Influences on young people's physical activity in Scotland: a socio-ecological approach

by

Joanna Louise Michelle Kirby

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Special thanks go to my loving family who has supported me in so many ways.

Declaration

I declare that the submitted material as a whole is not substantially the same as published or unpublished material that has previously been submitted, or is currently being submitted, for a degree, diploma, or similar qualification at any university or similar institution. The extent of my individual contribution to the submitted material and the conditions and circumstances in which the work has been carried out are clearly stated in this synthesis.

Summary

Aim: I describe the original contribution my work has made to understanding individual, social and environmental influences on physical activity among young people in Scotland. The work I present is based on six publications from five studies.

Design/Methodology/Approach: Two studies used quantitative methods and include a 5-year longitudinal study and a cross-sectional pupil and school-level study. Data were collected through self-administered questionnaires. Three studies used qualitative methods including focus group discussions, photography and descriptive writing. All studies involved adolescents (10-15 years) attending schools in Scotland.

Key Findings: My longitudinal evidence showed significant gender and developmental effects through early-mid adolescence, particularly at the primary-secondary school transition. While boys reported higher levels of physical activity than girls at all ages, baseline physical activity was a significant predictor of later activity levels for both genders. The importance of social influences was evident across my research. Survey data showed boys to report higher peer support, parental support and independent play than girls. Among both genders, peer, paternal and maternal support decreased with age, whereas independent play increased. Time spent with friends was particularly important and was further highlighted in qualitative findings. Being with friends was a benefit of active travel to school, walking, and general physical activity.

Other factors influencing physical activity included proximity and access to local facilities, and the school environment. Most notable was the importance of cost and value for money. In general, pupils were satisfied with school facilities, but felt time for physical education (PE) could be increased. Among adolescent girls, survey data showed the best predictor of physical activity to be hours allocated to PE in fourth year of secondary school. Provision of PE and extra-curricular clubs are likely to be of greater importance to girls' participation than schools facilities. Longitudinal data showed girls reporting lower levels of perceived competence, self-esteem and physical self-worth than boys at each age. Furthermore, girls' physical perceptions decreased markedly over time, whereas among boys, only perceived competence decreased, while global esteem increased.

Influences on physical activity participation were shown to be context specific, e.g. pupils reported not having bicycle storage as a barrier to cycling to school. Walking was a popular activity among girls, although areas in which walking took place, and reasons for walking could differ between geographical locations.

Conclusions: In line with the socio-ecological model, my findings demonstrate the complex interaction of individual, social and environmental factors on physical activity participation among young people. They highlight the need for all sectors to work together in developing the most suitable interventions, considering the activity, its context and the population being targeted.

Abbreviations

CAHRU	Child and Adolescent Health Research Unit
FAS	Family Affluence Scale
HBSC	Health-Behaviour in School-aged Children study
MVPA	Moderate-to-vigorous physical activity
PASS	Physical Activity in Scottish Schoolchildren study
PAQ-C	Physical Activity Questionnaire for Older Children
PE	Physical Education
P7	Primary 7 – final year of primary school
	(age 10/11 at start of school year)
QUAL	Qualitative
QUANT	Quantitative
S1	Secondary 1 – first year of secondary school
	(age 11/12 at start of school year)
S2	Secondary 2 – second year
	(age 12/13 at start of school year)
S3	Secondary 3 – third year
	(age 13/14 at start of school year)
S4	Secondary 4 – fourth year
	(age 14/15 at start of school year)
SES	Socio-economic status
SheS	Scottish Health Survey
SHPSU	Scottish Health Promoting Schools Unit

Chapter 1 : Introduction

1.1 Background

The benefits of regular physical activity among young people are well recognised. Beneficial health outcomes include growth and development, bone health, cardiovascular disease, certain cancers, weight status and mental well-being.[1;2] Even small amounts of physical activity can provide health benefits among high-risk young people, for example, those who are overweight or obese.[2] Importantly, physical activity behaviours established during childhood are shown to track into adulthood, making this a key time for increasing and maintaining participation.[3] As such, physical activity has become a focus of health promotion among children and adolescents.[4]

1.2 Young people's physical activity in Scotland

1.2.1 Guidelines and Policies

In recent years, the Scottish Government has focused on increasing physical activity participation among young people. The last decade has seen a number of relevant policy documents, including *'Lets Make Scotland More Active: a strategy for physical activity'*[5] and its 5-year review.[6] In line with international guidelines, Scottish guidelines recommend that young people engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) a day, seven days a week.[5] The Scottish Government set the target that *"80% of children aged 16 and under should be meeting the current recommended levels of physical activity by 2022"* (pg.22).[5] As well as physical activity policies, those aimed at tackling

obesity are also in place.[7;8] Scotland's Curriculum for Excellence,[9] states that children and young people should regularly experience a wide range of purposeful, challenging, progressive and enjoyable physical activities, in addition to the required two hours of physical education (PE) a week. The Active Schools network also strives to encourage involvement in physical activity and sporting opportunities outside of PE lessons. In response to the specific need to increase activity among adolescent girls, the 'Fit for Girls' programme was rolled out across secondary schools in Scotland.[10]

1.2.2 Participation Rates

Alongside actions to increase young people's physical activity, large scale surveys have tracked levels in Scotland, for example, the Scottish Health Survey (SHeS) and Health Behaviour in School-aged Children (HBSC) study. There are disparities in the reported proportions of young people meeting physical activity recommendations according to both surveys, and this is likely to reflect different ways in which physical activity is measured. The SHeS collects data from children on different activities (e.g. sports and exercise; active play; walking; housework or gardening). It does not collect information on intensity and so assumes that all activities are of at least moderate intensity. Total physical activity is summarised into an overall measure of activity, which takes into account the average participation time and the number of active days in the last week. Since 2008, the SHeS has shown the percentage of children aged 2-15 years (based on a sample of approximately 2000) reaching recommended levels (including physical activity at school) as stable (71-73%).[11] The most recent

survey in 2011 showed that among 13-15 year olds, 69% of boys but only 48% of girls met the recommended guidelines.[12] Data on individual age/gender groups are based on a small sample and must be interpreted with caution.

The HBSC study[13] has collected cross-sectional data on young people's MVPA levels since 2002 and provides eight years of comparable data (approximately 2000 pupils at ages 11, 13 and 15 respectively in 2010 survey). It asks young people to report the number of days over the past week they were physically active for a total of at least 60 minutes per day. The question is preceded by text that defines MVPA as *'any activity that increases your heart rate and makes you get out of breath some of the time'*, and provides examples of such activities. The survey has shown a small increase in the proportion meeting guidelines from 19% in 2002 to 23% in 2006, but a decrease to 15% in 2010.[13] Approximately half (48%) of young people in Scotland reported they usually walk to school, with this being more common among primary than secondary school pupils. Regular cycling to school was particularly rare, (1%), the majority of which were boys.[13]

The HBSC study collects Scottish data alongside 42 other countries in Europe and North America.[14] Findings (2009/10) showed that participation in one hour of MVPA per day by boys and girls aged-11 ranks Scotland 29th out of 39 countries (providing physical activity data). By age 15, this position has fallen to 34th, with England and Wales placed 9th and 20th respectively.[14]

Findings from both surveys show that while efforts are currently in place across Scotland to increase young people's participation, there is still work to be done to reach these targets. Understanding the influences which may impact on physical activity behaviours throughout adolescence is therefore important in order to correctly target promotion efforts.

1.3 Models of health behaviour

Health behaviour is influenced by a complex interaction of factors. Dahlgren and Whitehead's[15] social model of health (Figure 1-1) demonstrates the various individual, sociological and environmental factors that influence health and perceptions of wellbeing. The layered model suggests that while age, gender and genetic make-up will influence a person's health potential, these are beyond individual control. The outer layers present a set of potentially modifiable factors which include personal lifestyle, the physical and social environment and wider socio-economic, cultural and environmental conditions.

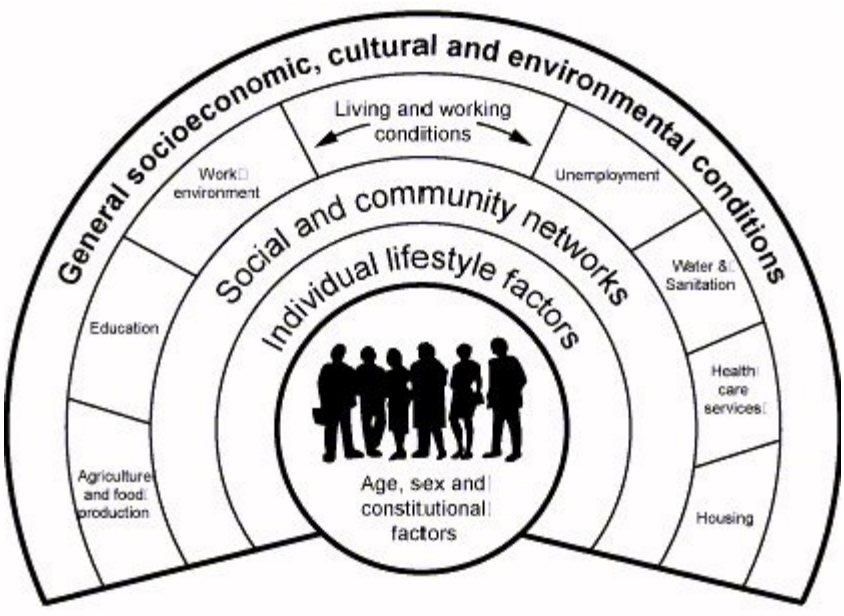


Figure 1-1 : Dahlgren and Whitehead's (1991) Social model of health[15]

Looking specifically at physical activity, a large number of correlates have been associated with participation among young people.[16;17;18] The literature further suggests that correlates are multilevel.[19] Models can be used to provide a framework to understand the multiple factors that act as facilitators or barriers to being physically active. Theoretical models, such as the Stages of Change model[20] and Health Belief model[21] focus on the individual and the psychology of the change process. While these models still retain an important place in health promotion theory, they do not take into consideration the multiple factors which influence physical activity participation such as the social and physical environment. The socio-ecological model[22] acknowledges that health behaviour determinants are multi-level and that it takes a combination of both individual and environmental/policy level interventions to achieve substantial changes in health behaviours. In order to increase physical activity, efforts need to

focus not only on the behaviour choices of each individual but also on the factors that influence those choices. However, while a socio-ecological model provides an overarching framework for behavioural influences, its application to certain behaviours such as physical activity, may vary, and as such, more specific physical activity models, such as that shown in Figure 1-2 are required.

A further weakness of the general model is the lack of information about how the broader levels of influence operate or how influences interact across levels. The model may run the risk of broadening perspectives without providing guidance about how to improve interventions. This said, the socio-ecological model allows us to identify opportunities to promote physical activity participation by recognising the multiple factors that influence an individual's behaviour. Interaction will occur at different levels of influence, for example, a psychological influence may interact with the environment, meaning that behaviours must be targeted individually. For example, in the context of this synthesis, active travel to school is likely to have different influences on behaviour than participation in PE. In this synthesis, I present individual, social and environmental factors influencing young people's physical activity in Scotland. Efforts to change behaviour are more likely to be successful when the multiple levels of influence are addressed at the same time. For this reason, I use the socio-ecological model as the framework for describing my research findings, whilst also discussing their context-specific nature.

The socio-ecological model proposes behavioural influences which include individual (e.g. beliefs), social (e.g. influences from peers and family) and physical environmental factors (e.g. geographical location). In a recent review of physical activity correlates,[23] the authors present an adapted ecological model of the determinants of physical activity (Figure 1-2). It demonstrates the inter-relations between individuals and their social and physical environment, as well as how regional and national policies and global impacts can influence physical activity participation.

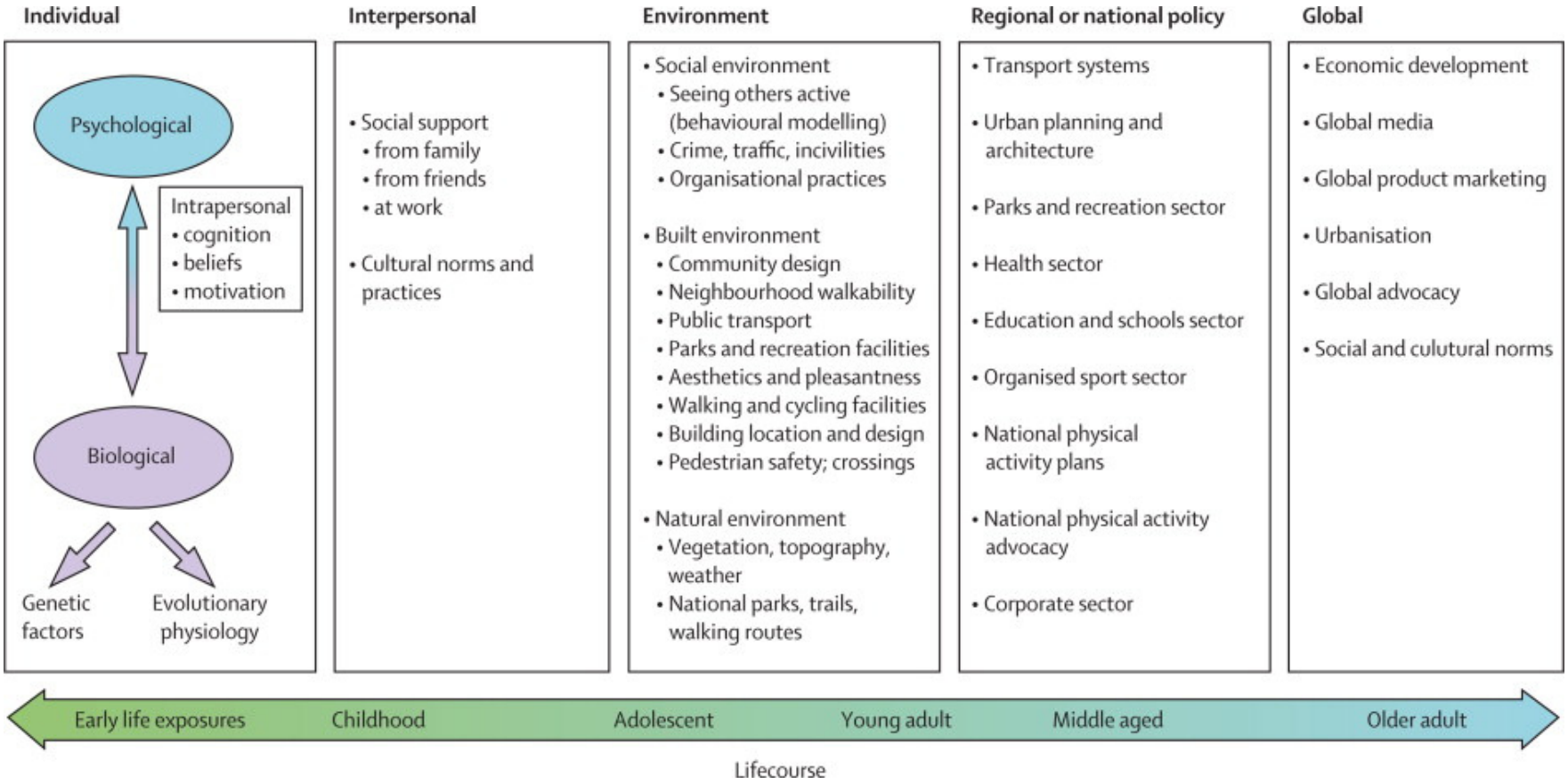


Figure 1-2 : Adapted ecological model of the determinants of physical activity (Bauman *et al.*)[23]

1.4 What the literature tells us

As described in section 1.3, health behaviours, including physical activity, are determined by a variety of individual, social and environmental factors. Furthermore, gender differences have been shown to exist within these.[24] In this section, I present a concise review of the literature. My aim has been to identify recent high quality systematic reviews or reviews of systematic reviews. In some cases, where neither is present, I have identified the most appropriate evidence, e.g. longitudinal studies to examine associations. I include evidence from both quantitative and qualitative study designs. I did not exclude studies based on a criterion of year of publication, but I favoured more recent publications, given the expansion of physical activity research in this area within the last decade. I searched the following databases: PubMed, Web of Knowledge, BioMed Central, Ovid Medline, and Cochrane Database of Systematic Reviews. Primary search terms relating to physical activity, child and adolescent, individual, social (peer and parental) and environmental (neighbourhood and school) factors were used. Studies or reviews relating to physical activity interventions were not included in my search. On identification of relevant reviews, reference lists were further scrutinised to identify any other potential reviews or studies which could assist in my review of the current evidence.

1.4.1 Individual factors

Focusing on broader determinants of health behaviour, to include the social and physical environment, is now accepted as a more appropriate framework than individual-level factors alone.[23] Individual factors however still form an

important part in the overall understanding of this complex area. They include such factors as a person's attitudes, beliefs and self-efficacy.[16] Previous research among children and adolescents has identified a range of reported perceived benefits. These include psychological enhancement (e.g. sense of achievement, enhanced mood), feeling good physically (e.g. refreshed or energised) and improved sports performance (e.g. improved fitness, skill development).[25] Mulvihill and colleagues[26] identified feelings of well-being, enjoyment and weight control as key motivational factors, especially in young women. On the other hand, perceived barriers may have a negative impact on participation and include such factors as lack of energy or motivation to be physically active and time constraints.[25] A review investigating reasons for participation in sport and physical activity[27] highlighted a lack of qualitative evidence regarding barriers to being active among younger children.[27] Individual factors, such as physical self-perceptions, in particular physical conditioning and sports skills, have been identified as significant correlates of activity among children, with boys displaying higher perceptions than girls.[28]

1.4.2 Social factors

A range of social factors are associated with physical activity among young people.[16] Supportive social environments might prompt and reinforce physical activity participation, for example through parental physical activity and support,[29] family cohesion and parent-child communication.[30] Encouragement to be physically active by family and friends and participation with a friend has been associated with MVPA among adolescent girls.[31] Peer contact is also important in the development of protective factors, such as participation in

physical activity and socialising through, for example, youth club membership.[32] Conversely, a lack of social support can have a negative impact on physical activity levels, with low levels of support (parental or peer) resulting in being less active.[33] Evidence from qualitative studies[27] suggests that physical activity participation is motivated by the development and maintenance of social support networks. Among younger children, parental support can be a motivating factor, while adolescents are motivated by both family and peer support. In particular, support from family and significant others at key transitional phases, such as changing schools is essential in maintaining participation.

1.4.3 Environmental factors

In this synthesis I describe environmental factors as characteristics of the physical context in which individuals spend their time (e.g. home, neighbourhood, school). This can include factors such as urban design, traffic, distance to and type of activity facilities; as well as crime, safety and weather conditions.[34] In a review of quantitative literature, children's physical activity was positively associated with public access to recreational facilities and schools as well as a good transport infrastructure, such as safe walking routes. Poor transport infrastructure, (number of roads to cross and speed of traffic) and local conditions (crime, area deprivation) were negatively associated with physical activity.[34] The physical environment has previously been shown as secondary to individual and social environmental determinants.[35] However, accessibility to facilities can determine whether or not they are used for physical activity. Their presence may support achievement of recommended levels of physical activity by providing opportunities for participation.[35]

1.4.4 Context-specific Physical Activity

Consideration of specific contexts in which physical activity may take place has directed recent research; for example, the commute to school, school break times, and leisure-time physical activity.[36] Furthermore, the type of activity which young people prefer can vary by age and gender. 'Active play' for example, is more common among younger than older children, and boys have higher participation in team based, competitive activities, whereas girls show higher levels in informal activities such as dance or walking.[33] Giles-Corti and colleagues[37] extended the concept of a socio-ecological model in proposing that influences are likely to be context-specific, varying according to type of behaviour and setting. Context-specific studies are still in the minority,[38] however, there is evidence that physical activity is declining in specific contexts, such as active transport, organised sports, leisure-time and PE.[36] Understanding influences within the different contexts in which young people are active is important. In a review of correlates of time-specific physical activity among children, only a few correlates demonstrated a consistent association with physical activity.[18] Looking specifically at walking, Pikora and colleagues[39] identified key environmental features, including structural aspects, safety, access to interesting, pleasing physical environments and availability of community and commercial facilities.

1.4.5 Consistent correlates

The increasing breadth of knowledge in physical activity research is highlighted by two recent reviews of reviews, which identified the most consistent correlates of physical activity.[23;40] Bauman and collagues[23] identified seven reviews relating to children and adolescents.[16;17;41;42;43;44;45] A small number of variables were shown to be consistent correlates, namely self-efficacy and previous physical activity (children and adolescents) and family social support (adolescents only). Neighbourhood design, recreation facilities and locations, and transportation environment were consistent correlates for transportation and leisure activity.[23] The authors stated that the majority of studies to date have used cross-sectional designs and subjective measures of physical activity, and emphasise the need for longitudinal studies. Biddle and colleagues' review[40] focused on correlates of physical activity among youth from non-intervention quantitative studies and included nine reviews.[16;17;29;34;38;41;43;44;46] The authors reported a number of correlates, including demographic and biological (age and gender), psychological (positive motivation, positive body image and barriers to physical activity), social/cultural (parental influence and social support) and environmental (access to facilities, distance from home to school, time spent outside, and local crime). They suggested that beyond age and gender, other correlates are likely to have small or small-to-moderate effects in isolation, and are most likely to work in interaction with other influences.

1.5 Synthesis Overview

Understanding influences on young people's physical activity is important in the delivery of effective promotion strategies. In this chapter, I have described young people's physical activity participation in Scotland and have introduced some of the literature to date. I have highlighted the importance of continued research in this area and identified gaps in the knowledge. For example, where large scale cross-sectional studies are important in monitoring young people's participation and factors influencing this behaviour, there is increased emphasis on longitudinal research to track behaviour change over time. Furthermore, a greater understanding of the different contexts in which young people are active is important for identifying opportunities for increasing activity in day-to-day life. While quantitative methods are essential in providing this data, qualitative methods are increasingly recognised as further informing such findings.[47] A mixed-methods approach could help contribute to the evidence base in understanding changes in physical activity at critical transitional phases across the lifecourse.[27]

In this synthesis I present six of my publications (Appendices I-VI) which contribute to understanding individual, social and environmental influences on young people's physical activity in Scotland and go towards addressing some of the gaps identified. In Chapters 2 and 3, I map out the development of my research, and describe the methods used respectively. I present my publication findings in Chapter 4, and describe how individual, family and peer, and environmental influences impact on young people's physical activity in Scotland.

In Chapter 5, I present key conclusions and implications from my research and make suggestions for future research. Finally, I report the impact my research has had to date in Chapter 6.

Chapter 2 : My Published Works

2.1 The publications

In this synthesis I describe the original contribution my work has made to understanding individual, social and environmental influences on physical activity among young people in Scotland. The work I present is based on six publications from five studies, which I worked on between 2007-2012 while at the Child and Adolescent Health Research Unit (CAHRU), University of Edinburgh (2007-2011), and University of St. Andrews (2011-2012). The studies and associated publications are presented in Table 2-1. For the purposes of this synthesis, the five studies have been labelled A-E and are referred to as such throughout. Full copies of each publication are found in Appendices I-VI.

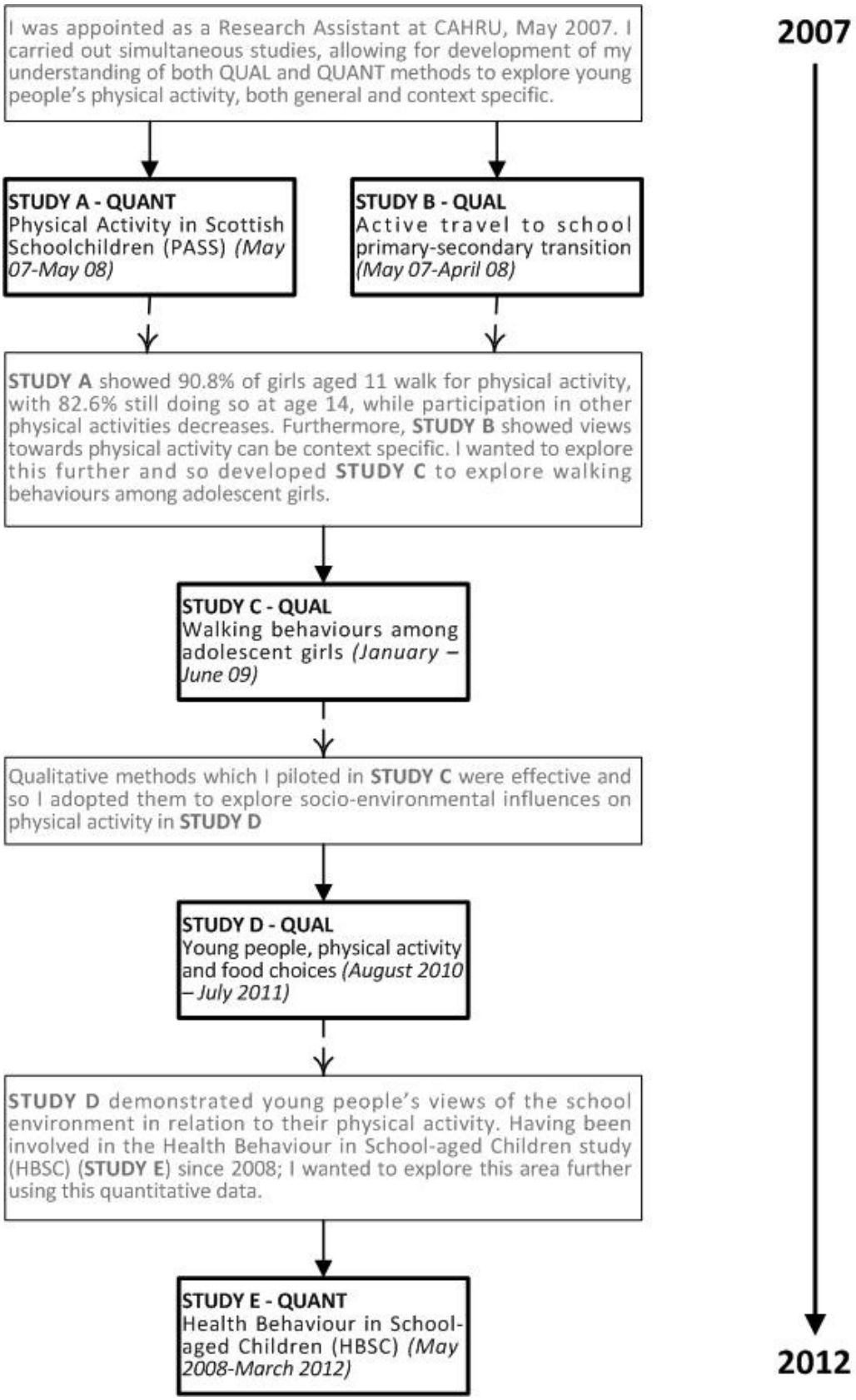
Table 2-1 : The Studies (A-E) and Associated Publications

Study Name and Description	Publication(s)
STUDY A: Physical Activity in Scottish Schoolchildren (PASS) Study *A 5-year longitudinal study investigating patterns and determinants of physical activity among early adolescents (aged 11-15 years) in Scotland.*	• **Kirby, J**., Levin, KA, Inchley, J. (2011) Parental and peer influences on physical activity among Scottish adolescents: a longitudinal study. *Journal of Physical Activity and Health*, 8, 785-793.[48] (Appendix I) • Inchley, J., **Kirby, J**., Currie, C. (2011) Longitudinal changes in physical self-perceptions and associations with physical activity during adolescence. *Pediatric Exercise Science*, 23, 237-249.[49] (Appendix II)
STUDY B: Active Travel Primary-Secondary Transition Study *Four case studies of active travel transition projects, incorporating qualitative exploration of young people's views on active travel.*	• **Kirby, J**., Inchley, J. (2009) Active travel to school: views of 10-13 year old schoolchildren in Scotland. *Health Education*, 109 (2), 169-183.[50] (Appendix III)
STUDY C: Walking behaviours in adolescent girls Study *Pilot qualitative study investigating of walking behaviours, experiences and attitudes towards walking among adolescent girls in Scotland.*	• **Kirby, J**., Inchley, J. (2013) Walking behaviours among adolescent girls in Scotland: a pilot study. *Health Education*, 113 (1), 28-51.[51] (Appendix IV)
STUDY D: Young People, Physical Activity and Food Choices Study *Qualitative investigation of socio-environmental factors on young people's physical activity and food choices.*	• **Kirby, J**., Levin, KA, Inchley, J. (2013) Socio-environmental influences on physical activity among young people: a qualitative study. Health Education Research, doi: 10.1093/her/cyt085. [52] (Appendix V)
STUDY E: Health Behaviour in School-aged Children (HBSC) Study *Cross-national survey investigating adolescent health behaviours, health and lifestyles in their social context.*	• **Kirby, J**., Levin, KA, Inchley, J. (2012) Associations between the school environment and adolescent girls' physical activity. *Health Education Research*, 27(1), 101-104.[53] (Appendix VI)

2.2 My Research and Publications in Context

In this section I explain how my interest in young people's physical activity was developed, how my research has progressed, and the way in which my publications have complemented and informed one another. Figure 2-1 shows the progression of my quantitative (QUANT) and qualitative (QUAL) research and my process of thought.

Figure 2-1 : Map of Research Progression



Since graduating in 2004 (MSc. Health Promotion), I have worked in the area of public health research. As a result of my undergraduate studies (BSc. Sport and Exercise Science), my interests have always been in physical activity. I joined CAHRU (University of Edinburgh) in 2007 as Research Associate on **Study A.** At this time, my research interests in young people's physical activity started to take shape. Alongside other colleagues, I produced two publications from this study data. One explores longitudinal changes in parental and peer influences on physical activity;[48] the other explores physical self-perceptions and associations with physical activity.[49]

My interest extends to context-specific activities, such as active travel. **Study B** was a joint initiative between Sustrans (sustainable transport charity) and the Scottish Health Promoting Schools Unit (SHPSU) and was developed based on decreases in active travel to school as children move from primary to secondary. A pilot project was established to develop and evaluate ways of promoting active travel among children over this transition period and I, alongside colleagues, carried out four case studies across Scotland. During each, we used qualitative methods to explore the views of young people on active travel to school.[50]

Study A demonstrated that despite overall physical activity decreasing among girls with increased age, reported levels of walking remained high. Furthermore, Study B showed that young people's views on physical activity could be context-specific. Intrigued by this and feeling that understanding this relatively unexplored area of physical activity, namely walking, may help increase activity levels among this group I, alongside one other colleague, developed a study to

explore this activity (**Study C**). I investigated walking behaviours, experiences and attitudes towards walking among adolescent girls, using focus group discussions, and piloted a mapping exercise. My publication[51] explores adolescent girls' walking from a contextual perspective to further understand how this activity fits into their broader physical activity participation, and how the social and physical environment plays a part in shaping their attitudes and behaviours.

The methods I piloted in Study C went on to inform **Study D**, which explored influences on young people's physical activity and food choices. The associated paper[52] relates to the physical activity data and draws on a variety of qualitative methods, including focus group discussions, maps, photography and descriptive writing. My findings identified school as a key area where physical activity took place, either as part of the PE lesson, extra-curricular club or active commuting. As such, I was interested in exploring associations between the school environment and physical activity among girls using quantitative methods. Being based at CAHRU, I was part of the research team working on **Study E**. Using both pupil-level and school-level data, I explored alongside two other colleagues, including a statistician (Levin), the extent to which the school environment is associated with physical activity among adolescent girls.[53]

Chapter 3 : Methods

3.1 The Studies

As described in Chapter 2, in this synthesis I bring together six publications from five studies, both quantitative and qualitative. Combining different studies, I employ a mixed-method approach in the interpretation of my findings. In this chapter I describe the methods used for data collection and analyses. Table 3-1 presents details on the study characteristics.

Table 3-1 : Study Characteristics

Study	Study type	Methodology	Participants
A	Quantitative; longitudinal	Self administered questionnaire	1632 schoolchildren from 4 Scottish local authorities recruited from P7 and tracked yearly until S4. Final longitudinal sample; n=641
B	Qualitative	13 focus group discussions	25 primary (P7) and 41 secondary school pupils (S1 and S2)
C	Qualitative	4 focus group discussions (including map exercise)	27 secondary school girls (S1 and S3)
D	Qualitative	14 focus group discussions (including map exercise); 9 photography and descriptive writing sessions	131 secondary school pupils (S1 and S2)
E	Quantitative; cross-sectional	Self administered pupil and school questionnaire	1978 secondary school girls (S2 and S4); 123 head teachers

P7 – final year of primary school; S1 – first year of secondary school; S2 – second year of secondary school; S3 – third year of secondary school; S4 – fourth year of secondary school

3.2 Quantitative Research Methods

Studies A and E used quantitative survey-data. Study A is a 5-year longitudinal study which investigated patterns and determinants of physical activity among early adolescents in Scotland.[33] A cohort of schoolchildren was tracked from the final year of primary school (P7) to the fourth year of secondary school (S4) and data were collected annually by self-report questionnaire. The original cohort comprised 1632 schoolchildren from four Scottish local authorities. The final longitudinal sample comprised 641 pupils (39.3%), including only pupils in S4 who had completed the survey in each of the 5-years. This loss to follow-up (due to factors such as parental withdrawal; school change; absence on day of data collection; incomplete/missing questionnaire) compares favourably to other large-scale longitudinal studies of a similar time period.[54;55;56]

Study E is a cross-national study involving 43 countries and regions in Europe and North America. It uses a standard questionnaire developed by an international network of researchers and used by all participating countries. The target groups are 11, 13 and 15 year olds with a sample of approximately 1500 in each age group in all participating countries. A school-level questionnaire is also completed by head teachers at participating schools.

3.2.1 Measurement of Physical Activity

Accurate measurement of physical activity is of key importance in understanding this behaviour. In Studies A and E, we used self-report measures of physical activity in the form of self-administered questionnaires. Although increased

emphasis is being placed on using objective measures in physical activity research,[57] subjective measures allow for large amounts of data to be collected in surveys such as these. It should be noted however, that whereas vigorous activity is often over-reported in self-report surveys,[58] moderate physical activity has a tendency for under-reporting, due to it being part of everyday life and more difficult to recall accurately.[59] This may be particularly true of children and adolescents, whose physical activity tends to be more spontaneous than adults, and where a broader range of activities may be present.

In Study A we used the Physical Activity Questionnaire for Older Children (PAQ-C). This instrument uses 9 items to assess physical activity during the last 7 days in a variety of contexts (e.g. school, PE classes, break times, after school, evenings and weekends). As such, it enables young people to recall and report a wide variety of situations in which they may have been physically active. The PAQ-C has demonstrated good reliability and validity in previous studies.[60;61;62] Furthermore, findings within a Scottish population have been comparable to previous research.[63]

In our Study E publication[53] we use a tool to assess MVPA, in line with the recommended physical activity guidelines. Young people were asked how often they took part in at least 60 minutes physical activity a day in the past 7 days with optional responses 0-7 days. Physical activity was described as *'any activity that increases your heart rate and makes you out of breath some of the time'* and includes physical activity done in sports, school activities, playing with friends and walking to school and examples were provided (running, walking quickly,

dancing and football). Similar to PAQ-C, this allows young people to consider all different types of physical activity they may have participated in. This particular item is a shortened version of the original, developed by Prochaska and colleagues.[64]

3.2.2 Measurement of socio-economic status (SES)

In Studies A and E, we measured pupil SES using the Family Affluence Scale (FAS); a validated measure which assesses the material conditions of the households in which young people live, including family car ownership, bedroom occupancy, family holidays and computer ownership.[65] The scale allows young people to report more easily on their level of family wealth; an aspect which has previously been difficult to capture when asking specific questions on parental occupation or income.[66] A composite FAS score was calculated to derive a three point ordinal score, comprising low, middle and high affluence.

I considered differences in SES during analyses in one qualitative study (Study D). Here I used percentage free school meal entitlement[67] as an indicator of school-level SES. Based on distribution levels, I categorised schools as low, medium or high SES, with two schools in each category included. While the quantitative measure (FAS) takes account of pupil-level SES, my qualitative work considers school-level SES, and so children from varying levels of SES may attend schools categorised as low, medium or high SES.

3.2.3 Statistical Analyses

Two publications used longitudinal data, presenting findings on parental and peer influences[48] and the influence of self-perceptions[49] on physical activity. Gender differences in proportions being active and associations between physical activity and explanatory variables were analysed using chi-square tests. Temporal trends between age groups were assessed using the chi-squared test for linear trend, taking account of the effect of school clustering. Taking account of clustering is important, as individuals within the same cluster (e.g. school) are likely to be more similar to each other than to individuals in other clusters (for example, due to environmental or socio-economic factors).

While chi-square tests allowed for the impact of each associated influence to be explored, logistic regression was required in order to establish the extent to which each of these impacted on young people's physical activity and whether these varied according to age and gender. Logistic regression is a multivariable method used in the analysis of dichotomous outcomes. It is particularly appropriate for models involving disease state (e.g. diseased/healthy) and decision making (e.g. yes/no), and therefore is widely used in health studies.[68] In logistic regression, the logarithm of the odds of a positive outcome transforms this into the outcome's probability (odds ratio). As such, we used logistic regression analysis to investigate the way in which different variables (e.g. social influences, self-perceptions) were associated with young people's physical activity ('active' versus 'low active') at three ages. Findings are presented in each publication as odds ratios.

My most recent quantitative publication[53] uses cross-sectional data from Study E. The analyses were carried out by the statistician (Levin), who combined pupil and school-level data in the associations between the school environment and adolescent girls' physical activity, using multi-level modelling methods. Multi-level modelling has the advantage of analysing data where there is more than one level, in this case, the pupil (lower level) and school (higher level). Univariate linear multilevel regression models were fitted with a physical activity outcome variable. The multilevel modelling took account of the clustered nature of the data, pupils clustered within schools, clustered within stratum (education authority and school type).

More detailed accounts of all quantitative methods and analyses can be found within the individual publications (Appendices I, II and VI).

3.3 Qualitative Research Methods

All three qualitative studies[50;51;52] involved focus group discussions. These were based on a standardised semi-structured interview schedule and facilitated by me. The interview schedules were devised from topics identified within the existing literature. However, topics were left broad and open in order to allow unrestricted discussion. Several advantages of using focus groups among young people have been documented. They acknowledge participants as experts,[69] encourage a greater range of responses, and reduce the likelihood of participants answering a question they may not fully understand or not responding at all.[70] Focus groups allow for differences between participants to be revealed, and are considered particularly useful in attitudinal research and when the interaction

between participants can help to illuminate the research issue.[71] In Study C, I split focus groups according to geographical location (urban versus rural) to explore walking behaviours. 'Geographical location' was based on the Scottish Household Survey 2008 6-fold urban/rural classification.[72]

Darbyshire and colleagues[73] suggest that using a multi-method qualitative approach is valuable in offering complementary insights and understanding that may be difficult to access through reliance on a single method. In Study C, I piloted methods using maps to explore walking behaviours among adolescent girls. Understanding how the local environment impacts on people's walking behaviour can help provide more 'walkable' environments[74] and the use of maps as a tool to identify individual's definitions of their local walking neighbourhoods is insightful.[75] Perceived neighbourhood areas have been shown to be considerably smaller than those commonly used in physical activity research and the use of maps allows individuals to identify exactly the areas within which they walk or are physically active.[75] These methods, alongside the use of photography and descriptive writing were used in Study D to explore influences on physical activity. Using mobile phones, digital or disposable cameras, participants were asked to take photos representing aspects of the local environment relevant to their physical activity behaviours. Children's self-directed photography has previously proved an insightful method of capturing aspects of their everyday lives.[76]

3.3.1 Data analysis

Interview schedules and coding schemes were guided by previous literature. All focus group discussions were recorded and transcribed and the coding scheme was applied systematically across all transcripts. For studies where other qualitative data were used, (e.g. maps, images and descriptive writing), these were also coded using set criteria. The application of themes across all data sources allowed for a systematic overview of the scope of the data.[77] Data were analysed using NVivo software.

More detailed accounts of all the qualitative methods and analyses can be found within the individual publications (Appendices III, IV and V).

3.4 Mixed Methods

The use of both quantitative and qualitative methods (a mixed method approach) in health research has become increasingly common.[78] By combining methods, it is possible to use the strengths and minimise the weaknesses of both. Quantitative research has the advantage of gathering descriptive information and examining the relationship between variables among different populations. It provides statistical evidence that can help establish a probable cause and effect. Qualitative research focuses on the contexts and meanings behind such findings. It helps in the understanding of processes and provides detailed information within a given setting or context through the voices of the study participants.

Greene and colleagues[79] suggest that by combining quantitative and qualitative methods (in a single study), the researcher can achieve convergence of results; identify overlapping facets that emerge on closer inspection; augment the information gained from an initial approach; identify and examine contradictions; add scope and breadth to a study; and guide the use of additional sampling, data collection and analysis techniques. Many models used to describe mixed methods research do not account for multiple studies within a sustained programme of inquiry in which mixed methods may be used at different stages of the research. Five studies, either purely quantitative or qualitative are presented here, but I interpret findings together considering the broader understanding of influences on physical activity among young people using a socio-ecological approach. Integrating quantitative and qualitative research can make appropriate synthesis more challenging, but may lead to a richer perspective.[80] Although this synthesis does not fall into the traditional construct of a mixed-methods study design, the study progression, as previously demonstrated in Figure 2-1 (pg 25), shows that my research follows the concepts of a mixed-method design.

Chapter 4 : Publication Findings

My original contribution to the field of physical activity research focuses on furthering the understanding of individual, social and environmental influences on young people's physical activity in Scotland. In this chapter I present the main publication findings. While I acknowledge there is overlap between individual, social and environmental influences, for the purposes of this synthesis I present these separately.

4.1 Determining associations and assessing causality

Associations made in my research must be treated with caution due to the multifactorial nature of physical activity behaviour. While we account for certain factors in our quantitative analyses,[48;49;53] there still remains difficulties in identifying all the features of a particular variable that might have a role in physical activity behaviour. As such, this must be considered in all associations presented in this synthesis.

A number of criteria have previously been established for inferring causality.[81] Temporality relates to whether the supposed cause (e.g. high self efficacy) precedes the effect (e.g. physical activity participation). Cross-sectional studies are concerned with a representative sample at a single point in time and therefore cannot provide evidence about the direction of cause and effect. Longitudinal studies however, track a group of individuals over time and are more useful when investigating trends in behaviour and attitudes. When a variable is measured repeatedly in the same individual, the variance of change will be smaller than if

different individuals were to be surveyed each time. As such, longitudinal data can help establish causality through the temporal sequence of the data. However, there are still challenges in determining causality in longitudinal data.

4.2 The Models

In Figure 4-1, Figure 4-2 and Figure 4-3, I present three models which combine the findings from all six publications, focusing on individual, social and environmental influences respectively. Each model relates to influences on 'physical activity participation', which includes general physical activity, as well as context specific activity (active travel to school and walking for leisure or travel). Whether each factor is positively or negatively associated with physical activity participation is represented by ticks and crosses respectively. Where both a tick and cross are present, the findings vary between studies or population groups, or are inconclusive. The models present an overview of my findings but do not present differences according to age, gender, SES or geographical location. Such variations are described in the accompanying text.

4.3 Individual influences

Figure 4-1 demonstrates individual factors associated with young people's physical activity in Scotland. These include, age, gender, SES, perceived benefits, perceived barriers and self perceptions.

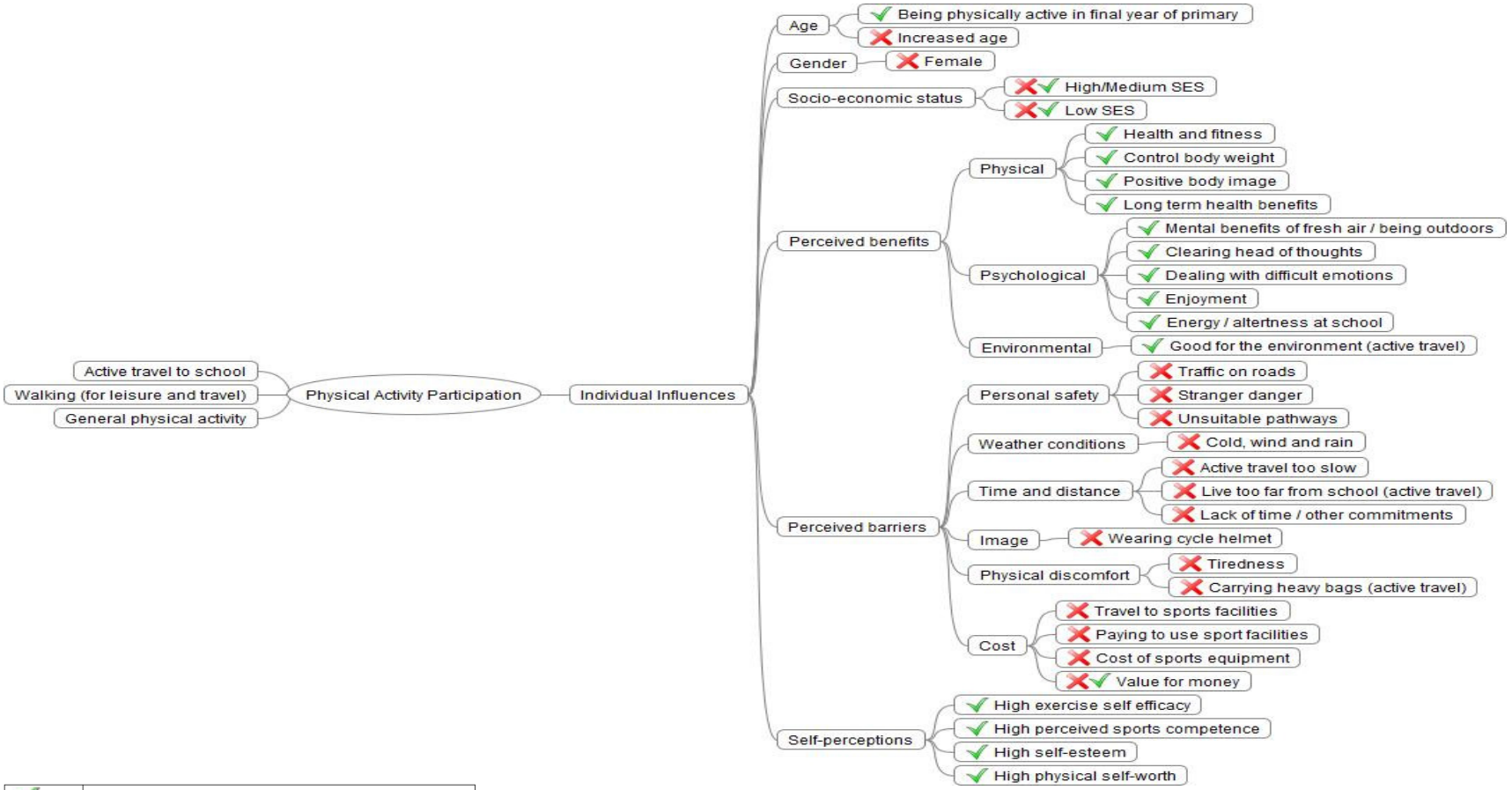


Figure 4-1 : Individual influences on young people's physical activity in Scotland

4.3.1 Age and Gender

There were differences in physical activity participation according to age and gender, with girls reporting lower levels than boys at all ages and participation decreasing with age among both. Being physically active at a younger age increased the likelihood of being active during the early secondary school years. More specifically, baseline physical activity (being 'active' in P7) was a strong predictor for being active in S2 among boys and girls.[48;49] Key variables, including parental/peer influences[48] and self-perceptions[49] were shown to have differing levels of effect on participation among young people at different ages and are described in further detail in sections 4.3.5 and 4.4 respectively.

Age and gender were not key areas of exploration during focus group discussions, rather a consequence of comparing data from pupils in early and later secondary school years and across genders. Walking for example, was shown to be common among S2 and S4 girls, whereas the context in which walking took place could alter with age. Less walking occurred with family members at older ages, but there was increased time spent walking with friends.[51] Some barriers to active travel identified by secondary school pupils were not evident in primary, suggesting some age-related differences in factors influencing active travel. For example, early secondary school pupils felt intimidated by the presence of older students in the streets or blocking roads.[50]

4.3.2 Socio-economic status (SES)

As shown in Figure 4-1, the relationship between SES and physical activity was not consistent.[48;49;53] In our investigation of parental and peer influences[48] and self-perceptions[49], SES was not a significant factor related to physical activity in the univariate model. However, as previous literature has consistently shown SES to be a confounding variable in physical activity, SES was adjusted for in the multivariable model.

In our investigation of the school environment,[53] SES was also accounted for using FAS. In this instance, the final multivariable model for the association between pupil and school characteristics showed that compared with low SES girls, those from medium/high SES achieved on average approximately a quarter or half a day extra of MVPA respectively. The strongest school-level predictor of MVPA was time allocated to PE in S4, irrespective of school SES.

Variations according to SES could depend on the activity in question.[52] I showed variations among pupils from schools with different percentage of free schools meals as a measure of SES.[52] The relationship was clearest in sports facility access, where easy access was more common among pupils attending schools from medium/high SES. Use of greenspace was common among all pupils, but was most common among those from low SES schools. Cost and value for money were important factors associated with physical activity among all, but more evident among pupils attending schools in areas of lower SES.

4.3.3 Perceived Benefits

Perceived benefits can be categorised as physical, psychological or environmental. Findings on perceived benefits were largely related to active travel[50] and walking.[51] Perceptions of physical benefits included improving health and fitness, controlling body weight, 'looking better' (a positive body image), and long term health benefits. Psychological benefits included the mental health benefits of being outdoors and getting fresh air. Actively commuting to school could help pupils feel more energised and alert at school.[50] Physical activity was also associated with clearing the head of thoughts and helping to deal with difficult emotions. Enjoyment was a perceived benefit associated with walking, although this could be restricted to specific situations. While improved health and fitness were important benefits, these were not the main drivers of behaviour.[51] Social benefits ('being with friends') were the main motivating factor, as described in all three qualitative studies (Section 4.4).[50;51;52] Environmental benefits were mentioned only in relation to active travel. Young people discussed the links between active transportation and helping to alleviate environmental problems, including reducing fuel consumption and pollution.[50]

4.3.4 Perceived Barriers

Financial costs of traveling to sports facilities, paying to use sports facilities (e.g. swimming pool) and buying sports equipment (e.g. dance outfits among girls), were all mentioned as barriers (Figure 4-1). While cost was primarily discussed as a barrier, the issue of value for money was also discussed. A venue perceived to be good value (e.g. astroturf) could encourage use.[52]

Young people could find being active physically uncomfortable and tiring and also reported barriers related to time. They did not feel they had enough time to be active due to other school or extra-curricular commitments, or as a result of the distances they needed to travel to access facilities.[50;52] Living too far from school, or the time taken for active travel were cited as barriers to actively travel to school.[50]

Concerns about personal safety related primarily to traffic or busy roads to cross and impacted on the extent to which pupils felt safe and confident as pedestrians and/or cyclists. Many also reported they would not walk or cycle to school if the weather was bad. Image, such as having to wear a cycle helmet, was also cited as a reason for not cycling to school.[50] 'Stranger danger' was mentioned but was not a primary safety concern. Parental and girls' own safety concerns about their neighbourhood were described as barriers to walking among rural girls.[51] Restrictions on 'independent play' also impacted on young people's physical activity.[48]

4.3.5 Self-perceptions

Positive self-perceptions were associated with greater physical activity, including exercise self-efficacy, perceived sports competence, physical self-worth and self-esteem.[49] Boys consistently reported more positive self-perceptions, while girls reported lower levels of perceived competence, global self-esteem and physical self-worth than boys at all ages. Furthermore, girls' physical self-perceptions decreased over time whereas among boys, while perceived competence

decreased, global self-esteem increased. Multivariable analyses showed that high perceived competence had the greatest impact on being active among older boys, while higher exercise self-efficacy was more important among older girls.[49]

In focus groups, pupils were asked how confident they felt about walking or cycling to school. This question did not produce much discussion, suggesting that confidence may not be a concept which young people associate with active travel, unlike skills-based activities such as sports and team games.[50]

4.4 Family and Peer Influences

Figure 4-2 presents the social influences identified in my research. This corresponds to family influences (parental decisions/attitudes and parent activity level) and peer influences (peer activity level, support and socialising). My findings show how social influences can exert positive and negative effects on participation.

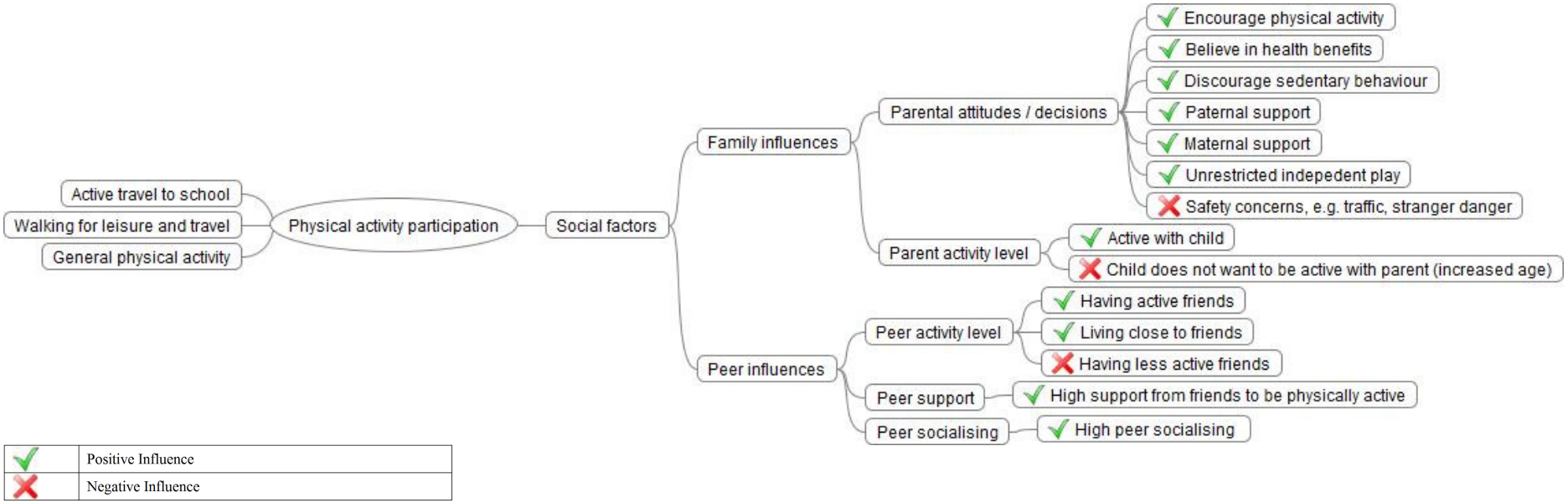


Figure 4-2 : Social influences on young people's physical activity in Scotland

4.4.1 Parental influences

Compared with peer influences, parental support was less likely to be associated with being active among adolescents. However, where the influence of parental support was apparent, being active was associated with support from the same-sex parent. Among S2 girls, having high maternal support increased the odds of being active, whereas S2 and S4 boys with high paternal support were more likely to be active.[48]

'Independent play' (how often young people were allowed to play out in the local streets or park without an adult) was associated with physical activity. Girls in S2 reporting 'unrestricted play' were four-and-a-half times more likely to be active compared with those reporting 'restricted play', demonstrating the impact this could have on activity levels. Young people gained extra autonomy as they became older.[48] A large proportion of girls felt their walking levels had increased with age, partly due to increased autonomy.[51]

The decision to actively commute to school was made largely by the child, but some parental influences, both positive and negative were reported. Parents could encourage their child to walk or cycle to school, often due to the health benefits associated with exercise, while parents who were less encouraging had concerns over safety, either that of their child or for the bike being left at school. In cases where the choice was a joint decision between child and parent this was based on discussions around the route, having other children to commute with and the weather.[50]

4.4.2 Peer influences

A common finding was the importance of peers/friends on physical activity participation. Such influences could be positive or negative, based on factors such as peer activity level, support and socialising. Pupils who actively commuted to school tended to do so with friends and the social benefit was a strong motivator.[50] Likewise, walking was often a consequence of being with friends, and was reported to be more enjoyable if with friends.[51]

Adolescents are increasingly influenced by their peers as they get older. Peer support increased the odds of being active in S4 by over 2.5 times for boys and girls, over and above activity at baseline. High levels of peer socialising were consistently associated with being active among boys. However, in S2 this was not the case for girls. At this age, girls are perhaps likely to spend time in 'non-active' activities with their friends. By S4, peer socialising predicted physical activity among girls, although the effect was smaller than that of peer support. Despite decreasing physical activity as girls become older, girls who remain active by S4, may socialise with friends who are similarly active.[48]

Living close to friends was often reported as a facilitator and being with friends was a positive aspect of being active. For young people who did not feel active, walking with friends was seen as helpful in increasing their activity levels. Female-only focus groups tended to contain friendship groups whereby girls who were active were so with other friends within that group. Across focus groups, being active with friends was common. Similarly, friends could have a negative

impact on physical activity participation by encouraging their peers to be inactive.[52]

4.5 Environmental Influences

Figure 4-3 presents the environmental influences identified in my research, in relation to school environment, physical environment and geographical location.

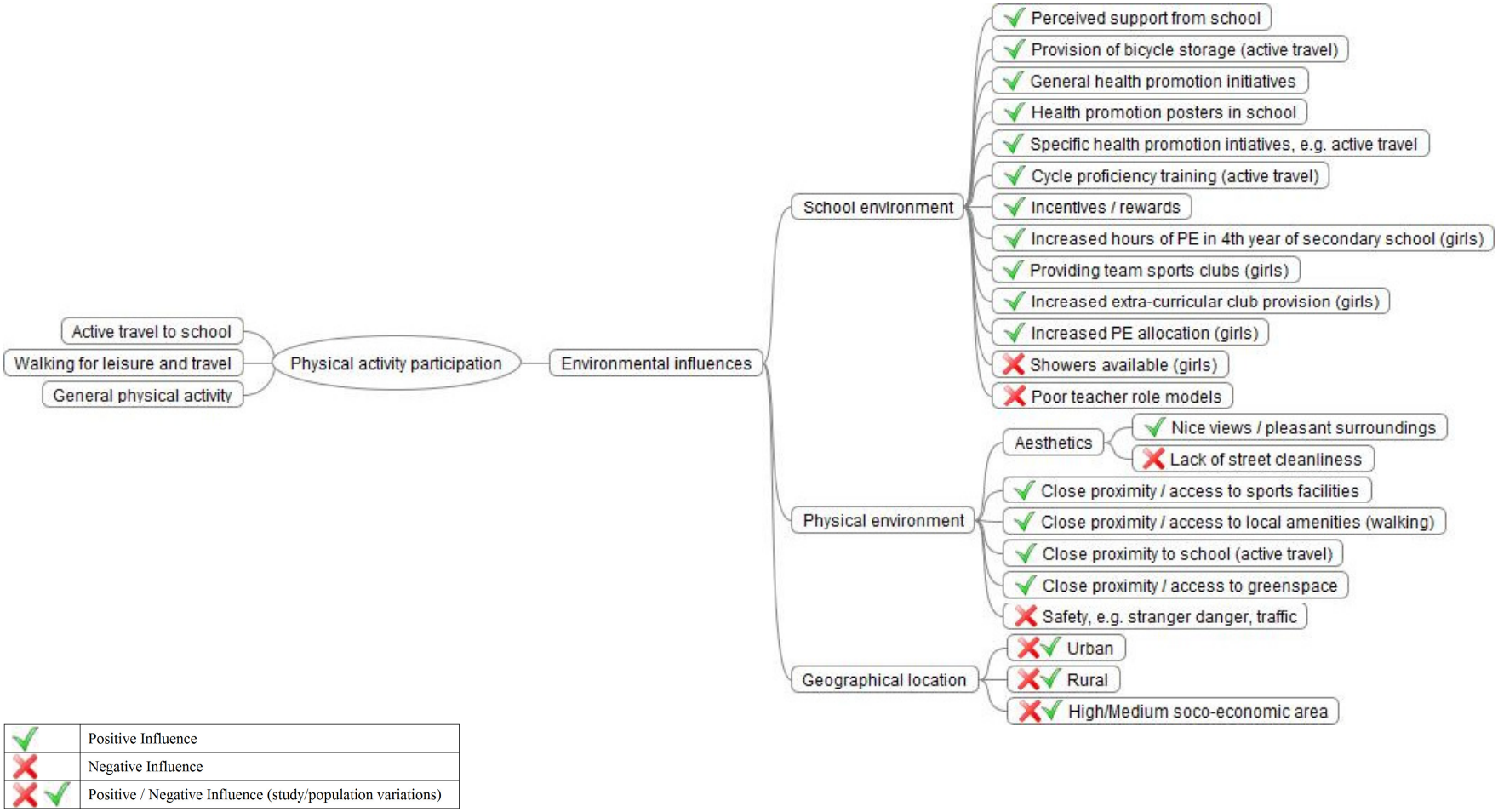


Figure 4-3 : Environmental influences on young people's physical activity in Scotland

4.5.1 School environment

As demonstrated in Figure 4-3 the school environment can influence pupils both with the facilities provided, and the support/promotion for physical activity. The best predictor of adolescent girls' MVPA days was hours allocated to PE in fourth year of secondary school. The availability of school sports facilities however, was not related to reported activity.[53] Pupils reported being content with school facilities, even where these were limited, as long as PE options remained high.[52] By contrast, provision of facilities such as bicycle storage was an important factor in pupils' decisions to actively commute to school.[50] Pupils reported preference for improved changing rooms, although the condition of changing rooms was not the subject of large amounts of discussion.[52] However, having shower facilities in school was associated with decreased MVPA among adolescent girls.[53]

Young people who were active in school sports (curricular or extra-curricular) commonly reported taking part in the same sport in the community.[52] Schools which provided less than two team-sports clubs, compared with schools that provided four or more were associated with decreased MVPA among girls. Compared with schools with no after-school clubs, girls who attended schools with after-school activities at least one day per week were likely to have increased MVPA days. PE allocation and extra-curricular activities are likely to be of greater importance than school facilities per se.[53]

Perceived support from schools for active travel came mostly in provision of facilities (e.g. bicycle storage), or cycle proficiency training. School health

promotion initiatives were viewed as a positive way of making pupils more active, and in particular, active travel projects could have a positive effect on awareness and participation. Pupils who felt their school could do more to encourage active travel recommended having more organised school walks or incentives. Having teacher role models was seen as important.[50] Both rural and urban girls mentioned their school as a place where they walk daily, often citing corridors or school grounds.[51]

4.5.2 Physical environment

Pupils raised some potential barriers to active travel in the physical environment, including lack of cycle paths and poor street lighting.[50] Urban and rural girls reported different walking behaviours, with walking destinations largely dependent on proximity and access to areas such as shops, as well as distance to school.[51] Young people often reported being active in areas close to home or school.[52] Availability of local sports facilities was variable across SES groups. Greenspace was commonly used by young people, especially in areas of lower SES, where sports facilities were less accessible.[52]

4.5.3 Geographical location

As demonstrated in Figure 4-3, living in an urban or rural location did not dictate the amount of walking, but rather the context in which it took place.[51] Girls in urban areas were more likely to walk to and from school and walk to town and/or shops, whereas those from rural areas were more likely to simply ‘go for a walk’. The mapping exercise showed that rural girls used a larger geographical area for

walking, though had a larger school catchment area and distances between friends' homes.

While SES appeared to contribute to the distance young people would travel to use particular facilities, their use of the local facilities differed depending on their location. Young people were more likely to use local facilities, but would be prepared to travel further for particular facilities, such as larger sports centres and swimming pools.[52]

Chapter 5 : Discussion

5.1 Key Conclusions and Implications

In this chapter I consider and reflect on my findings as a whole, identifying the key conclusions and implications for practice, as well as providing examples of interventions required. More specifically, in Table 5-1, I present the key conclusions in the context of my research and highlight where this evidence has originated. I also present what implications this evidence will have on practice, and make suggestions as to who need to act and how. In doing so, I provide examples of the types of interventions required. I continue with a discussion of my findings in the context of other research and future intervention development.

Table 5-1 : Key Conclusions and Implications for Practice

Key Conclusion	What's My Evidence?	Implications for Practice	Who needs to act and how?
Physical activity is influenced by a complex interaction of individual, social and environmental factors; the relative importance of which can vary according to age and gender.	Influences can have both positive and negative effects on physical activity participation (Figures 2-1, 2-2, 2-3). Longitudinal evidence shows how these influences vary by age and gender (STUDY A)[48;49] Some factors are important across both genders and across all ages and levels of SES, such as cost and value for money, use of greenspace and access to local facilities (STUDY D)[52]	Interventions need to be targeted at a population level, taking into consideration those factors known to have the most influence within that group.	All sectors to work together to make physical activity accessible. • Leisure centres/sport facilities and travel sector to work together to provide free transport (e.g. bus ticket refund) if attend • Free use of community swimming pools for all ages • Organised activities within local greenspace targeted at young people • Provision of a central venue where a variety of activities can take place
Influencing factors can be context specific.	Pupils report specific barriers and facilitators to being active when discussing particular activities, e.g. active travel or walking. Walking was popular among urban and rural girls; areas in which walking took place, and reasons for walking could differ between geographical locations. (STUDIES B, C) [50;51]	Promotion strategies should consider the activity and the context in which it takes place.	Each sector to determine how they fit into physical activity promotion. • Promotion of active travel to school through organised walking/cycling events and provision of bicycle storage • Designing streets and communities to reclaim public spaces and promote active

Key Conclusion	What's My Evidence?	Implications for Practice	Who needs to act and how?
			living • Providing incentives to encourage physical activity in various settings
Being active in primary school is associated with increased likelihood of being active at secondary school. The primary-secondary school transition is a key time for changes to occur.	Activity levels drop at the primary-secondary school transition. Physical activity at baseline (final year of primary school), was a strong predictor of being active in S2 and S4, when considered against other influencing factors (STUDY A)[48;49]	Important to establish physical activity participation at primary school and maintain across secondary years. Early interventions and those which target primary-secondary transition are required.	Education and school, community and organised sport sector to work together to bridge this gap. • Establishing strong links between secondary schools and feeder primary schools and develop strategies to maintain activity levels, e.g. walk to school day prior to start of new term. • Establishing links between schools and local sports clubs/ leisure centres to ensure pupils have a path from school to community-based activities
Social influences are important across genders and ages, although the relative influence of parents and peers changes with age. 'Being with friends' is a fundamental motivation for being active, particularly in relation to walking and active travel to	The influence of family and friends is a core theme across my research (STUDIES A, B, C, D)[48;50;51;52] 'Independent play' (how often young people allowed to play out in the local streets or park without	Interventions which promote the social side of being active, in particular for active travel and walking for leisure, may be most beneficial.	Education and school, parks and recreation, leisure and organised sport sector. • Promoting physical activity as a social event, e.g. cost discount if use facility with friends

Key Conclusion	What's My Evidence?	Implications for Practice	Who needs to act and how?
school.	an adult) associated with physical activity (STUDY A)[48]		• Promoting parent-child activities • Including parents in promotion strategies, particularly where safety concerns exist • Providing social support groups at school or in the community.
Availability of school sports facilities does not necessarily lead to increased physical activity participation. The exception is active travel to school, where bike storage facilities are considered important.	Compared with schools that provided four or more team-sports clubs, schools which provided less than two, were associated with decreased MVPA among girls (STUDY E)[53] Compared with schools with no after-school clubs, girls who attended schools with after-school activities at least one day per week were likely to have increased MVPA (STUDY E)[53] Pupils showed a willingness to take part in more than the current 2 hours a week of PE (STUDY D)[52]	It is likely that the activity and activity provision is more important than the sports facilities available. Creating opportunities within school for being active (e.g. PE lessons, extra-curricular clubs) is more important than providing facilities.	Education and school sector. • Developing a plan to make most effective use of school facilities. • Increasing PE time to 3-5 hours per week. • Establishing links with local facilities for use in PE and extra-curricular clubs • For schools with good facilities, make these available out of school hours • Providing safe bicycle storage and encouraging its use.

Key Conclusion	What's My Evidence?	Implications for Practice	Who needs to act and how?
	Pupils reported not having bicycle storage as a barrier to cycling to school (STUDY B)[50]		
Positive self-perceptions are associated with increased physical activity. However, self-perceptions are consistently lower among girls than boys at all ages, with this gap widening with age.	Girls reported lower levels of perceived competence, global self-esteem and physical self-worth than boys at all ages (STUDY A)[49] Multivariable analyses showed high perceived competence had the greatest impact on being active among older boys, while higher exercise self-efficacy was more important among older girls (STUDY A)[49]	Physical activity programmes must focus on promoting physical competencies and confidence, especially among girls. Identifying activities which young people feel most comfortable with may help increase participation levels.	Education and school, leisure and organised sport sectors • Consulting regularly with girls as to what activities they would like at school. • Introducing girls to activities they feel most comfortable with, to build confidence before moving on to new activities. • Promoting walking through organised community events. • Informing girls about opportunities to be active within the community.
School shower facilities are associated with decreased levels of physical activity among adolescent girls.	Having shower facilities in school was associated with decreased MVPA among adolescent girls (STUDY E)[53]	The types of shower and changing facilities could impact on pupil participation.	Education and school sector • Removing communal showers and/or replace with private showers. • Making changing rooms more comfortable and appealing for female pupils.

My research supports the literature which consistently reports boys to be more active than girls and increased age to be associated with decreased physical activity.[16] My findings show that physical activity participation is influenced by a complex interaction of individual, social and environmental factors. In a recent review, the most important predictors of MVPA among boys were self-efficacy, peer support, home physical activity equipment and temperature, whereas among girls, having low perceived barriers, living close to school and having a walkable neighbourhood, were associated with increased MVPA.[24] My findings confirm significant age and gender differences and highlight the need for interventions to be targeted at specific groups.

I have shown that being active in primary school increases the likelihood of being active at secondary school. This concurs with previous research suggesting that physical activity participation during childhood can form the foundation for activity habits in later life.[82] I have identified the primary-secondary school transition not only as a time where physical activity levels begin to fall, but also when other influencing factors, such as the relative importance of parents and peers, and levels of self-perception are likely to change. As such, there is a need for early interventions, and particularly those which target the primary-secondary school transition.

In Chapter 4, I use three models to demonstrate individual, social (family and peer) and environmental influences. Bauman and colleagues' ecological model,[23] (Figure 1-2, page 14) demonstrates the inter-relations between individuals and their social and physical environments. My findings correspond to the broader

categorisations of their model, but also identify specific factors, such as paternal and maternal influences, the school environment and the activity context. Bauman et al.[23] include regional and national policies and other global factors in their model. These are outside the scope of my research but have the potential to impact on physical activity participation. The importance of social influences is emphasised across my research. Previous research has shown that parents maintain substantial influence over their children, but that the health significance of parent-child relations is intricately woven with that of the peer world once children become more independent.[83] This shift from parental influence to peers was evident in my research.

Friendship plays an important role in shaping physical activity behaviours. A recent review on social network analysis identified three themes relating to the effect of friends on physical activity,[84] namely friendship similarities in physical activity, peer group influences on physical activity, and social preference (popularity) and physical activity. In my investigations, I ensured focus group participants were accompanied by at least one friend.[52] Female-only focus groups tended to contain friendship groups in which active girls were likely to be active with other friends in the focus group. Female social groups which include physically active girls may encourage others to be physically active. Being active with friends was common in my research, particularly in team games, such as football (boys) and basketball (girls), challenging the view that girls feel more comfortable and prefer individual, non-competitive activities. I found that active girls are likely to socialise with other active girls, highlighting the importance of friendship groups.[48] The opportunities for being with friends proved to be an

important reason for participating in active travel or walking. Actively commuting to school was an ideal opportunity to spend time with friends, and was particularly relevant during the transition from primary to secondary school when making new friends was important.

Parents also play a part in the decision to be active. Safety could be a concern in relation to active travel. My initial findings suggest that involving parents in active travel interventions may help ease safety concerns, and in line with previous research, that school-based interventions with a parental component may be effective.[85] Involving parents in physical activity interventions is complex,[86] but the small amount of evidence available suggests that family and home based interventions are most effective.[87] My publication[48] added to the current evidence, as the majority of literature on social influences on young people's physical activity up until that time was largely cross sectional and focused on only one type of social influence.[30] Where parents influenced their children's activity levels as they became older, this influence came from the same-sex parent. The important role mothers played in encouraging their daughters to walk, or actively participating themselves was discussed by adolescent girls.[52]

My findings demonstrated the importance of positive self-perceptions in physical activity, but also indicated that girls' perceptions of the physical self are particularly vulnerable during the adolescent years. This is particularly important, as focusing on promoting physical competencies and increasing confidence could have a large effect on participation levels. Identifying activities

which allow girls to do this is important. Walking may be a suitable activity to target, with active travel to school also reported as an activity many adolescents would feel confident in doing. Being active within friendship groups, including team games, was reported among girls.[52] Being active in a friendship group may help to alleviate negative self-perceptions. The recent Scottish initiative, 'Fit for Girls,' is addressing this as part of encouraging physical activity among inactive secondary school girls. Evaluation findings from this intervention have shown that consulting girls and offering activities they feel comfortable with at school can result in improved attitudes and engagement.[10]

A fundamental finding in my research relating to the school environment is that school sports facilities do not impact on physical activity participation.[52;53] Opportunities for being active at school are more important than facilities themselves. The best predictor of MVPA among adolescent girls, was hours allocated to PE in the fourth year of secondary school, indicating that providing PE at an influential age during secondary school can impact on girls' physical activity levels. Research on the impact of school facilities on physical activity is limited,[34] but my findings demonstrate that schools can increase participation by focusing on using what facilities they do have and using these to their full potential. This offers encouraging findings for schools with limited sports facilities.

I found that the presence of showers at school decreased physical activity levels among girls.[53] This is perhaps not surprising given the increased negative self-perceptions among adolescent girls. Girls may feel self conscious about their

bodies at this age and therefore the requirement to use showers at school and the associated lack of privacy may discourage participation in physical activity rather than encourage it. The provision of private showering facilities may encourage girls to participate.

5.2 Developing Interventions

In Table 5-1, I present key conclusions from my research, as well as what implications these have on practice. The next stage is to determine how these findings can be used to develop interventions, and so I also propose examples of who needs to act and how. My research as a whole has shown the complex interaction of individual, social and environmental factors on physical activity participation. This highlights that increasing physical activity participation among young people is not the responsibility of a single sector or group, but rather the co-ordination of all of these. Interventions involving changes to the physical, political and economic environment are particularly important in promoting physical activity as they will help to address the facilitators and barriers to individual behaviour change among young people. For example, if health promotion interventions are aimed at encouraging young people to walk and cycle more, then the infrastructure for cycling and walking needs to exist e.g. good road safety and school bicycle storage. If not, then health promotion efforts are likely to have little impact. I present particular examples of how sectors may work together in Table 5-1.

Being active with friends and the influence of family was a common theme throughout my research. As such, the potential for social influences in the

promotion of physical activity is large. When establishing programs it is important to be aware of the cultural, demographic, and environmental factors that influence participation and acceptability of interventions at the individual and community level. Interventions should therefore, be tailored to the particular population being targeted.

5.3 Strengths

A key strength of this synthesis is my interpretation of quantitative and qualitative data together, enabling me to make conclusions about young people's physical activity and suggestions for practice in Scotland. By examining this area using different methods, I have been able to focus on the degree to which my findings converge, thereby enhancing the validity of my results. For example, my quantitative work demonstrated how influences on physical activity participation varied by age and gender and in multivariable models, physical activity at baseline and SES were adjusted for.[48;49] My qualitative exploration of socio-environmental influences on physical activity[52] explored a wide range of factors and highlighted that while there were variation by age and gender, certain influences were present regardless of these, such as value for money and proximity to facilities. The use of maps in my qualitative work further showed that perceptions of ease of access to facilities could vary by SES.[50;52]

The inclusion of longitudinal data is particularly useful in identifying the key times at which physical activity behaviours change, and which influences are most relevant at this time. Furthermore, these are identified according to gender. My findings demonstrate the context-specific nature of physical activity

behaviour. However, while these may be used to inform interventions in Scotland, both within the school and community setting, I acknowledge that findings may vary in different countries and among different cultural groups.

5.4 Limitations

Both quantitative studies included large, representative samples of young people in Scotland. In our investigation of the school environment, a large cross-national sample of adolescent girls and head teachers was used. However, 35 out of 158 state-funded schools (22%) did not respond to the school-based questionnaire, and so the omission of these schools may have resulted in some bias.[53] The primary limitation of the longitudinal study was loss-to-follow-up, also resulting in the potential for attrition bias. While our final sample was comparable to other longitudinal studies over a similar time period,[55;56] this remains a factor which must be considered in the interpretation of results. Comparisons were made between the longitudinal sample and those lost-to-follow up on key variables. There were differences according to family affluence, 2-parent status and physical self-worth. However the longitudinal sample did not differ significantly from those lost to follow-up by gender, physical activity, social support, or other self-perception variables.[48;49] Two qualitative studies included large sample sizes.[50;52] Findings on walking behaviours however, were based on a pilot study involving only a small sample of adolescent girls.[51] While data provided valuable information on a small group of urban and rural adolescent girls in Scotland, a larger sample across more diverse locations and including a broader age range would allow for a more comprehensive range of views.

The primary outcome in my quantitative studies was participation in physical activity, namely being 'high active'[48;49] or number of days of MVPA.[53] In both studies there were also a high number of secondary outcomes relating, for example, to social influences, self-perceptions, and the school environment. A potential risk of using large numbers of secondary outcomes relates to the problem of multiplicity.[88] It has been suggested that where multiple measures are tested, the p-value should be adjusted upwards to reduce the chance of type I error (i.e. findings of 'false significance').[89] In my research, the level of statistical significance was chosen as $p<0.05$, which by definition means that one test in 20 will appear to be statistically significant when it is in fact due to chance.[90] As such, the risks of multiple testing (i.e. interpreting findings when multiple outcome measures are used without adjustment of the p-value) should be considered when interpreting my study findings.[90;91]

Furthermore, in behavioural research, there is the possibility of multiple causal factors (which might 'cause' physical activity) and also reciprocal determinism, where the causal relationships are bi-directional. Exposure to a specific factor does not inevitably lead to the behavioural outcome.[23] As discussed in section 4.1, temporality relates to whether the supposed cause (e.g. high self efficacy) precedes the effect (e.g. physical activity participation). In this synthesis, I present both cross-sectional and longitudinal data. My inclusion of longitudinal data helps to establish causality through the temporal sequence of the data. However, there are still challenges in determining causality in longitudinal data and this must be considered in the interpretation of my findings. Another area of possible limitation in my quantitative work is that related to confounding.

Potential confounders, such as SES and physical activity level at baseline were adjusted for in the multivariable models. However, it must be acknowledged that my findings also have the potential to be influenced by residual and/or unmeasured confounding factors.[92]

While survey techniques are valuable in the collection of large scale cross-sectional and longitudinal surveys and comparable data has been reported with objective measures, it must be acknowledged that young people can have difficulty in accurately recalling physical activity behaviours.[93] Vigorous activity is often over-reported in self-report surveys,[94] whereas moderate physical activity has a tendency for under-reporting, due to it being part of everyday life and more difficult to recall accurately.[95] While I use only subjective measures (i.e. survey data) in my research, combining subjective and objective data types would allow for more accurate measurement of physical activity behaviours among young people. Objective measures could include accelerometers to accurately measure young people's participation in physical activity as well as its type and intensity, or Global Position Systems (GPS) to measure the areas in which physical activity take place, as well as distances/routes for walking or active travel. Geographical Information Systems (GIS) enable objective measurement of the environment, linking geographical and epidemiological information through spatially locating socio-demographic, behavioural and environmental data[75] and further serves as a way of objectively measuring the neighbourhood environment. School audits (e.g. determining school involvement in health initiatives and provision of facilities) could also be used to identify what is present within a specific area. Indeed, at the time of conducting my research, other UK studies have adopted

such methods effectively. In Bristol, the PEACH Project (Personal and Environmental Associations with Children's Health) has investigated determinants of physical activity behaviour in children longitudinally, using a combination of computerised questionnaires, accelerometers and GPS. Such methods have been used, for example, to present findings on greenspace use[96] and active travel.[97] Similarly in Norfolk, the SPEEDY Project (Sport, Physical activity and Eating behaviour: Environmental Determinants in Young People); a population based cohort study, aimed at improving understanding of patterns of and influences on physical activity (and diet) among children. Most recently, self-reported data on travel mode to school, alongside objective measure (e.g. school facility audits and objective measures of neighbourhood and route environments) have been used to investigate individual, socio-cultural and environmental predictors of uptake and maintenance of active commuting in children.[98] Such combinations of data within a Scottish context would be beneficial to overall understanding of young people's physical activity participation.

5.5 Future Research

In the interpretation of my findings I have exposed areas with potential for future research. In our investigation of parental and peer influences on physical activity,[48] while the source of social support was identified (maternal, paternal, peer), the results were based on a mean score of combined scale items and therefore the relative influence on specific types of support (e.g. encouragement, transportation) is not known. I demonstrated how these influences changed over time, however, future research should examine the types of support for physical

activity experienced by individuals and how this differs by gender and age group. Furthermore, I did not consider other potential social influences, such as siblings, teachers or significant others. Their inclusion could help further our understanding of young people's social environment. Negative self-perception impacted on physical activity participation, particularly among girls.[49] Future research should aim to identify those physical activities most likely to foster positive self-perceptions during the adolescent years.

My research investigates young people attending school in Scotland, and in some cases relates to specific samples of young people, for example early secondary school adolescent girls, or those living in urban or rural areas. Exploring a broader range of ages and environments would allow interventions to be tailored to specific groups. Given the context-specific nature of my research, further examination of these relationships in different countries and among different cultural groups would be beneficial.

Combining mapping exercises with focus group discussions was demonstrated to be an effective method for collecting data on physical activity behaviours.[51;52] Future research would benefit from testing the utility of such techniques for gathering data on physical activities among a larger and broader range of populations. Also of benefit would be the combination of qualitative techniques, such as these, alongside objective measures. Combining different data types in one larger study in Scotland would allow for a more thorough understanding of physical activity behaviours among young people and the relative importance of

subjective versus objective measures of the wider environment within which physical activity takes place.

Chapter 6 : Research Impact

My research extends to my desire to translate my findings into practice, and where possible make an impact on improving young people's physical activity participation and ultimately, health. In this chapter I describe the wider reach and outputs of my research.

6.1 Conference Presentations and Academic Outputs

I have disseminated my findings to academic audiences and key stakeholders via oral/poster presentations at national and international conferences (Table 6-1).

Table 6-1 : Conference Presentation Details

Conference (date; location)	**Type**	**Title**
Cycling Scotland (November 2007, Glasgow, UK)	Poster / Oral	Attitudes towards Active Travel to School among school children in Scotland.
2nd International Congress on Physical Activity and Public Health Conference (April 2008, Amsterdam, Netherlands)	Oral	Physical activity trends and patterns amongst Scottish schoolchildren across the primary-secondary school transition and early secondary school years.
Society for Social Medicine Annual Scientific Meeting (September 2008, Southampton, UK)	Oral	Social influences on physical activity participation amongst Scottish schoolchildren: a longitudinal study.
International Society for Behavioral Nutrition and Physical Activity Meeting (June 2009, Lisbon, Portugal)	Poster	Self-Perceptions and physical activity in Scottish schoolchildren: a longitudinal study.

To date, our active travel publication[50] has been cited by five publications, relating to research both in Scotland and internationally.[99;100;101;102;103] The self-

perceptions paper[49] has been cited twice, in relation to psychological benefits of physical activity and young people's physical education.[104;105] The parental and peer influences paper[48] was included in a recent systematic review on physical activity parenting questionnaires and their associations with child activity levels.[106] Measures from the PASS questionnaire have been employed by others; most notably within Fife and West Lothian Councils in local research to inform policy and practice.

6.2 Policy and Practice

At the time of my publication,[50] qualitative research in active travel to school was limited and is still in the minority compared with quantitative data. My publication drew on pupils' own ideas about the ways active travel should be promoted, and as such, has important implications for the development of appropriate and acceptable school-based active travel programmes. While the publication represents the academic output, the main output for informing good practice around active travel was a Sustrans case study publication.[107] This was made available to schools across Scotland, as well as key stakeholders (e.g. School Travel Co-ordinators) to help create their own primary-secondary school transition active travel initiatives. The findings have also featured in other Sustrans publications; Active Travel News: Delivering the Obesity Strategy – Transport has its part to play.[108]

The final report of Study C findings was requested by the pedestrian charity Living Streets. While no direct reference to this work has been made by Living Streets, the report has added to their knowledge base of walking in Scotland. It

offers an insight into walking behaviours among adolescent girls from two different geographical locations within Scotland and confirms the need for future physical activity interventions directed towards adolescent girls to include low-to-moderate intensity activities, such as walking. Specific motivations and barriers were identified according to settlement type, which may help in the development of appropriate interventions to promote walking among adolescent girls.

The two publications from Study A,[48;49] present findings from a much larger data set, presented in the PASS Final Report.[33] This report has had wide dissemination and has been a source of information across Scotland among health professionals and schools. It has been an important resource tool for trainee PE teachers and undergraduate students at the University of Edinburgh and has formed the basis for lectures relating to the promotion of physical activity among young people. Since CAHRU's move to the University of St Andrews, it has been disseminated to undergraduate medical students. The report has also informed the development of the Fit for Girls programme, in particular, informing the training of PE practitioners.

In addition to Scotland's physical activity strategy 'Let's Make Scotland More Active', a 5-year review was published in 2009.[6] The review presents ways in which Scotland is assessing progress towards national physical activity targets and outcomes. PASS is presented within this section alongside other large scale surveys.

Study D was funded by the Chief Scientist Office (CSO); part of the Scottish Government Health and Social Care Directorates that supports research initiated by the research community in Scotland, and advises the Scottish Government on how research contributes to improvements in health and healthcare. The CSO has published an Executive Summary of our findings,[109] which highlights implications for practice and policy, as well as future research.

The publication on the school environment and adolescent girls' physical activity used data from the Scottish HBSC study (Study E).[53] The dissemination of the Scottish HBSC study and its impact on policy is extremely wide and outside the scope of this synthesis. In the publication itself we present specific findings directed towards current practice and suggest that providing more opportunities to be active within the school setting may have a positive effect on girls' physical activity levels, even in schools where availability of sports facilities may be limited.

6.3 Feedback to Participants / Schools

Where possible, findings from studies were reported back to participating schools, both as an incentive for taking part, and to help schools put findings into practice or to use as educational tools. Throughout the 5-year longitudinal study (Study B), all participating schools received a yearly briefing paper, presenting results from their individual school. All schools received copies of the final report.

In Study D, the six participating secondary schools in Edinburgh were provided with individual Fact Sheets. These presented the main influences affecting physical activity and food choices among young people and provided 'Suggested points of action', based on the study findings. Feedback from schools suggested that these fact sheets were subsequently used by teachers and as class tools in Health Education lessons.

The data presented in this synthesis is still being disseminated through further publications and presentations, as well as providing the background for future research. Strong links remain between myself and CAHRU and future collaboration with the University of St. Andrews and other academics is anticipated.

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Published Works - Author Contributions

Below I describe my and co-authors contributions to the papers included in this PhD. The papers have been written and/or co-written by Joanna Kirby (JK), Jo Inchley (JI), Kate Levin (KL) and Candace Currie (CC). Any additional contributions from other colleagues are detailed under the acknowledgments section within individual publications.

Kirby, J. & Inchley, J. (2009) Active travel to school: views of 10-13 year old schoolchildren in Scotland. *Health Education*, 109 (2), 169-183.

The study design was developed by JI in liaison with the study funders, Sustrans. Data were collected in autumn term of 2006 and summer term of 2007. Data was collected in 2006 by JI and one other researcher, Lynn Cuthbert (not a co-author). All 2007 data (focus groups and one-to-one interviews) were collected by JK. All recordings were transcribed by an independent party. Data analysis and interpretation was carried out by JK and JI. JK led the paper and produced the first draft. JI reviewed and revised the first draft, with JK and JI subsequently working together to produce the final manuscript. Both authors authorised the final manuscript for submission.

Kirby, J, Levin, KA, & Inchley, J. (2011) Parental and peer influences on physical activity among Scottish adolescents: a longitudinal study. *Journal of Physical Activity and Health*, 8, 785-793.

This paper uses data from the Physical Activity in Scottish Schoolchildren (PASS) study. JI and CC conceived the idea for the study and study design. Data collection and entry was carried out by two independent organisations. JK joined the study at the end of the data collection. JK carried out the initial data analysis for this paper with support from JI and further advice from statistician KL. JK led the paper and produced the first draft. JI reviewed and revised the first draft, with JK and JI subsequently working together to produce the final manuscript. All three authors approved the final manuscript for submission.

Inchley, J, Kirby, J, & Currie, C. (2011) Longitudinal changes in physical self-perceptions and associations with physical activity during adolescence. ***Pediatric Exercise Science,*** **23, 237-249.**

This paper uses data from the Physical Activity in Scottish Schoolchildren (PASS) study. JI and CC conceived the idea for the study and study design. Data collection and entry were carried out by two independent organisations. JK joined the study at the end of the data collection. JK carried out the initial data analysis for this paper with support from JI. JI led the paper and produced the first draft. JK and CC reviewed and revised the first draft, with all three authors subsequently working together to produce the final manuscript. All three authors approved the final manuscript for submission.

Kirby, J, Levin, KA, & Inchley, J. (2011) Associations between the school environment and adolescent girls' physical activity. ***Health Education Research*****, 27(1), 101-104.**

This paper uses data from the Scottish Health Behaviour in School-aged Children (HBSC) study. Data collection and entry were carried out by an independent organisation. All data analyses were carried out by KL with input from JK and JI. JK led on the paper and produced the first draft. JI and KL reviewed and revised the first draft, with all three authors subsequently working together to produce the final manuscript. All three authors approved the final manuscript for submission.

Kirby, J. & Inchley, J. (2013) Walking behaviour among adolescent girls in Scotland: a pilot study. ***Health Education*****, 113 (1), 28-51.**

JK and JI conceived the idea for the study and study design. Data collection was carried out by JK. Focus groups were transcribed by an independent party. Initial data analysis was carried out by JK and further analysed by JI. JK led on the paper and produced the first draft. JI reviewed and revised the first draft. JK and JI subsequently worked together to produce the final manuscript. Both authors authorised the final manuscript for submission.

Kirby, J, Levin, KA, Inchley, J. (*under review*) Socio-environmental influences on physical activity among young people: a qualitative study. Submitted to *Health Education Research* on 9th November 2012.

JK conceived the idea for the study and produced the study design with input from JI and CC. Data collection was carried out by JK. Focus groups were transcribed by an independent party. Initial data analysis was carried out by JK and further analysed by JI. JK led on the paper and produced the first draft. KL provided specific expertise on inequalities and area levels of deprivation. JI and KL reviewed and revised the first draft. JK and JI subsequently worked together to produce the final manuscript. All authors authorised the final manuscript for submission.

I certify that the author contributions stated above are correct and accurate.

Author Name	Job title / Organisation	Signature	Date
Joanna Kirby	Research Fellow, University of Warwick	[redacted]	14/2/13
Dr. Jo Inchley	CAHRU Assistant Director / Research Fellow, University of St Andrews	[redacted]	19/2/13
Professor Candace Currie	CAHRU Director / Professor of Child and Adolescent Health, University of St Andrews	[redacted]	20·2·13
Kate Levin	Senior Research Fellow, University of St Andrews	[redacted]	01/03/13

At the time of carrying out the research, all authors were based at the Child and Adolescent Health Research Unit (CAHRU), University of Edinburgh, with the unit now based at the University of St Andrews (since September 2011). Joanna Kirby was a Research Associate at CAHRU from May 2007- March 2012.