical activity, Baron and Kenny's (1986) framework has been most commonly used (Cerin & Mackinnon, 2009).

To conduct research on mediation analysis, a reference was made to physical activity research that utilized the Kremers et al. (2006) model. Hence it was considered appropriate to test mental wellbeing as a mediator of sedentary behaviour, by adapting the model from the Kremers et al. (2006). For the mediation analysis, the outcome variable was sedentary behaviour, the mediator was mental wellbeing and the independent variable was perceived neighbourhood characteristics; this was repeated with physical activity as the independent variable. Through analysis it was examined if the independent characteristics were associated with sedentary behaviour through indirect or mediated pathways. Two approaches were compared for the mediation analysis: 1) the product of coefficients approach using the Sobel test and 2) the product of coefficients approach with percentile bootstrapped confidence intervals.

In the following paragraph mediation is explained in detail:

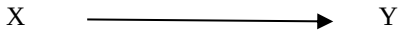


Figure 1: depicts a simple relationship between X the independent variable and Y the outcome variable. Simple relationship between X (independent variable, neighbourhood characteristics) and Y (dependant variable, sedentary time of the individuals)

In mediation, the overall effect of X on Y is the direct effect and the indirect effect pass through M (M is the mediator) (Zhao et al., 2010).

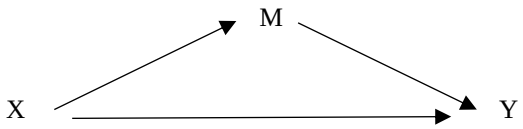


Figure 2: A relationship between the perception of the neighbourhood (X) and sedentary behaviour (Y) that is mediated by another individual level characteristic, such as mental wellbeing (M).

Zhao et al. (2010) explain it was often not implied that the entire pathway between X and Y can be explained by M because some of the pathway between X and Y may be direct and bypass the mediator, M. Note that Bauman et al. (2002) stated that there may be more than one mediator between X and Y.

To estimate the association between the variables in the three variable pathways regression models were mostly utilized, the regression variables were denoted as βa, βb, βc and βc' The βc is the coefficient for the direct pathway between the exposure, X and the outcome Y (Figure 3).

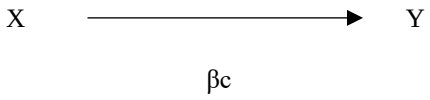


Figure 3: The regression coefficient between X and Y is denoted by βc.

The βa is the coefficient for the pathway between the exposure, X and the mediator, M; βb is the coefficient for the pathway between the mediator, M and the outcome Y; and lastly βc' is the coefficient for the pathway between X and Y, controlled for M, known as the direct effect. All of these have been depicted in Figure 4. MacKinnon et al. (2007) describes that the total effect is the sum of the direct and indirect effect.

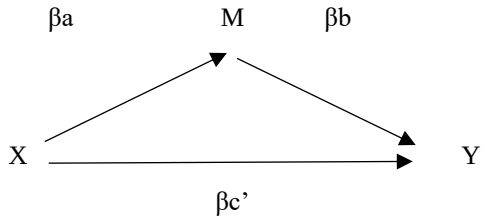


Figure 4: The regression coefficient between X and M is denoted by β_a, regression coefficient between M and Y by β_b and the adjusted pathway between X and Y by β_c'

To examine if the association between sedentary time and neighbourhood factors was mediated by mental wellbeing, linear regression models were fitted using bootstrapped mediation procedures, this was included in the PROCESS SPSS macro (IBM, 2018). The first equation regressed the mediator, mental wellbeing, on the independent variable, sedentary time. The second equation regressed the dependent variable on the independent variable. The third equation regressed the dependant variable on both the independent and mediator variable. This was repeated with physical activity as the independent variable instead of neighbourhood factors.

In mediation there were four criteria; (1) the independent variable was significantly related to the dependent variable; (2) the independent variable was significantly related to the mediator; (3) the mediator was significantly related to the dependent variable;

and (4) the final step was that the association between the independent and dependent variables was attenuated when the mediator was included in the regression model.

MacKinnon et al. (2007) suggested that the calculation of the indirect effect could be carried out by a significance test and the most common method they postulated was the product of coefficients β_a and β_b pathways (β_a X β_b). MacKinnon et al. (2007) further stated that this calculation of the pathways was like the calculation of the difference between the total (βc Figure 3) and the direct pathway (β_c' Figure 3.4). Instead, Baron and Kenny (1996) suggest the use of a Sobel test to test the presence of a mediated effect. In the Sobel test S_a and S_b were suggested as the standard errors of the β_a and β_b pathways (Sobel, 1982). The Sobel test assists in finding out whether the direct effect is less than the indirect effect (Sobel, 1982).

Results of the mediation analysis

Pathway between neighbourhood perception and sedentary behaviour: examining mental wellbeing as a mediator

The estimate for indirect relationships between perceived neighbourhood characteristics (X) and sedentary behaviour (Y) with mental wellbeing as a mediator (M) was computed. There was no evidence of indirect relationships using the product of coefficients approach, the Sobel test. Using the percentile bootstrapped confidence intervals, there was also no evidence of an indirect relationship for the perceived characteristics.

The estimate for indirect relationships between physical activity (X) and sedentary behaviour (Y) with mental wellbeing as a mediator (M) was computed. There was no evidence of indirect relationships using the product of coefficients approach, the Sobel

test. Using the percentile bootstrapped confidence intervals, there was also no evidence of an indirect relationship for physical activity.