Do active children become active adults?
Investigating experiences of sport and exercise using the 1970 British Cohort Study

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Abstract

Leading a physically active lifestyle is known to provide a wide variety of health benefits, from reduced risk of diabetes and cardiovascular diseases, to improved mental well-being and healthy weight maintenance. Despite this, the majority of adults are not sufficiently active to benefit health.

Government has consistently sought to increase levels of physical activity in the population (as well as develop elite sport talent) by focusing policy on the promotion of traditional, competitive sport in schools. The main rationale for this approach is that children who play lots of sport in school will continue participating as adults.

The academic literature has frequently criticised the focus on traditional, competitive sports, citing evidence that they have limited appeal to many children, exclude those with lower levels of skill and fitness, and may be counter-productive in terms of promoting lifelong activity. There is, however, scant prospective, quantitative evidence available to support either perspective.

The research presented in this thesis uses longitudinal data from the 1970 British Cohort Study, and robust statistical methods, to identify how childhood experiences of sport and exercise develop between primary and secondary school, and how they are associated with adult exercise behaviour. Hypotheses based on government policy assertions and academic theory are tested.

The findings provide little support for government policy: the cohort members' participation in school sport was not independently associated with their exercise behaviour in adulthood. In contrast, there was consistent support for academic theory. Parental and family influences (posited by family socialisation theory) were consistently identified as key determinants of sport and exercise experiences, both in school and in adulthood. Likewise, an interest in physical fitness in childhood (i.e. intrinsic motivation, as described in self-determination theory) also affected adult exercise behaviour.

The findings are used to suggest alternative approaches by which government might encourage physical activity in the population.

I hereby declare that, except where explicit attribution is made, the work presented in this thesis is entirely my own.

Will Parry

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Chapter 1

Introduction

1.1 Background

In recent decades, government and academic interest in physical activity has grown as worrying trends in overweight and obesity have become apparent. Levels of obesity in England have risen dramatically since the late 1970s (National Obesity Observatory, 2010), the situation being described as an "obesity epidemic" (National Institute for Health and Clinical Excellence, 2006). This rise has been accompanied by a rise in type-2 diabetes prevalence (Masso Gonzalez et al., 2009). Simulations based on Health Survey for England (HSE) data up to the year 2007 (Brown et al., 2010) have estimated that 40% of the adult population (aged 20 to 65) could be obese by the year 2020. The number of people with diabetes in the UK could rise from 3.2 million in 2013/14 to more than 5 million in 2025 (Diabetes UK, 2012).

Simply put, weight gain results from an imbalance between energy intake and expenditure. Even a small, sustained imbalance of +7kcal/day will lead to weight gain (Hall et al., 2011). Although a complex interplay of factors are thought to be responsible for the obesity crisis (Butland et al., 2007), reductions in physical activity play a role (Fox and Hillsdon, 2007). Health Survey for England (HSE) data from 2012 (Scholes and Mindell, 2013) show that 66% of men and 56% of women reported meeting the new Department of Health recommendations (Department of Health, 2011a) for physical activity. Although this seems encouraging, simply walking 'briskly' for around 11 minutes twice per day would be sufficient to meet these recommendations.

The previous version of the recommendations required at least 30 minutes of activity to be accrued in a day for it to be counted at all (Department of Health, 2004). In 2008, the HSE estimated that only 39% of men and 29% of women reported being sufficiently active to meet these recommendations (Craig et al., 2009). Alarmingly, a study undertaken in the same year – using accelerometers to objectively measure physical activity over a week (Chaudhury et al., 2010) – found that only 6% of men and 4% of women were meeting the recommendations. Less walking and cycling, labour saving devices in the home, an increase in sedentary leisure activities (television and computer use), and more time spent immobile at work have together resulted in considerable reductions in energy expenditure (Bauman, 2004). It has been estimated that the average adult expends 250-500kcal/day less now than 50 years ago (Fox and Hillsdon, 2007).

This is worrying, as physical activity is important to health for a number of reasons over and above weight maintenance. In the 1950s, Jeremy Morris (Morris et al., 1953; Morris and Crawford, 1958; Paffenbarger et al., 2001) was the first to definitively identify that physical activity was associated with all-cause mortality and cardiovascular diseases. Morris realised that in a society where occupations were becoming increasingly sedentary, physical activity undertaken in leisure time would need to substitute for occupational activity. The now famous Whitehall and Whitehall II studies investigated this possibility (Morris et al., 1973, 1980, 1990).

Exercise activities (running, swimming, cycling, etc.) were found to be far more beneficial to health than domestic activities (such as gardening or house work) and even work-like activities (such as DIY and building). Sustained, 'moderately vigorous' activity (reaching 7.5kcal/minute energy expenditure) was required to confer a significant health benefit (Paffenbarger et al., 2001).

Since these studies, a wealth of evidence has accumulated demonstrating the extraordinary benefits of physical activity, particularly activities that can be classed as exercise (Caspersen et al., 1985):

- reduced risk of developing type-2 diabetes, independent of weight loss (Sigal et al., 2004; Bassuk and Manson, 2005);
- a 30-45% lower risk of all-cause mortality in older age, the benefit increasing with age (Bauman, 2004);
- reduced risk of cardiovascular diseases, particularly ischaemic heart disease and stroke, due to reductions in the risk factors associated with these dis-

eases (Wannamethee et al., 2000; Lee and Skerrett, 2001; Press et al., 2003; Yu et al., 2003; Andersen et al., 2006);

- improved cardiovascular health in general, with increased heart rate variability, lower resting heart rate (De Meersman, 1993; Sandercock et al., 2005) and lower diastolic and systolic blood pressure (Whelton et al., 2002);
- reduced risk of cancers of the colon and breast (Wannamethee et al., 1993; Giovannucci et al., 1995; Thune and Furberg, 2001); and
- improved mental well-being (Steptoe and Butler, 1996; Strauss et al., 2001; Sacker and Cable, 2006; Johnson and Krueger, 2007). Exercise has even been recommended as a preventative measure for mild to moderate depression, and its effects on reducing stress and anxiety are well-supported (Fox, 1999).

In response to the obesity crisis, government has sought to increase levels of physical activity in the adult population. These attempts have faced a consistent obstacle in the limited scope available for intervention. The most common approach is to use public information campaigns, such as *Change4Life* (Mitchell et al., 2011) and the physical activity recommendations (Department of Health, 2004, 2011b), to encourage people to become more active. Other approaches include improving travel infrastructure to encourage active modes of travel (such as with the Barclays Cycle Scheme (Transport for London, 2012) and Cycle Superhighways in London (Transport for London, 2011)) and subsidising leisure facilities (by providing free swimming schemes and refurbishing local authority leisure centres, for example).

Unfortunately, these efforts tend to be largely ineffective. Public information campaigns tend not to influence exercise behaviour (Leavy et al., 2011; Abioye et al., 2013), and subsidisation tends to increase participation by those people who are already active. For example, funding for the free swimming programme was cut after government-commissioned research showed that up to 80% of swimmers in target groups (60 year olds and over, and 16 year olds and under) would have swum anyway in the absence of the scheme (PricewaterhouseCoopers LLP, 2010).

An alternative approach is to intervene with children using the educational system. Schools offer the ideal setting for mass intervention by government policy makers (Bassey, 2005) because attendance is compulsory, lasts for many years and is undertaken during a period of life thought to be amenable to behaviour change. Ever since Balfour's Education Act of 1902 (Parliament, 1902), government has sought to improve the health and fitness of children, and consequently the population, by including physical education and sport in school provision. As the obesity crisis has grown, physical education and school sport policies have been published with increasing frequency (Department of National Heritage, 1995; Department for Culture Media and Sport, 2000; Department for Culture Media and Sport and Strategy Unit, 2002; Department for Children Schools and Families, 2008; Department for Culture Media and Sport, 2012b). These policies are all based on one main assumption: getting children to participate in more sport in school will cause them to become physically active adults.

However, these policies are not solely focused on health and fitness; they also aim to foster sporting talent by providing children with coaching and routes into sport competition so they can become the "stars of the future" (Department for Education, 2013). For this reason, traditional, competitive sports (such as team games and athletics) are promoted above other forms of exercise. This preference for traditional, competitive sport has frequently been criticised in the academic literature. It is known that competitive sports have limited appeal to many children (Penney and Evans, 1997; Penney and Harris, 1997; House of Commons Education Committee, 2013) and it has been suggested that excluding other forms of exercise "is likely to be counter-productive in terms of promoting lifelong participation" (Green, 2004, p.81). In particular, traditional sports are known to be unpopular with girls (Kirk, 2005).

Considering the central role these policies play in efforts to increase physical activity, one might expect them to be supported by a wealth of research evidence. Surprisingly, this is not the case. Reviews of the research literature have consistently found that evidence linking child and adult physical activity is weak (Dishman et al., 1985; Trost et al., 2002; Bauman et al., 2002). Much of the research evidence is retrospective in design and suggests that the dominant childhood influence on adult exercise behaviour is parental and family socialisation into a physically active lifestyle (Birchwood et al., 2008; Marsh et al., 2010b; Haycock and Smith, 2012). This raises the possibility that a focus on competitive sport could exacerbate pre-existing differences in activity: children who are already active will enjoy and benefit from school provision, whilst less active children will accrue negative experiences and might develop self-perceptions of not being 'sporty'.

1.2 Aims

This research aims to identify how childhood experiences of sport and exercise translate to adult exercise behaviour, using quantitative methods applied to data from the 1970 British Cohort Study (Centre for Longitudinal Studies (CLS), 2014). Government policy assumes that getting children to participate in lots of traditional, competitive sport in school will cause them to become physically active adults (Department of National Heritage, 1995; Department for Culture Media and Sport, 2000; Department for Culture Media and Sport and Strategy Unit, 2002; Department for Children Schools and Families, 2008; Department for Culture Media and Sport, 2012b), and this will subsequently improve the health of the population. In contrast, the theory of family socialisation suggests that parental and family influences are the dominant childhood drivers of participation (Moore et al., 1991; Fredricks and Eccles, 2003; Birchwood et al., 2008; Haycock and Smith, 2012).

Consequently, the research presented in this thesis has two main aims:

- to test the assumptions inherent in government policy on school sport and physical education; and
- to fill a gap in the research literature by providing prospective, quantitative evidence on the link between childhood experiences of sport and exercise and adult exercise behaviour.

Government policy contains recurring themes that permeate the policy discourse. These provide an explanation as to why traditional, competitive sport continues to form the basis of policy. The research presented in this thesis tests the assumption that promoting competitive sport in school will result in lifelong participation in sport and exercise. By doing so, it aims to stimulate discussion in policy circles so that future policies aimed at encouraging physical activity in the general population might be more effective.

As previously mentioned, the majority of research on the link between childhood and adult exercise behaviour is retrospective (p.22). In contrast, the research presented in this thesis is prospective and ongoing, using data from the 1970 British Cohort Study (BCS70). The BCS70 follows a cohort of British citizens born in 1970 who reside in Great Britain. The main strength of this dataset is that variables relevant to the study of physical activity were collected both in childhood and adulthood – at ages 10, 16, 29 and 34[1]. Also, being a multi-purpose study, it contains a vast array of variables that can be used to control for confounding.

1.2.1 Research questions

The research presented in this thesis aims to answer the following main research questions using data from the BCS70:

1. Is the amount of school sport and physical education at age 10 associated with positive experiences of sport and exercise? Is there evidence of family socialisation into sport and exercise at this age?
2. How does participation in sport and exercise inside school compare to that outside school at age 16? Is the amount of participation associated with positive experiences at this age?
3. Are experiences of sport and exercise at age 16 associated with those at age 10? Is their further evidence of family socialisation into sport and exercise at age 16?
4. In what way are childhood experiences of sport and exercise associated with adult exercise behaviour?

The variables measuring adult exercise behaviour in the BCS70 at ages 29 and 34 are relatively simple. Therefore, in order to provide validation for their use as an outcome, an additional research question is answered in this thesis:

5. Is the measure of exercise behaviour at ages 29 and 34 associated with health outcomes?

[1]Recently, the BCS70 wave at age 42 has been released, which also contains variables relevant to physical activity research (Centre for Longitudinal Studies (CLS), 2014)

1.3 Structure

This thesis is structured as follows:

Government policy context This chapter reviews government policy documents to identify themes which shape school sport and physical education in Britain today. Although this policy does not cover the period during which the BCS70 cohort members attended school, it is shown that the type of provision being promoted is similar to that which the cohort members experienced.

Academic literature This chapter presents theories in the academic literature which provide a framework for this research. It then provides a review of empirical research on the correlates of physical activity and highlights limitations with the evidence base. Finally, it examines previous research which has specifically investigated the link between childhood experiences of sport in school and adult exercise behaviour.

Data and methods This chapter describes the 1970 British Cohort Study (BCS70) data used in this research. It explains which waves are used and why, the sample design and data collection procedures, the final sample achieved and issues relating to missing data. It also provides an overview of the statistical methods used in this research and why they have been chosen.

Experiences of sport and exercise at age 10 This chapter presents a cross-sectional analysis of BCS70 data when the cohort members were aged 10. It identifies whether there were differences in experiences of sport and exercise between the sexes at this age, and compares models based on physical education as an intervention with ones based on family socialisation and self-determination theory.

Experiences of sport and exercise at age 16 This chapter presents both a cross-sectional and longitudinal analysis. It examines school provision and how participation in particular activities varied inside and outside school by sex in the BCS70 at age 16. Derived measures of participation, motivation and physical self-concept are developed. Cross-sectional associations are briefly examined before concentrating on the longitudinal association of experiences at age 10 with those at age 16.

Adult exercise behaviour and health outcomes This chapter provides a slight detour from the main research focus. In order to validate the simple variables measuring adult exercise behaviour in the BCS70, it models the association of adult exercise behaviour with two health outcomes: body mass index (BMI) and psychological distress (measured using the Rutter malaise scale).

Childhood experiences and adult exercise behaviour This chapter presents the main findings of this research. It examines the way in which the cohort members' experiences at ages 10 and 16 are associated with adult exercise behaviour at age 34, controlling for a range of confounding variables.

Discussion This chapter summarises the findings of the research and discusses its implications. It then highlights the limitations of the research and includes some suggestions for future research.

Chapter 2

Government policy context

2.1 Introduction

This chapter reviews government policy documents in order to identify themes which permeate the policy discourse. These themes provide the basis for the assumption this research aims to test: that getting children to participate in lots of traditional, competitive sport in school will cause them to become physically active adults. Although there has been a proliferation of policy documents from the mid-1990s onwards, these do not directly relate to the period in which the BCS70 cohort members attended school. Therefore, this chapter ends by showing how the type of provision being promoted by government policy today is similar to that which the cohort members experienced at school. As a result, it is reasonable to suggest that the findings of this research are relevant to current government policy.

2.2 The Wolfenden gap

Ever since the 1950s, provision in schools has generally comprised a highly structured, sport-based, multi-activity form of physical education (Kirk, 1992; Donovan et al., 2006). Generally, government has sought to encourage children's participation in sport, aiming to maintain it as they grow into young adults. The main assumption of this approach is that active children will become active, healthy adults. In 1960, as a result of concerns that Britain was being left behind on the international stage in terms of sport infrastructure and international competitiveness (Jefferys, 2012), the Wolfenden report *Sport and the Community* (Wolfenden et al., 1960) was commissioned. This highlighted what became known as the 'Wolfenden gap' – the drop-off in the number of young people continuing to play sport after completing their compulsory education. It was thought that this drop-off was due to a lack of continuity between school and community provision.

The report suggested that by addressing this gap in provision, sports participation would be maintained into and throughout adulthood. However, more than 40 years later, it was still being discussed by a House of Commons Select Committee (Central Council for Physical Recreation (CCPR), 2005) and in government policy (Department for Culture Media and Sport and Strategy Unit, 2002). In the period between the work of the Wolfenden Committee and the late 1980s, there was a lull in political interest in sport. Largely, politicians were happy to leave sports bodies to manage sport provision and promotion, and control of funding was handed over to the Sports Council in the early 1970s (Jefferys, 2012). The obesity crisis had yet to fully emerge (National Obesity Observatory, 2010), and politicians tended to regard sport as peripheral to the concerns of central government (Jefferys, 2012).

In the late 1970s, questions arose as to the value of school sport and physical education in the curriculum. In 1977, the Munn Committee Report in Scotland came to the conclusion that physical education was a "non-cognitive" subject (Bailey et al., 2009). This pressure led to an "elaboration of the structuring discourses in physical education" by physical educationalists, PE teachers and philosophers (Kirk, 1992, p.156). As a result, physical education gradually became more technical, professionalised and academic, and increasingly focused on sports performance, skills development and tactical thinking (Green, 2001).

2.3 Sport: Raising the Game

As the obesity crisis began to emerge, central government intervened with legislation to ensure schools provided sport and physical education. In 1988, the Education Reform Act (Parliament, 1988) introduced the first National Curriculum, which included physical education as a compulsory 'foundation subject', but the first National Curriculum for Physical Education was not introduced until 1992, when John Major was prime minister. It was designed to ensure children participated in physical education and sport throughout compulsory schooling, and reached specific levels of ability by particular ages (McKinlay, 1993). It was formulated with input from several famous elite athletes. This approach was criticised as being as being akin to "asking a Formula 1 racing driver's advice on how to design a new public transport system" (Fox, 1992, p.8).

John Major was personally very keen on sport in schools. In 1995, *Sport: Raising the Game* (Department of National Heritage, 1995) was released, which began a trend of increasing government intervention in school sport and physical education. It asserted that sport had been relegated in schools and that the availability of facilities, playing fields and dedicated time had been in decline for many years. This assertion has now become widely accepted as fact, despite there being strong evidence to the contrary (Roberts, 1996). In fact, participation in sport by children has increased on average over the last three decades, despite concurrent decreases in physical fitness and increases in obesity (Stratton et al., 2007; Sandercock et al., 2010; Stamatakis et al., 2010). It seems that sport participation inside school has failed to counteract increases in sedentary behaviour outside school. *Sport: Raising the Game* focused on intervening at an early age to promote traditional, competitive sports on the basis that these helped to develop the qualities of sportsmanship (i.e. 'build character'), taught "healthy sporting habits" and would enable young people to "[adopt] a healthy and active lifestyle in future years" (Department of National Heritage, 1995, p.6).

Raising participation rates and encouraging lifelong participation were not the only goals however. Another core aim first introduced in *Sport: Raising the Game* (Department of National Heritage, 1995), was the identification and development of future elite sporting talent. The policy was released soon after high profile failures in the Olympic Games and football World Cup, and so fostering future sporting talent became a goal of school sport policy:

> "We must [...] ensure that individuals with talent are identified quickly and systematically and that we make proper provision to allow sporting talent to flower" (Department of National Heritage, 1995, p.34).

It set out the intention of establishing a British Academy of Sport for the talented and claimed that "the success of the talented will encourage others to strive to improve" (Department of National Heritage, 1995, p.34). It was suggested that schools could publish information on their sporting aims and achievements, as this would "provide pupils with an excellent incentive to try harder" (Department of National Heritage, 1995, p.12). The link between school provision and elite sport had been made explicit, and sports governing bodies now had an officially sanctioned influence on physical education and school sport.

2.4 A Sporting Future For All

A Sporting Future For All was published 5 years later by the Department for Culture, Media and Sport (Department for Culture Media and Sport, 2000) under Tony Blair's government. This strategy document sought to "widen participation" (Department for Culture Media and Sport, 2000, p.13), bringing sport to everyone and encouraging long term participation in all age groups and social classes, re-asserting the claim made in *Sport: Raising the Game* that "in too many schools physical education and sport have declined" (Department for Culture Media and Sport, 2000, p.7). The strategy made ambitious claims for the benefits of physical education and sport in schools: "sporting achievement and academic standards go hand in hand" (Department for Culture Media and Sport, 2000, p.8), physical education and school sport "enables all young people to develop physical skills, helps personal and social development" and "help to make sport and healthy exercise a lifelong habit" (Department for Culture Media and Sport, 2000, p.29).

It also maintained a strong focus on the identification of talent, seeking "more success for our top competitors and teams in international competition" (Department for Culture Media and Sport, 2000, p.5). The strategy introduced Specialist Sports Colleges that would be focused on elite sport. Any 14 year old pupils who had been identified as being talented sports people would be offered places and funding would be fast-streamed to enable the provision of the best facilities. "School sports co-ordinators" were introduced to raise standards in networks of primary schools. The strategy aimed to "professionalise the way sport is run" (Department for Culture Media and Sport, 2000, p.20) in order to encourage a progression to "higher levels of competition" (Department for Culture Media and Sport, 2000, p.13). The funding of sports governing bodies would become dependent on meeting performance targets related to the development of sport in schools and communities. Sport for the masses, rather than being an aim in itself, seemed to be a necessary initial step in the identification and development of the nation's elite sporting talent.

2.5 Game Plan

Two years later *Game Plan: a strategy for delivering Government's sport and physical activity objectives* (Department for Culture Media and Sport and Strategy Unit, 2002) was published. This 226-page Goliath example of 'evidence-based policy' contained research findings from many different sources, and sought to consolidate the goals of *A Sporting Future For All*. One of the overarching objectives of the report was "a major increase in participation in sport and physical activity, primarily because of the significant health benefits and to reduce the growing costs of inactivity" (Department for Culture Media and Sport and Strategy Unit, 2002, p.12). It stated that:

> "[...] government would most benefit from focusing on increasing levels of physical activity across the population to improve health. In addition, sport and physical activity in schools should remain a priority to improve health and physical literacy and engender lifelong participation" (Department for Culture Media and Sport and Strategy Unit, 2002, p.79).

The report also suggested how best to bridge the Wolfenden gap, recognising that individualistic, non-competitive activities (such as running, swimming, cycling, and walking/hiking, collectively referred to in the academic literature as 'lifestyle activities', Coalter, 1999) tend to be maintained from the teenage years into adulthood. The report set ambitious targets of 50% of the population engaging in healthy levels of physical activity by 2010 and 70% by 2020. Based on the old guidelines for physical activity (Department of Health, 2011b), the first target was missed and the second would never have been reached – for many years, the proportion meeting the recommendations had hovered around 35% (National Centre for Social Research (NatCen) and Department of Epidemiology and Public Health (UCL Medical School), 2012)[1].

Again, it was structured around an elite sport development objective: "a sustainable improvement in success in international competition, particularly in the sports which matter most to the public, primarily because of the 'feelgood factor'

[1]Now the recommendations have been changed (p.19), there is an outside chance that the 2020 target could be reached.

associated with winning" (Department for Culture Media and Sport and Strategy Unit, 2002, p.12). For 'evidence-based policy', little evidence was actually presented within the main body of the document to support this as a realistic objective. The 'feelgood factor' was described vaguely as the sense of euphoria in society due to a "victory or a better than expected performance" (Department for Culture Media and Sport and Strategy Unit, 2002, p.62), which was contrasted with "a possible 'feelbad' factor following a poor performance" (Department for Culture Media and Sport and Strategy Unit, 2002, p.63).

The report identified that creating this feelgood factor was risky due to its inherent unpredictability. Likewise, it stated that "statistics show little evidence that international success has a long term impact on levels of participation [in sport]" and "the available evidence [...] suggests that there is no automatic link between high levels of participation and international success" (Department for Culture Media and Sport and Strategy Unit, 2002, p.72). Despite this, it went on to conclude that "we need a system of talent identification and development to form a bridge between increased mass participation and success in international competition" (Department for Culture Media and Sport and Strategy Unit, 2002, p.73), thereby linking its two core objectives together, with mass participation feeding a system geared toward increasing success in international elite sport, despite the dubious benefits.

2.6 Recent policy and London 2012

More recently, the *PE & Sport Strategy for Young People* (Department for Children Schools and Families, 2008; Sport England et al., 2009) aimed to involve 5 to 16 year olds in "at least two hours high quality PE and sport at school each week; and create new opportunities for them to participate in a further three hours each week of sporting activity" (Department for Children Schools and Families, 2008, p.3). Its ambitions for older children were a little more modest: "to participate in three hours each week of sporting activities through their colleges or in local clubs" (Department for Children Schools and Families, 2008, p.3) – an acknowledgement that levels of participation tend to reduce with age. The strategy included a strong emphasis on inclusivity, with an intention to "provide a more attractive range of sporting activity based on what young people say they want" (Department for Children Schools and Families, 2008, p.5) and providing opportunities for normally excluded groups such as girls, the disabled, minority ethnic groups, children who are from poor families and overweight or obese children. The definition of sport used in the document is broad and includes "individual fitness and alternative sports that are increasingly popular with young people" (Sport England et al., 2009, p.9).

It also included a public service agreement to "deliver a successful [London 2012] Olympic Games and Paralympic Games with a sustainable legacy and get more children and young people taking part in high quality PE and sport" (Department for Children Schools and Families, 2008). Although the focus on competitive sport was toned down as compared with *Game Plan*, it still emphasised competitive sport, talent identification and performance development, stating that:

> "[...] every young person should have:
>
> - access to regular competitive sport
> - coaching to improve their skills and enjoyment
> - a choice of different sports
> - pathways to club and elite sport
> - opportunities to lead and volunteer in sport"
>
> (Sport England et al., 2009).

The current, coalition government, has continued this approach (Department for Culture Media and Sport, 2012b), but the broad, flexible, inclusive aspects of the Labour government's policies seem to have been sidelined and the targets (hours per week) have been scrapped (Gove, 2010). The most recent policy has re-asserted the primacy of traditional, competitive sport, with its emphasis on the legacy of the London Olympics, a national 'School Games' and a strong focus on participation in intra and inter-school competition in traditional sports (Department for Culture Media and Sport, 2012b). Indeed, it is very reminiscent of *Sport: Raising the Game* (Department of National Heritage, 1995). There has even been a resurgence of politicians asserting that competitive sport 'builds character' (Gove, 2014; Wintour, 2014). Arguments are made that these types of activity confer wide-ranging benefits beyond fitness: perseverance, determination, hard work, fair play, how to win and lose graciously, and how to lead and work as part of a team (Department for Culture Media and Sport, 2010a); benefits which seem strongly reminiscent of a public school ethos from the early 1900s.

The London 2012 Olympics have been a key feature of recent efforts to promote sport in schools. London won the opportunity to host the games on the promise that they would "inspire a generation" to participate in sport (Department for Culture Media and Sport, 2008, 2012a). Unfortunately, there is little evidence to suggest the games will have any effect on participation (Green, 2012; Bauman et al., 2013; Mahtani et al., 2013; Parry, 2013b). This should probably not surprise the government – 10 years earlier, *Game Plan* concluded that "the quantifiable evidence to support each of the perceived benefits for mega events is weak" (Department for Culture Media and Sport and Strategy Unit, 2002, p.66) and "it would seem that hosting events is not an effective, value for money method of achieving either a sustained increase in mass participation or sustainable international success" (Department for Culture Media and Sport and Strategy Unit, 2002, p.75).

Nevertheless, the focus in government policy on promoting competitive sport in schools is now, arguably, stronger than ever. It seems clear that the desire to foster national sporting talent in specific, traditional sports has resulted in the exclusion of other forms of sport and exercise. Many activities (such as recreational, outdoor/adventure, lifestyle and artistic physical activities) are not promoted, or actively discouraged (Press Association, 2012). Despite concerns being raised during a recent House of Commons Education Committee about the narrow focus on competitive sport in current policy (House of Commons Education Committee, 2013; Parry, 2013a), there is currently little sign that this will change in the near future. If anything, the focus on competition and traditional sports is strengthening, particularly in primary schools (Prime Minister's Office et al., 2014).

2.7 Government policy and the BCS70

None of these policies were released during the period in which the cohort members of the BCS70 attended school. Fortuitously, they can be compared with the provision the cohort members experienced. Government research was conducted during the period the cohort members attended school, which shows how school sport and physical education was structured. A survey of primary schools undertaken by Her Majesty's Inspectors of Schools in 1978 found that team games were "played in almost all the classes [surveyed]" (Department of Education and Science, 1978, p.69). Traditional educational gymnastics "with the emphasis on sensitivity and the ability to invent sustained sequences of movement" and a type of gymnastics "influenced by the British Amateur Gymnastic Association's award scheme" were also commonly taught (Department of Education and Science, 1978, p.69). Gymnastics was included in "well over four fifths" of curricula, and equipment was available in "nine out of ten classes" (Department of Education and Science, 1978, p.68). Swimming was also commonly provided, with provision increasing with the age of the children: at age nine, two thirds of children had swimming classes; at age 11 this rose to ~90% (Department of Education and Science, 1978, p.68).

A survey of state maintained secondary schools in England, undertaken by Her Majesty's Inspectors of Schools between 1975 and 1978 (Department of Education and Science, 1979), found that more than 90% of secondary schools included physical education and team games as part of their core curricula. In most of the remaining schools, where it was an optional part of the curriculum, almost all children still took part. Generally, around three or four school periods per week were taken up by team games, other traditional sports and physical education. Its centrality to school life in England at the time is demonstrated by the survey finding that "No other subject was found in the 'core' of virtually all the schools." (Department of Education and Science, 1979, p.22).

In comparison with provision today, the greatest difference relates to primary schooling. Gymnastics has now fallen out of fashion, and there has been an increasing focus on providing 'high quality' physical education, structured primarily around the development of physical literacy (Whitehead, 2010; Youth Sport Trust, 2013). There is now wide acceptance that specialised training is required for primary teachers to deliver physical education to young children (Kirk, 2012; Gibson, 2012). Secondary school provision, is relatively unchanged, still being primarily focused on traditional competitive sports. However, many schools now offer sports which were once gender-specific to both girls and boys (Quick et al., 2010).

Generally, the school provision experienced by cohort members seems to have aligned reasonably well with that being promoted by politicians and policy makers today. Although primary school gymnastics has disappeared, the extensive provision of traditional, competitive sports in both primary and secondary school accords well with the current aims of government policy. This provides some reassurance that the main assumption of policy – that getting children to participate in lots of traditional, competitive sport in school will cause them to become physically active adults – can be effectively tested by analysing data from the BCS70.

The following chapter reviews the academic literature relevant to this research. Theories relating to lifelong activity and psychology are presented; the correlates of physical activity are reviewed, and limitations with the evidence base are highlighted. Finally the chapter reviews the available evidence on the links between childhood activity and adult exercise behaviour.

In summary:

1. Government policy has consistently sought to increase children's participation in physical education and school sport in order to make them fitter, healthier and more likely to be active in adulthood.

2. Traditional, competitive sports have formed the core of school provision for decades, and continue to be promoted over other forms of physical activity.

3. Along with increasing participation by all, government policy also seeks to identify and develop future elite sporting talent from an early age, in order to foster success in international sports contests.

4. Competitive sports are believed to confer a variety of benefits in terms of 'character development' that other activities do not provide.

5. The provision experienced by the cohort members of the BCS70 during their school years was very similar to the kind of provision which is promoted by government policy today – i.e. largely comprising traditional, competitive sport.

Chapter 3

Academic literature

3.1 Introduction

A wealth of theoretical and empirical literature has accumulated which is relevant to the research presented in this thesis. This literature has developed in several, relatively isolated, disciplines: sociology, psychology and epidemiology. This chapter reviews this literature so as to provide a solid foundation for the research presented in this thesis. The review is broken down into several sections:

- **Theories of lifelong activity** – key theories describing how childhood participation in sport and exercise may translate into adult exercise behaviour are presented and discussed. These provide a conceptual framework for this research and also provide the basis for measures of participation;
- **Psychological theories** – theories related to psychological constructs of motivation, achievement goal formation and physical self-concept are described. These provide the basis for measures of subjective experiences of sport and exercise;
- **Correlates of physical activity** – the empirical research is reviewed to summarise commonly identified correlates of physical activity, which are used in this research to control for confounding;
- **Limitations with the evidence base** – some important criticisms that have been made of the academic literature on physical activity are highlighted in order to show how this research addresses them;

- **School sport and adult exercise behaviour** – finally, the relatively small amount of empirical research specifically aimed at addressing the link between experiences of school sport and adult exercise behaviour is reviewed, providing a clear justification for undertaking the current research.

3.2 Theories of lifelong activity

It is widely agreed that early learning experiences are important to encouraging lifelong activity (Health Education Authority, 1997; Rees et al., 2001; Green, 2002a, 2004; Kirk, 2004b, 2005). The accumulation of enjoyable experiences in a wide range of activities when young, and subsequent development of proficiency in preferred activities, is thought to support the maintenance of an active lifestyle in adulthood. Essentially, a portfolio of skills and positive experiences can be developed in childhood, which provide a resource from which the individual can draw throughout their lives, stimulating continued participation.

3.2.1 Family socialisation

Whereas government policy inevitably focuses on the benefits of 'high quality' physical education and school sport for children's participation in physical activity, the academic literature is increasingly focusing on the role of the family. It is thought that parental influence and the family 'culture' can normalise children into a physically active lifestyle (Moore et al., 1991; Fredricks and Eccles, 2003; Birchwood et al., 2008; Haycock and Smith, 2012), and this is a key determinant of whether this lifestyle is maintained into and across adulthood.

Parents who regularly participate in sport and exercise themselves provide an influential role model for their children (Haycock and Smith, 2012). Especially when very young, children observe, imitate and are reinforced by the behavioural norms they learn from their parents. Similarly, habitual behaviours developed during childhood tend to persist into adulthood, and so an active lifestyle may simply reflect this continuity (Roberts et al., 1991).

Apart from behavioural influences, parents can also provide practical and emotional support, investing their time and interest in supporting their children's participation in sport and exercise (Fredricks and Eccles, 2003; Kay, 2004; Haycock and Smith, 2012). Children who are provided financial support and transportation by their parents are more likely to have access to, and engage in, a wide variety of physical activities than those who do not (Health Education Authority, 1997; Rees et al., 2001). For young children, who are almost entirely dependent on their parents, this is particularly important in enabling access to highly organised activities such as team sports (Welk et al., 2003; Allender et al., 2006; Brockman et al., 2009; Trost and Loprinzi, 2011).

A potential implication of family socialisation into sport and exercise is the impact it might have on experiences in the school context. Children with very active family cultures will tend to develop fundamental motor skills more rapidly, and be more physically literate on entering school (Whitehead, 2001, 2010). Early experiences of successful participation may have a lasting impact on self-perceptions of ability and subsequent enjoyment of physical activity, especially as children come to realise between the ages of 8 and 12 that ability is not solely due to effort (Kirk, 2005).

The research presented in this thesis aims to identify whether family socialisation provides a good explanation for cohort members' experiences of sport and exercise in school, when they were aged 10 and 16, and their exercise behaviour in adulthood.

3.2.2 The Developmental Model of Sport Participation

Sport focused theoretical models have also been proposed, which attempt to structure how sports skills and participation develop from an early age (Côté, 1999; Balyi, 2002), and these have become popular in government policy and academia alike (Department for Culture Media and Sport and Strategy Unit, 2002; MacPhail and Kirk, 2006; Bailey et al., 2010). The *Developmental Model of Sport Participation* was proposed by Côté (1999; 2007) to explain the progression of young people from initial experiences of sport, to proficiency in a small number of sports, and then competitive specialisation in a specific sport. It consists of three sequential stages (adapted from Bailey et al., 2010; Kirk, 2005):

1. **Sampling (6 to 12 years):** children try out a wide range of sports in an informal and fun setting with friends. Fun and enjoyment are the main motivations for participation. A characteristic of this phase is 'deliberate

play', whereby a foundation of fundamental movement skills and tactical understanding is developed through participation;

2. **Specialisation (13 to 15 years):** children begin to focus on a smaller number of sports; perhaps only two or three. The motivations for participation start to change from fun and enjoyment to success in competition. A characteristic of this phase is 'deliberate practice' whereby children begin to formally train in order to improve performance. Enjoyment and deliberate play are still important aspects of this phase; and

3. **Investment (16+ years):** children become committed to achieving a high level of performance in a specific sport, training at a high intensity in order to achieve competitive success.

In practice, children can move on from the specialising phase in two additional ways: firstly, by 'dropping out' and becoming 'amotivated' (Kirk, 2005) to participate in sport in anything but a sporadic and infrequent basis; and secondly, by entering a recreational phase which involves participating for fun in informal settings, with little regard for performance or competitive success.

It is clear that these models ultimately structure physical education around a goal of highly invested, competitive performance in sport. It has been suggested that this focus might be detrimental to lifelong participation for many children (Kirk, 2004a). Those who do not wish to move on to the investment phase, preferring to participate recreationally, may be put off sport in school if they are not given the opportunities to participate in a non-competitive way.

The stages of the *Developmental Model of Sport Participation* are used in this research to inform the development of measures of participation in sport and exercise at age 16. There are a large number of variables available in the BCS70 at this age, which identify a multitude of sport and exercise activities cohort members participated in, frequently and infrequently, both inside and outside school. Frequent participation in these activities (suggestive of specialisation) are used to measure sport and exercise activity at age 16.

3.2.3 Competitive sport, lifestyle activities and activity choice

It is thought that the types of activities made available to children in school can have a significant impact on enjoyment and motivation to participate. Although many children enjoy sport in school, these activities do not appeal to all (Penney and Evans, 1997). It has been suggested that promoting them above other forms of participation “is likely to be counter-productive in terms of promoting lifelong participation” (Green, 2004, p.81). Despite this, both curricular and extra-curricular provision are frequently focused on competitive participation in a small number of gender-specific, traditional sports (Penney and Harris, 1997; Smith et al., 2009).

Even for those children who are keen on competition, specialisation too early or focusing on too few activities may be detrimental to lifelong participation (Kirk, 2004b, 2005), providing a portfolio which is too narrow to rely on in future. Green (2002a) has suggested that proficiency in three or more activities, preferably including ‘lifestyle activities’ (Coalter, 1999), may be necessary to provide an adequate portfolio of skills and experiences for lifelong participation.

Lifestyle activities are those which are “individual, flexible, non-competitive and fitness-oriented” and are particularly popular with adults (Coalter, 1996, cited in Green, 2002a). Table 3.1 shows the most popular ten activities for men and women in Great Britain, based on the 2002 General Household Survey (Fox and Rickards, 2004). The majority of these activities are lifestyle activities. The only traditional team game that is popular amongst men is football; for women, no team games are popular. Indeed, only a small proportion of adults play competitive sport at all (Kirk, 2005).

Lifestyle activities are also increasingly popular with children (Coalter, 1999) but are not traditionally provided in schools. Ever since the 1950s, provision in schools has generally comprised a highly structured, sport-based, multi-activity form of physical education (Kirk, 1992). Generally, traditional, competitive sports are preferred (Green, 2000, 2002a,b). The range of activities made available to boys and girls are often highly differentiated. For boys, football, rugby and cricket are more frequently provided; for girls, hockey, netball, rounders and dance are more common (Sport England, 2003, p.25). However, some activities tend not to be differentiated by sex (such as tennis, athletics and swimming).

Table 3.1: Top ten sports, games and physical activities for men and women in Great Britain, based on the 2002 General Household Survey

Men	%	Women	%
Walking	36	Walking	34
Snooker/pool	15	Keep fit/Yoga	16
Cycling	12	Swimming	15
Swimming	12	Cycling	6
Football	10	Snooker/pool	4
Golf	9	Weight training	3
Weight training	9	Running	3
Keep fit/yoga	7	Tenpin bowling	3
Running	7	Horse riding	2
Tenpin bowling	4	Tennis	2

Note: adapted from Fox and Rickards (2004, p.7)

Government policies have consistently encouraged this highly structured approach, with a concentration on performance improvement, competition and traditional sports, taught in a directive style (Department of National Heritage, 1995; Department for Culture Media and Sport, 2000; Kirk, 2005). Research into PE teachers' views of their subject (Green, 2002b; Green and Thurston, 2002) suggest that these policies serve to entrench teachers' pre-existing sporting ideologies, despite PE teachers also being concerned with promoting the enjoyment of sport amongst pupils (Green, 2000).

The activities available in schools, and the manner in which they are provided, do not accord with the way in which the overwhelming majority of people participate in physical activity. The proportion of young people who go on to compete at an elite level is vanishingly small (<1%), yet government policy and school provision seems aimed toward this minority: maximising performance and competitive success in an array of sports that (outside of the school context) are mostly practised by elite athletes.

In recent decades, there has been a gradual move to supplement the range of activities available in schools with other activities – frequently lifestyle activities. Evidence suggests that this is appreciated by many children (Smith et al., 2009) and may have influenced the small rise in participation levels by children and adults (Green, 2002a; Green et al., 2005). By providing more choice, children are more likely to find an activity they enjoy and become proficient in. For those who do not find competitive sports appealing, alternative activities that do not involve direct competition may provide an effective way to retain and encourage their long term participation, providing a resource on which to rely in future. Thus, continuity might be able to form between school participation and active lifestyles in adulthood, built on a foundation of enjoyable, varied experiences.

In this research, a typology of activities is developed at age 16 in order to incorporate the notion of activity choice into the study. The large number of variables measuring participation in particular activities at this age are used to develop measures of participation in lifestyle, team and (competitive) individual activities. By doing so, the long term influence of activity choice at age 16 on adult exercise behaviour can be determined.

In summary:

1. It is thought that positive, varied childhood experiences of sport and exercise are important to promoting lifelong participation.

2. Parental influence, support and the family 'culture' are thought to be important determinants of whether children are normalised into a physically active lifestyle.

3. Children who are already physically active due to family socialisation may be more likely to have positive experiences in school.

4. 'Sampling' a wide variety of activities when very young and then going on to develop proficiency in several (termed 'specialisation') is thought to provide a portfolio of skills and experiences beneficial to lifelong participation.

5. Many children do not enjoy competition, and so a strong focus on competitive sports may be detrimental to lifelong participation for these children.

6. Ensuring children experience 'lifestyle activities' – not generally provided in school – may be beneficial to lifelong participation.

7. Adults do not generally participate in competitive sports, but tend to take part in lifestyle activities.

8. School provision is often focused on traditional competitive sports that are highly gendered.

9. PE teachers' often have sporting ideologies focused on competitive performance in traditional sports, which are reinforced by government policy.
10. Providing a wide variety of activities in school (including non-competitive options) may be more likely to promote lifelong participation.

3.3 Psychological theories

Several psychological theories have been particularly productive to the study of participation in sport and exercise. Three are exploited in this research:

- Self-Determination Theory (Ryan and Deci, 2000a,b);
- Achievement Goal Theory (Nicholls, 1984; Nicholls et al., 1989); and
- Physical Self-Concept Theory (Marsh, 1996a,b).

3.3.1 Self-Determination Theory

Self-Determination Theory has been widely used to explain why people are motivated to participate in physical activity. It posits two main forms of motivation: intrinsic and extrinsic. Intrinsically motivated activity is that which satisfies basic psychological needs for feelings of competence, autonomy and social connection (Ryan and Deci, 2000b). It is typified by enjoyment, personal choice, interest and investment[1], and is associated with long term participation in physical activity (Trost et al., 2002; Teixeira et al., 2012).

Qualitative evidence has shown that young children participate in physical activity primarily for reasons associated with intrinsic motivation: it's fun and they get to socialise with friends (Kirk, 2004a; Allender et al., 2006). In contrast, extrinsic forms of motivation involve 'separable outcomes' and can vary considerably in their relative autonomy (Ryan and Deci, 2000b); at one extreme, a child might participate because they value fitness and health and see it as a way to achieve

[1]'Investment' in this case is not to be confused with the investment stage of the *Developmental Model of Sport Participation* (Côté, 1999; Côté et al., 2007).

these personal goals; at the other extreme, a child may be forced to participate as part of compulsory schooling. One can see how a child that is experiencing feelings of incompetence may end up amotivated by compulsory, competitive school provision, and could be put off sport and exercise.

In this research, self-determination theory has been used to develop several models of sport and exercise experiences in the cross-sectional analysis at age 10. There are measures of intrinsic motivation available in the BCS70 at both ages 10 and 16. The models presented in the final empirical chapter estimate the long term association of these measures with adult exercise behaviour.

3.3.2 Physical Self-Concept Theory

Retrospective, qualitative investigations (Coakley and White, 1992; Thompson et al., 2003; Allender et al., 2006; Strean, 2009) have shown that negative experiences of sport at school can have long-lasting detrimental impacts on the way people perceive their physical self. *Physical Self-Concept Theory* posits that we each have a set of inter-related self-perceptions or self-evaluations relating to physical ability, physiology, condition and involvement in physical activity (Hagger et al., 2005).

The most popular theoretical models for physical self-concept are multi-dimensional and hierarchical, containing several sub-domains which are measured using multiple question items. Two examples of instruments which have been developed to measure these sub-domains are the *Physical Self-Perception Profile* (PSPP, original (Fox and Corbin, 1989) and revised (Lindwall et al., 2011) versions) and the *Physical Self-description Questionnaire* (PSDQ, long (Marsh, 1996b) and short (Marsh et al., 2010a) versions).

The PSPP measures the sub-domains of perceived sports competence, body attractiveness, physical strength and physical condition. The PSDQ separates out some of these and adds additional sub-domains by including factors for perceived strength, body fat, levels of physical activity, endurance/fitness, sport competence, coordination, health, appearance and flexibility.

Physical self-concept is thought to have an important reciprocal relationship with physical activity – i.e. being physically active can improve physical self-concept, and high physical self-concept can help to maintain participation. Compulsory schooling is undoubtedly a crucial period of development and reinforcement of physical self-concept for children. They enter into an environment in which they can continually assess their appearance, physical abilities and behaviours against a large number of peers. These assessments are reinforced in particular sub-domains by the school system, which values competitive performance, provides formal assessment and rewards achievement.

In these settings, perceived ability or competence may be particularly important (Ryan and Deci, 2000b). Perceived ability has been found to influence intrinsic motivation to participate in physical activity (Carroll and Loumidis, 2001; Papaioannou et al., 2006; Cairney et al., 2012; Gråstén et al., 2012), and can mediate the relationship between participation and intrinsic motivation – i.e. people enjoy, and are motivated to participate in, activities they feel competent at, and conversely, feelings of incompetence can impede enjoyment and discourage participation. Importantly, in competition against others, these perceptions are judged on a relative basis – a child who is objectively fit and skilful can nevertheless have low perceived ability if competing against children who are stronger, faster or more skilful (Chanal et al., 2005).

In this research, the effect of cohort members' perceived ability on their enjoyment of sport has been examined in the cross-sectional analysis at age 10. At age 16, there are several variables relating to cohort members' physical self-perceptions. These have been used to develop measures for particular sub-domains of physical self-concept. The models presented in the final empirical chapter estimate the long term association of these measures with adult exercise behaviour.

3.3.3 Achievement Goal Theory

Schools are generally keen to promote a strong sporting ethos. If not carefully managed, a highly competitive sport 'climate' can foster perverse achievement goals. *Achievement Goal Theory* posits that there are psychological orientations to the pursuit of goals (Nicholls, 1984), and these are applicable to physical education and school sport contexts (Treasure and Roberts, 1995; Harwood and Biddle, 2002; Pintrich et al., 2003; Senko et al., 2011). Achievement goal orientations are influenced by children's individual personalities and the motivational climate promoted by the school and teachers.

The two main achievement goal orientations are known as ‘task’ and ‘ego’ orientations (Nicholls, 1984; Nicholls et al., 1989). Task (also known as mastery) orientation involves a self-referential approach to goals, whereby the aim is to learn and improve on one’s own ability. In contrast, ego (also known as performance) orientation involves externally referenced ability, whereby outperforming others with minimal effort is the aim.

Research has consistently found that the adoption of a task orientation fosters continued participation in physical activity (Papaioannou, 1995; Standage et al., 2003; Harwood and Biddle, 2002), because a sense of personal achievement is not dependent on continuous competitive success. Task orientation encourages children to seek out challenging experiences, whereas ego orientation can encourage risk aversion (Harwood and Biddle, 2002). Importantly, activities can inherently vary in their dominant orientation. For example, learning tricks on a skateboard is highly task focused, whereas team games are susceptible to the promotion of an ego based climate, because winning is the main aim.

Because they tend to be non-competitive, lifestyle activities are usually task orientated. In contrast, the types of activities which are commonly provided in schools (such as team games and competitive, individual activities) are much more likely to foster an ego orientation to achievement goals. Likewise, schools, teachers and pupils are often complicit in the promotion of an ego based climate. The research presented in this thesis draws on achievement goal theory to interpret model estimates at ages 10 and 16.

In summary:

1. In self-determination theory, individuals are intrinsically motivated to participate in activities which satisfy the basic psychological needs for feelings of competence, autonomy and social connection.
2. Intrinsic motivation is typified by enjoyment, personal choice, interest and investment.
3. Extrinsic motivations vary in their degree of autonomy, but are likely to discourage participation where they involve coercion.
4. During the school years, children pass through crucial developmental stages, where their physical self-concept is formed and reinforced through continual peer comparison.

5. Negative self-perceptions developed at school may have a substantial and long-lasting impact on motivation to participate in sport and exercise.

6. In the competitive school environment, perceived ability may be particularly important to intrinsic motivation and ongoing participation in sport and exercise.

7. Achievement goals can be either self-referenced (task orientated) or peer-referenced (ego orientated), and competitive sports may be particularly susceptible to ego orientation.

3.4 Correlates of physical activity

A very large body of literature has accumulated on the correlates of physical activity over the last few decades, the majority of it based on cross-sectional research. In order to examine whether childhood experiences of sport and exercise are associated with adult exercise behaviour, it is necessary to understand what other possible correlates of physical activity exist. These can then be included in models as controls to reduce the risk of confounding. This section provides a summary of these correlates, focusing mostly on those which are consistently associated with physical activity across studies, suggesting that causal processes may be involved. Broadly, these correlates can be grouped as follows:

- demographic factors – age and life stage, sex and gender, ethnicity;
- socioeconomic factors – social class, income, education;
- physiological factors – maturation, weight status, disability, limiting illness;
- social factors – influence of parents, friends, partners;
- health behaviours – diet, smoking; and
- environmental factors – facilities, green space, seasons, weather.

This review primarily draws on systematic reviews of the quantitative research literature. The causal processes thought to underlie associations are elaborated upon with reference to qualitative evidence and theory.

3.4.1 Demographic factors

Age and life stage

During very early childhood, age is not associated with levels of activity (Biddle et al., 2011). The first point at which a change in activity levels tends to occur is on transition to secondary school (Thompson et al., 2003). The increase in size of school (i.e. a larger peer group) combined with a greater focus on performance may contribute to this. As children reach adolescence, changes in level of activity with age become pronounced. Participation decreases (Henning Brodersen et al., 2007) and, during the final years of compulsory education, a significant cessation of school participation occurs (Quick et al., 2010).

It has been suggested (Green, 2002a) that adolescence is a time at which a wide variety of leisure activities are sampled and many are then quickly dropped or replaced. Various social and academic commitments become an increasing priority. Socialising with peers and the opposite sex become primary motivations as sexual maturity develops (Allender et al., 2006). Qualitative investigations have found that young adults can begin to regard physical education as “babyish” (Coakley and White, 1992), where activities do not fit well with their developing adult identities. Also, as they progress through school, opportunities to participate tend to become increasingly focused on performance and competition, which may serve to exclude those who are less able (Thompson et al., 2003; Kirk, 2004a).

When young people leave the school environment, participation frequently ceases during the transition from adolescence to adulthood, for which the term the “Wolfenden gap” was originally coined. The main cause of this cessation is that participation becomes entirely self-motivated. Those with little motivation for sport and exercise are unlikely to seek out opportunities to participate. In essence, school provision boosts participation levels beyond their natural equilibrium (Birchwood et al., 2008).

For adults, increasing age causes the body to gradually become less flexible, less muscular, and more prone to injury. At older ages (60+ years), participation in many of the sports and activities of youth is a physical impossibility, and low impact and intensity alternatives become the preferred choices (Long, 2004). According to cross-sectional data from the Health Survey for England (HSE, National Centre for Social Research (NatCen) and Department of Epidemiology and Public

Health (UCL Medical School), 2012), there is a slow, gradual decline in the proportion of adults meeting the guideline recommendations from early adulthood until middle age, at which point the rate of decline steadily increases.

Estimates based on multivariate models of sports participation tend to demonstrate an initially large decline with age, which gradually flattens out (Marsh et al., 2010b). The proportion of the UK population that falls into the older age group is growing as people live longer. As a result, if the association with age does not change markedly over calendar time, the proportion of the population that is inactive will grow. Seeing as the research presented in this thesis is based on cohort data, it inherently controls for age, as relevant data are collected at specific ages (10, 16, 29 and 34).

Sex and gender

Sex is known to have a consistent association with levels of participation in mid to late childhood, with girls generally being less active than boys (Biddle et al., 2011). This disparity does not exist in very early childhood (<6 years, Hinkley et al., 2008), but by adolescence it becomes a consistent phenomenon across studies (Sallis et al., 2000).

For girls in particular, the physiological changes they go through during puberty seem to be a strong driver of desistance from physical activity. Qualitative research suggests that girls become much more self-conscious on entering puberty (Coakley and White, 1992; Thompson et al., 2003) and are also influenced by prevailing gender stereotypes (Eccles and Harold, 1991; Stevenson, 2002). It is common for girls to perceive being physically active or 'sporty' as unfeminine (Rees et al., 2001; Allender et al., 2006; Evans, 2006). More generally, the provision of opportunities to be physically active is gendered in society.

Certain activities are generally regarded as feminine (such as hockey, dance, netball, etc.) and others as masculine (football, rugby, cricket, etc., Fox and Rickards, 2004). This stereotyping also occurs in schools, which frequently provide gender-specific sport and activity options. Despite recent efforts to counter this phenomenon, it remains pervasive and PE teachers are frequently complicit in the promotion of gendered activities (Smith et al., 2009). Traditional sports, in particular, have been criticised for being dominated by a masculine perspective, involving a discourse of competition and elitism that is inherently excluding of stereotypically feminine qualities (Stevenson, 2002; Kirk, 2004a, 2005).

Similarly, adult women are generally less active than men. The gender gap established by adolescence continues throughout adulthood (Bauman et al., 2002). Certain activities are more popular among women and are generally regarded as feminine (such as aerobics, yoga, dance, etc.) and others are more popular among men and are generally regarded as masculine (weight training, football, rugby, etc., Fox and Rickards, 2004; Department for Culture Media and Sport, 2010b).

Adolescent and adult women commonly report weight loss as a primary motivation for exercising (Foster et al., 2005). These motivations are reflected in the predominant gender stereotypes in western societies. For women, this is a very slim, ultra-feminine form, and for men a muscular, ultra-masculine form. Competitive sport, due to its inherent relationship with performance and strength, tends to be positioned toward the masculine end of this spectrum.

People who do not conform to some kind of sporting stereotype may be discouraged from participation in sport and exercise, particularly in social contexts (Allender et al., 2006). The gendered construction of sport and exercise pervades our culture; it is inherent in school provision, print media, advertising and television coverage of sport, which tends to be overwhelmingly dominated by male competition (Godoy-Pressland, 2014).

Another possible reason for women being less active than men is that they also remain the primary caregivers for children within the family unit, and so the time and work burden of caring frequently falls primarily to them (Kay, 2004). Additionally, studies looking at the sharing of housework have shown that women spend more time than men on housework (Gershuny and Robinson, 1988; Kan et al., 2011), even when both are working full-time. Childcare and domestic responsibilities, particularly for women, may reduce the time available for exercise.

In practice, it can be challenging to separate the influence of sex in a physiological sense from gender as a stereotype or social construct. The research literature frequently conflates the two. Differences in physiology might be expected to impact preferences in terms of sport and exercise, but it is generally accepted that gender stereotypes are pervasive in society, and the main driver of differences in participation and preference. From a very early age, children tend to be influenced by and adhere to social norms for masculine and feminine preferences, which are often reinforced by their parents and other adults (Witt, 1997; Miller et al., 2009; Zosuls et al., 2011).

Because of the well-established importance of sex and gender to experiences of sport and exercise, both in the school setting (through gendered activities) and in wider society, the research presented in this thesis analyses the cohort members' experiences of sport and exercise by sex. In so doing, it is able to control for sex and compare the experiences of male and female cohort members in detail.

Ethnicity

Some studies have found that ethnic minority children are less likely to participate in sport and exercise than white children (Health Education Authority, 1997; Van Der Horst et al., 2007; Biddle et al., 2011), but associations are inconsistent across studies. Adults in some ethnic groups are also less likely to participate in physical activity (Higgins and Dale, 2010). Some cultures promote traditional gender roles, and this may explain low levels of physical activity in the female Pakistani and Bangladeshi communities in particular. One issue with UK based evidence is the strong likelihood of confounding with socioeconomic factors (NICE, 2007). The research presented in this thesis does not investigate associations with ethnicity, because the BCS70 cohort contains very few individuals from ethnic minorities.

3.4.2 Socioeconomic factors

Socioeconomic factors are inconsistent correlates of physical activity in children (Van Der Horst et al., 2007; Biddle et al., 2011). However, a great deal of qualitative evidence has found that children who are provided financial support and transportation by their parents are more likely to have access to and engage in a wider variety of physical activities more regularly than those who do not (Health Education Authority, 1997; Rees et al., 2001). This may be important in enabling children to participate in organised activities as, particularly when very young, children are entirely dependent on their parents (Welk et al., 2003; Allender et al., 2006).

Children from high socioeconomic status families are also more likely to attend schools that have better facilities for sport and physical education, and greater extra-curricular provision (Kay, 2004). It is also possible that parents from high socioeconomic status backgrounds are more likely to encourage participation in their children and participate themselves, due to a normative subculture, leading to intergenerational transmission of physically active lifestyles (Birchwood et al., 2008; Kirk, 2005; NICE, 2007).

In contrast with children, socioeconomic status and education are consistently correlated with adult physical activity (Bauman et al., 2002; Trost et al., 2002). Financial advantage may confer an ability to afford access to a wider variety of opportunities for adults to be active. Ready access to a car can make participation in club sports and gym activities more convenient. Gym or sports club membership and sports equipment is often expensive, and the quality and availability of facilities may also vary geographically with level of deprivation (Rowe et al., 2004). Similarly, social norms in a particular socioeconomic group may foster participation.

Education is highly correlated with social class and also with physical activity (Trost et al., 2002). It had commonly been presumed that a high level of education may increase the knowledge individuals have of the health benefits and risks of particular lifestyle choices, and therefore allow them a greater ability to control their actions. The current consensus is that this is not the case, however, with reviews now finding that there is no consistent relationship of knowledge of health and exercise with physical activity behaviour (Trost et al., 2002). Thus, alternative hypotheses attempt to explain the correlation by suggesting that extended periods in educational settings may simply increase the duration of time that individuals have easy access to organised activities and sports, in a similar fashion to those provided by schools, acting to smooth the transition from highly organised school provision to proactive choice as a working adult (Rowe et al., 2004).

Currently, it seems that there are no definitive causal explanations in the research literature for the associations of socioeconomic factors with sport and exercise participation. Ultimately, this area requires much further elaboration in future. The research presented in this thesis controls for confounding by social class, income and education in the final models presented in each empirical chapter.

3.4.3 Physiological factors

Children begin to realise between the ages of 8 and 12 that ability is not directly related to effort (Kirk, 2005). Along with innate ability and inherited physiology, maturation and weight status are additional physiological factors which affect perceived ability and participation (Health Education Authority, 1997; Kirk, 2004a).

When puberty begins, the difference between the maturational age of children in the same school year can be vast, with growth spurts occurring any time between 10.5 and 16.5 years in boys, for example (Stang and Story, 2005). Add in month of birth effects (where the youngest children in the year group are up to a year younger than the oldest, Wattie (2013)) and any competitive participation within year group will be systematically biased. These differences can have a big impact on experiences of competition and physical activity in general (Thompson et al., 2003).

The evidence linking physical activity to weight status in children is inconclusive but strongly suggests that the amount of physical activity is not the primary determinant of weight status (Biddle et al., 2011) or weight gain over time (Wilks et al., 2011). However, overweight children are more likely to be bullied in primary school (Griffiths et al., 2006) and can develop a negative body image (Reulbach et al., 2013). As a result, overweight tends to discourage participation in physical activity.

In adults, weight status is generally associated with physical activity. Levels of physical activity tend to reduce with increasing overweight (Trost et al., 2002). Overweight makes physical activity more uncomfortable and difficult, which can lead to a vicious cycle of reduced activity and further weight gain (Golubic et al., 2013). Body size and shape, along with obesity risk, are to a large extent genetically determined, and so may be less modifiable than is commonly supposed.

Adiposity is amongst “the most heritable of human traits” (Farooqi and O’Rahilly, 2007), with between 45% and 75% of variation in body mass index likely due to heritable factors. One of the reasons that professional sports people tend to make poor role models for the general public (Allender et al., 2006) is that they attain physiques that are unachievable by most people, built on inherent genetic advantage coupled with full-time training.

Disability and limiting illness may also affect participation. Disabled people in the UK are not as active as the rest of the population (Department for Culture

Media and Sport, 2013), and this may reflect a lack of appropriate opportunities to participate (London Assembly, 2012). Opportunities tend to be more limited and less varied for the disabled, and they may need special assistance and facilities to participate effectively (Finch, 2001). However, the quantitative evidence generally finds no association of illness with activity levels in adults (Bauman et al., 2002; Trost et al., 2002).

The final analyses presented in each empirical chapter of this research control for early maturation in childhood, and weight status and disability/limiting illness in both childhood and adulthood.

3.4.4 Social factors

Apart from the influence of parents and family, children are also influenced by their peers. Having the opportunity to socialise with friends is a key motivator for participation in leisure activities, whether physical or sedentary (Kirk, 2004a; Allender et al., 2006). For adults, cohabitation and child rearing are associated with levels of activity (Popham and Mitchell, 2006). For married or cohabiting adults, the support of a partner can help to maintain a physically active lifestyle (Trost et al., 2002).

Caring for children, on the other hand, is generally associated with lower levels of sport and exercise activity (Kay, 2004). For mothers, the presence of a supportive partner who is willing to share childcare responsibilities may negate this effect. More generally, frequent, long term involvement in sport and exercise activities is encouraged by joint participation with friends and partners (Trost et al., 2002). Just as with children, socialising and having fun can be a key motivating factor for adult participation in physical activity (Allender et al., 2006).

There is limited scope in the BCS70 to control for the influence of peer and partner activity on cohort members' experiences of sport and exercise. In adulthood, variables measuring whether the cohort member cohabits, is married and/or has children in the household are controlled for, but the BCS70 does not contain measures of peer/partner activity.

3.4.5 Health behaviours

Physical activity in children and adolescents is associated with other health behaviours such as eating a healthy diet and not smoking (Biddle et al., 2011). Health related behaviours are also correlated with one another in adults. Physical activity has been found to consistently correlate with eating a healthy diet, and is also correlated with non-smoking (Trost et al., 2002). One might assume that knowledge of the health risks associated with certain behaviours was responsible for this, but awareness of health risks is not consistently associated with activity patterns, and is not usually reported as the main reason for people being physically active (Allender et al., 2006).

The research presented in this thesis incorporates controls for smoking at age 16 and in adulthood, and some basic dietary controls are incorporated into the analysis of health outcomes in adulthood.

3.4.6 Environmental factors

Generally, there is weak evidence of associations of activity levels with facilities and characteristics of the environment, and almost none in the UK (Bauman and Bull, 2007). This area of research is relatively new and is still developing. Amongst children, time spent outside is correlated with activity levels, but access to facilities and availability of opportunities to participate in physical activity may also be important (Biddle et al., 2011).

For adults, the evidence base is also quite inconsistent. There is some evidence that the availability of facilities is associated with participation, but perceptions of availability may be just as important. The most stable associations are related to the seasons, as the temperature, daylight hours, and precipitation levels vary throughout the year (Trost et al., 2002). For example, cycle commuting is much more popular in the spring and summer than in autumn and winter in the UK (Transport for London, 2013).

Better weather makes being active outside more pleasant, increases the variety of activities available, and may negate the need to pay for access to indoor facilities. There is also some evidence that the aesthetics, population density, proximity of shops and services, and the design of pedestrian routes in the environment can affect levels of activity (Bauman and Bull, 2007).

As with social factors, there is limited scope to control for environmental factors in the BCS70. At ages 10 and 16, an effort has been made to control for the school environment using proxy measures. On the whole, the inconsistent findings of the research literature in this area provide some reassurance that the impact of this should be minimal. Similarly, most of the measures of experiences of sport and exercise in the BCS70 relate to the last year, rather than being specific to a season, current weather, etc.

In summary:

1. There are many correlates of physical activity that have been identified in the research literature.
2. For some of these correlates, the evidence is more consistent and robust than for others.
3. The correlates for which evidence is consistent and robust include age, sex/gender, physiological factors and (for adults) socioeconomic factors.
4. The correlates for which evidence is less widely available and consistent include social factors, health behaviours and environmental factors.
5. The correlates often vary in their strength of association with physical activity depending on age and sex, making these the most important correlates to control for.
6. There are many other correlates in the research literature, which tend to be sporadically incorporated into studies.

In the final models presented in each of the empirical chapters of this thesis, variables have been incorporated in order to control for confounding by the correlates of physical activity wherever possible. Being a large scale, multi-purpose study, the BCS70 contains a vast array of variables which can be used for this purpose. However, in one or two cases, either no measures were available or proxies have been used. The specific control variables used are described in detail in each of the empirical chapters.

3.5 Limitations with the evidence base

Several of the correlates described above are not consistent across studies. There are also many other correlates in the literature that are sporadically included and not widely supported. These characteristics reflect the inherent complexity and proliferation of physical activity research. Generally, the correlates included in a study are dependent on the discipline within which the research is situated. This variety and proliferation has been both a benefit and a hindrance to progress. Many factors have been found to be associated with physical activity, but research has not progressed much farther than this.

Bauman et al. (2002) have highlighted that the failure to discern causal relationships is a major deficiency in the research literature. They suggest that causal mechanisms should be clearly stated with reference to hypothesised causal pathways. By operationalising and testing these pathways using appropriate research methods, concrete progress could be made. Additionally, the majority of physical activity research is cross-sectional and so does not allow temporal ordering to be discerned. The authors list several criteria which are necessary for the deduction of causality (adapted from Bauman et al., 2002, p.7):

- strong associations, replicated across studies, which suggest that causal mechanisms are possibly functioning;
- the temporal sequence needs to be correct;
- stronger causal evidence is provided by a pattern between the determinant and activity level which is analogous to a dose-response relationship; and
- the causal model needs to be conceptually plausible.

Of these four characteristics, only the first has truly been achieved. In order to make further progress with physical activity research, prospective, longitudinal designs are vital. Cross-sectional research can only result in the estimation of concurrent associations, whereas longitudinal designs can allow causal ordering over time and long term associations to be explicitly examined (as is the case in the research presented here).

The majority of research in the literature is limited to identifying correlates based on a discipline-specific theory and mostly fails to elucidate whether these correlates are likely to be moderators, mediators or confounders in causal pathways.

Bauman et al. (2002) also note that the lack of cumulative progress may be a function of the complexity of physical activity behaviour: "[it may be that] physical activity is too complex a behaviour to be encompassed by a single theory" (Bauman et al., 2002, p.12).

The research presented in this thesis aims to tackle the concerns raised by Bauman et al. (2002) by using robust quantitative methods and taking a multi-disciplinary perspective. The methods used are specifically suited to providing insight into causal mechanisms based on observational data. Many of the analyses are longitudinal, and so the correct temporal sequence is incorporated. Where possible, dose-response relationships have been identified, and the models have been developed based on conceptually plausible theories, exploiting the sociological, psychological and epidemiological literature.

In summary:

1. The evidence base is broad and highly varied, due to differences in disciplinary focus.
2. There is little in the way of robust causal investigation, most research being cross-sectional.
3. Future research should involve prospective, longitudinal designs based on causal hypotheses, which aim to elicit dose-response relationships.
4. Physical activity is a highly complex set of behaviours, which may not be possible to explain using any single theory.
5. The research presented in this thesis uses methods suited to causal investigation based on observational data, and takes a multidisciplinary approach.

3.6 School sport and adult exercise behaviour

This section focuses on UK-based research studies which have explicitly investigated the links between childhood experiences of sport and adult exercise behaviour. Seeing as government policy is based on the assumption that encouraging childhood participation in sport will lead to increased participation in adulthood, one might expect there to be a great deal of robust UK-based evidence to support this notion. Surprisingly, this is not the case. Reviews of the research literature have consistently found that the evidence base is weak and unable to satisfactorily support or refute this premise (Dishman et al., 1985; Trost et al., 2002; Bauman et al., 2002).

Indeed, there is very little research into the relationship between childhood and adult physical activity worldwide. The research which is available is generally unable to provide evidence for temporal ordering or lacks detailed measures relating to childhood experiences of physical activity. Quantitative research on this topic has frequently involved retrospective designs – asking adults to recall their childhood experiences – in cross-sectional studies (Curtis et al., 1999; Taylor et al., 1999; Birchwood et al., 2008; Marsh et al., 2010b).

The possibility of retrospective questions producing biased and imprecise estimates is well-known (Raphael, 1987; Coughlin, 1990; Matt et al., 1999). Measurement errors are introduced and recall biases, possibly involving a mechanism of reverse causality, cannot be ruled out (i.e. adults who are active may be more likely to recall positive experiences of activity in their youth).

Much of the available research involving prospective longitudinal designs has also tended to suffer from weaknesses which reduce its utility for examining this topic. Studies are often too short-term – spanning a few years – and focus on childhood or adolescence (Basterfield et al., 2011; Henning Brodersen et al., 2007; Prochaska et al., 2003). These studies tend to focus on tracking of activity levels, rather than examining childhood experiences in any detail. Malina (2001) undertook a review of tracking studies, finding that 81% of the longitudinal correlations (N=313) fell between 0.10 and 0.49, implying low to moderate tracking of physical activity.

One interesting study Malina reviewed was based on a small sample (N=278) of Belgian males (Vanreusel et al., 1997), which found that the rate of becoming inactive between ages 17 and 30 was much higher for those who were predominantly engaged in competitive sport, with almost all dropping out by age 30, as compared to those who were engaged predominantly in recreational sport, the majority of whom remained active at age 30. The study also found that those who were very active at age 17 were only slightly less likely to become inactive (28%), than become moderately active (38%), or remain very active (34%) at age 30, suggesting that exercise behaviour is unstable over time. Finally, the research also found that those who were inactive at age 17 were highly likely to remain inactive at age 30 (78%), suggesting that inactivity tracks more strongly than activity.

The only large scale, prospective UK study was undertaken on the Medical Research Council's National Survey of Health and Development cohort, born in 1946 (Kuh and Cooper, 1992). The study examined the association of teacher reports of sporting ability and energy levels at ages 13 and 15, respectively, with adult reports of sporting and recreational physical activity at age 36, controlling for sex, education, extroversion, childhood ill health and mother's education. The results indicated that high sporting ability and energy levels in childhood led to a high level of participation in sports and recreational activities at 36 years.

However, the study did not investigate childhood experiences of physical activity *per se*, and so cannot provide much in the way of conclusions relevant to policy development today. The childhood measures were basic and the conclusions reflected the specification of these variables. Other disadvantages of this study include the age of the cohort, which may limit its relevance to today's population, and the relatively simplistic model specifications used. In general, it seems that the inherent difficulty and investment required to undertake very long term, large scale, prospective longitudinal research into physical activity has prevented studies of this type from being carried out (Roberts et al., 1991; Bauman et al., 2002).

The qualitative studies available in the literature are generally retrospective in design, exploratory, and inherently limited to in-depth analysis of interview data from very few individuals, and so cannot be generalised to large populations. Nevertheless, they have provided rich descriptions of how childhood experiences may work to affect adult activity behaviour. Negative experiences seem to be particularly powerful, with study subjects reporting events that have stayed with them throughout their life, affecting their tendency to participate in sport and exercise (Allender et al., 2006).

Memories of school experiences in a study of young adults living in London (Coakley and White, 1992) were frequently negative, affecting current motivation and interest. Boredom, lack of activity choice, feelings of incompetence, and negative peer evaluations were common. Negative feedback, name calling and teasing by peers were cited as reasons for avoidance of competitive sport. For young women, unflattering PE kits and lack of privacy whilst showering and in changing rooms could lead to feelings of embarrassment and discomfort.

In a Canadian study by Strean (2009), it was found that powerful negative experiences at school could last throughout life. Subjects reported memories of humiliation that destroyed their self-confidence. These had enduring impacts on how they felt about physical activity in adulthood. Often these memories were associated with competition, performance and elitism. The association of physical education with humiliation could be so intense that it remained emotionally charged and very upsetting to recall during the study. One interviewee suggested they would have grown up healthier if "left completely alone by adults in terms of physical play" (Strean, 2009, p.217).

The subjects were also asked to recall the most positive memories of physical activity from their youth. Interestingly, these were all experiences of informal play with friends, with no organisation or involvement from adults. Another Canadian study of adults (Thompson et al., 2003) found that PE teachers had sometimes been complicit in excluding children who were not skilled at sports. Strean (2009) also found that the role teachers played was crucial to creating enjoyable experiences. Teachers who taught in a caring way, who were completely involved in lessons and strove to be fair and provide individualised learning experiences were related to positive memories. A focus on fun and inclusive participation was associated with positive experiences; performance, technical skill and competition were not. Interestingly the structure and content of lessons were rarely recalled at all.

The London study by Coakley and White (1992) also provided evidence that school experiences act to define 'sport' for young adults. Subjects in the study felt sport only related to highly organised, traditional, competitive activities involving teams, matches, etc. Those who participated in other forms of physical activity thus defined themselves as not into 'sport'.

A mixed method US study of university students' experiences at school (Kimball et al., 2009) found PE lessons rarely offered any skills or experiences that had ongoing value. Male students who had learnt how to lift weights at school found this valuable if they continued participating in university, but female students tended to perceive they hadn't learnt anything useful during PE at school. Those who remained active found their own personal motivations for remaining active. The authors concluded that participation changed radically between the school environment, which was mostly highly structured and focused on performance and competition, and the university and community environment, where participation became predominantly recreational or health-related, and was entirely self-motivated.

The research presented in this thesis provides the first detailed, UK based, large scale, prospective, and long term study in this area. By using longitudinal data from a contemporary British cohort, it addresses many of the concerns raised about the lack of evidence supporting the link between childhood and adult experiences of sport and exercise. It also improves greatly on the limited quantitative evidence which is available, by providing a much more detailed analysis of childhood experiences and their influence on adult exercise behaviour many years later. The following chapter describes the BCS70 dataset and the methods which have been used to analyse it.

In summary:

1. There is little quantitative evidence relating childhood experiences of sport and exercise to adult exercise behaviour.

2. The evidence available is either retrospective in design or is restricted to tracking activity over a few years.

3. The few cases of prospective research into this area are non-UK based and/or contain inadequate measures of childhood experiences of sport and exercise.

4. Qualitative research has suggested that:
    - Negative experiences of physical education and school sport may have long-lasting detrimental effects on adults and their physical self-perceptions.
    - Gaining proficiency in school may encourage participation in later life.
    - The structuring of physical education and school sport may define ‘sport’ for young people as traditional, competitive and performance orientated, preventing it from carrying over into adult forms of participation (recreational and fitness orientated).

5. The research presented in this thesis addresses the limitations of the available research by providing a detailed analysis of childhood experiences of sport and exercise and adult exercise behaviour, based on data from a large scale, long term, prospective and ongoing British cohort study.

Chapter 4

Data and methods

4.1 Introduction

This chapter describes the dataset used in this research – the 1970 British Cohort Study (BCS70, Centre for Longitudinal Studies (CLS), 2014) – and the statistical methods used to analyse it. The chapter includes a description of the dataset and the waves which have been used. It also highlights some of the methodological challenges of using the dataset, and discusses some of its advantages and disadvantages for the research presented here. Detailed descriptions of variables have been reserved for the relevant empirical chapters.

This chapter also includes an overview of the statistical models used. Descriptive and correlational methods are briefly described before focusing on these models. Although each of the model specifications are somewhat unique, they are all related to the group of methods known as structural equation modelling (SEM, Loehlin, 2004), and so share many features. The advantages and disadvantages of using these approaches are highlighted.

4.2 The 1970 British Cohort Study

The BCS70 is a large scale, prospective and multi-purpose study consisting of a cohort comprised of all people born in Great Britain (after the 24th week of gestation) between 0001 hours on Sunday 5th April and 2400 hours on Saturday 11th

April 1970 (Institute of Child Health, University of Bristol, 1970). The original study was called the British Births Survey. It focused on the circumstances and outcomes of birth. The study broadened considerably in subsequent waves, looking at health, education and social development in childhood and adolescence, and then the transition into adulthood, entry to the labour market, the formation of partnerships and parenthood (Elliott and Shepherd, 2006).

So far, nine waves have been conducted. The research presented in this thesis primarily exploits data from the four waves which contained information on experiences of sport and exercise – those that took place when the cohort members were aged 10, 16, 29 and 34 (in 1980, 1986, 1999 and 2004, respectively). There is an additional wave of data containing information on sport and exercise, which was collected in 2012 when the cohort members were aged 42, but this data was only recently made available, and so it has not been possible to include it in this research.

Table 4.1 (adapted from Elliott and Shepherd (2006) and Ketende et al. (2010)) shows details of every wave of the BCS70 currently available. For each wave, the table contains the year it took place, the age of the cohort members at the time, the target sample size, the observed sample size, the resulting response rate, and a brief summary of the data collected. The original eligible cohort was very large (17,287), and the response rate was near 100%. The target sample has gradually decreased over time due to deaths, and the observed sample has been affected by a combination of factors common to surveys (non-contact, refusals) and specific issues at particular waves:

- the British Births Survey was not originally intended to be a longitudinal study. As a result, tracing cohort members was particularly difficult for the second wave at age 5;
- at age 16, data collection was affected by national teacher strikes (Seifert, 1987). Many of the survey instruments in this wave were administered by teachers in schools; and
- at age 26, the response was affected by the 10 year gap between waves and because the survey was administered by post.

Table 4.1: Waves of the 1970 British Cohort Study, with information on the longitudinal sample response and data collected

Year wave began	Age	Target sample size	Observed sample size	Response rate (%)	Data collected from...
1970	0	17,287	16,571	95.9	Medical records and mother
1975	5	16,379	12,939	79.0	Medical records, parents, cohort member
1980*	10	16,152	14,350	88.8	Parents, teacher and headteacher, cohort member, medical exam
1986*	16	15,974	11,206	70.2	Parents, teacher and headteacher, cohort member, medical exam
1996	26	15,682	8,654	55.2	Cohort member
1999*	29	15,387	10,833	70.4	Cohort member
2004*	34	15,289	9,316	60.9	Cohort member, children
2008	38	15,151	8,874	58.6	Cohort member
2012	42	15,002	9,841	65.6	Cohort member

Note: the target sample sizes in 2008 and 2012 have been estimated by linear extrapolation from the previous target sample sizes sourced from Ketende et al. (2010); this research primarily makes use of the waves marked with an asterisk (*year**)

Although table 4.1 provides a summary of the sample sizes available at each wave, it only focuses on unit non-response[1]. The earlier waves (in particular, those at ages 10 and 16) contain multiple survey instruments, completed at different times, by different respondents. As a result, although a cohort member may be recorded as responding, there may also be missing data for particular survey instruments for that member. Also, as is common in survey research, there may be missing data for some questions that are particularly sensitive or less easy to answer (i.e. item non-response[2]).

[1]Unit non-response is where a respondent is completely missing at a particular wave.

[2]Item non-response can occur for a variety of reasons: the respondent may not want to answer the question, may find it difficult to answer, or may have missed the question out by accident.

The main waves used in the current research involved a variety of data collection procedures and covered many different topics:

Age 10 – Children were traced for this wave using information collected during previous waves and with the assistance of Local Education Authorities (LEAs) in England and Wales and Regional Councils in Scotland (Butler et al., 1980). There were 10 main data collection forms split into an educational pack and a health pack. In the educational pack, six of the forms were completed by the child and were administered by the class teacher. The majority of these were test booklets, measuring cognitive abilities. A self-completion form asked the child questions about their educational experiences. There was also a form answered by the class and head teachers relating to the cohort member. The health pack contained three forms: the first form was a maternal self-completion form, the second was a parental interview form, and the third was a medical examination form (completed by a community medical officer and school nurse). Data collection took place between March 1980 and October 1981. A multitude of topics were covered, from the child's cognitive abilities to the family's socioeconomic background, from the class teacher's opinion of the child to medical opinion of the child's health. There are several questions in this wave relating to experiences of sport and exercise.

Age 16 – Children were again traced with the assistance of LEAs and Regional Councils (Goodman and Butler, 1986). The wave contained 16 separate survey instruments, again split into educational and health packs. Forms were completed by the child, their class and head teachers, their parents, community medical officer or school nurse and health visitors. Unfortunately, due to the teachers' strike that occurred throughout 1986, many of the instruments completed in schools suffered from low response rates. Sample sizes generally range from around N=4,500 to 6,500 for the school instruments and N=7,000 to 9,500 for the home completion instruments. The available sample size for the teacher-completed form is particularly low, with N=3,816. Data collection started in April 1986 but didn't finish until mid 1987, when many of the cohort members had left school. As a result, alternative versions ('home packs') of some of the survey instruments were created to take this into account. Overall, about two thirds of the responses to the more problematic educational pack were completed whilst the cohort members were still in school. A vast array of topics were covered. Of particular use for this research is the large amount of information on experiences of sport and exercise, both inside and outside school, contained in this wave.

Age 29 – Tracing of cohort members in adulthood was more difficult, as it was no longer possible to make use of council and LEA registers. For the previous wave, at age 26, the cohort members had been contacted using available addresses in order to identify if their whereabouts were known. Birthday cards were sent to cohort members in order to maintain contact and request updated information. The Driver and Vehicle Licensing Agency address database was also used to find cohort members' addresses. For those who were still missing, a tracing team expended additional effort contacting potential leads by post and telephone. The Family Health Service Authorities in England and Wales and the Health Board in Scotland were also approached for assistance in finding cohort members (Despotidou and Shepherd, 1996). For the wave at age 29, further attempts were made to trace cohort members. Searches were made of the electoral register, government department databases and health records; birthday cards were sent; media appeals made; and interviewers were instructed to make investigations during fieldwork (Bynner et al., 2000). The tracing was very successful, resulting in 14,087 traced cohort members. The interviews were conducted using face-to-face, computer aided personal and self-interviewing systems between October 1999 and May 2000. Again, a wide variety of topics were covered, now focused on adult life (e.g. housing, partners and children, employment, income, etc.) This wave contained three questions designed to measure exercise behaviour.

Age 34 – The wave at age 34 was conducted in a very similar fashion to that at 29, using the same tracing methods, mode of data collection and broadly covering the same topics (Dodgeon et al., 2006). Additionally, it included basic skills assessments for the cohort members and instruments for completion by and testing of cohort members' children, allowing inter-generational comparisons to be made. The sample issued to fieldworkers comprised 13,107 cohort members. Data collection occurred between February 2004 and June 2005. This wave contained the same questions relating to exercise behaviour that were included at age 29.

4.2.1 Advantages of using the BCS70

Prospective design

The main advantage to using the BCS70 for this research is the prospective design. By measuring cohort members' experiences of sport and exercise during both childhood and adulthood, their association can be estimated. Previous research in this area has generally had to rely on retrospective measures, which are prone to recall bias (Raphael, 1987; Coughlin, 1990; Matt et al., 1999). In the current research, the risk of reverse causality is the main concern (i.e. adults who are active may be more likely to recall positive experiences of activity in their youth). This is of particular concern where respondents are asked to recall experiences from the distant past, as would be the case here.

Sample size

Another advantage of using the BCS70 is the very large achieved sample sizes. Despite missing data, each wave of the study managed to collect information on several thousand cohort members. This gives statistical analyses high power[3], enabling complex models to be estimated, small effects to be detected, and subgroup analyses to be undertaken (e.g. by sex). Although missing data can introduce bias to analyses, the large sample sizes available in the BCS70 facilitate the use of approaches which can reduce this risk (for more detail on the handling of missing data, see p.91).

4.2.2 Disadvantages of using the BCS70

Cohort effects

There are also disadvantages to using cohort data for research. With any cohort there are issues relating to the generalisability of findings, known as 'cohort effects' (Bell and Jones, 2013). Strictly speaking, the findings of the current research only apply to the cohort members in the BCS70; specifically, those individuals born

[3]Statistical power is the ability to detect small associations, enabling the rejection of the null hypothesis (that there is no association) when it is false (Lieber, 1990).

in one week in April 1970, who grew up through the subsequent time period in Britain. In order to draw conclusions that apply more broadly, it is therefore necessary to make arguments based on additional sources of evidence, which relate to whether experiences of sport and exercise have changed markedly over time.

As previously described (p.34), government research from the late 1970s suggests that the general composition of school provision has not changed drastically over time. The greatest difference between provision today and that experienced by the cohort members relates to primary schooling (Department of Education and Science, 1978). Gymnastics has fallen out of fashion and has been replaced by 'high quality' physical education, which is structured around the development of physical literacy (Whitehead, 2010; Youth Sport Trust, 2013). Secondary school provision, is relatively unchanged (Department of Education and Science, 1979), still being generally comprised of traditional, competitive sports. However, many schools now offer sports which were once gender-specific to both girls and boys.

Of course, there are other aspects of children's lives today which would not have been present in the lives of the cohort members during the 1980s. In particular, the internet, computers and smartphones have had a great impact on the way in which young people consume media (Ofcom, 2013). Being predominantly sedentary, these sources of information and entertainment have the potential to detrimentally impact health if they displace physically active leisure pursuits.

Missing data

Missing data has the potential to be problematic in all quantitative research. There are two possible impacts of missingness on statistical analyses: loss of power due to reduction in available sample size, and introduction of bias due to subjects missing non-randomly. In cohort studies, both single-wave non-contact and refusals occur, and samples tend to shrink over time due to a permanent accumulation of these factors – a process known as sample attrition (Uhrig, 2008; Ketende et al., 2010). Cohort members can and do come back into cohort studies, as has been the case with the BCS70 in the most recent wave (TNS BMRB, 2013).

In the BCS70, there was significant disruption of the data collection process at age 16 (Goodman and Butler, 1986) due to the teachers' strikes, which occurred from 1985 to 1986 (Seifert, 1987). The missingness caused by the strikes provides a significant challenge to this research, and can also be considered a type of cohort effect. It massively reduced the available sample size for some instruments at this wave, and idiosyncratically affected cohort members' experiences in school. As a result, methods have been employed to compensate for missingness (described in detail from p.91).

Variables

An additional disadvantage of using cohort data, which applies to all secondary data, is the reliance on the variables collected. Unlike with primary research, there is no possibility for the researcher to specify which questions are asked. This often means that important variables are entirely missing or question design is not ideal. In the case of long term cohort studies, this problem can be exacerbated by the use of survey and question designs that appear outdated by current standards. This is true of the BCS70 in some cases – some questions are not designed as one might have preferred, and some questions one might hope to find asked were simply not included.

Despite this, the BCS70 does contain a large number of variables related to experiences of sport and exercise. At age 10, there are measures of school provision, participation outside school, perceived ability and enjoyment. At age 16, there is a vast amount of information on participation inside/outside school and subjective measures relating to intrinsic motivation and physical self-concept. In adulthood, at ages 29 and 34, there are variables measuring exercise behaviour, which are used as the ultimate outcome in this research.

In summary:

1. The 1970 British Cohort Study (BCS70) is a large scale, long term, multi-purpose and ongoing cohort study, of people born in one week in April in 1970.
2. The majority of the data used in this research are taken from the waves at ages 10, 16, 29 and 34.
3. There are some important advantages to using this dataset to answer the research questions:

   (a) The prospective design eliminates recall bias, an issue with retrospective designs.
   (b) The large sample sizes give rise to high statistical power, allowing complex analyses to be undertaken, even on subgroups.

4. There are also some disadvantages to using the BCS70:
   (a) Cohort effects – whereby the respondents and their experiences may not be generalisable, to some extent – cannot be ruled out.
   (b) There is a large amount of missing data in the BCS70 which has the potential to bias results.
   (c) There is an unavoidable reliance on the variables designed and collected at the time. Some desirable measures are missing; the design of others is not ideal.

5. Overall, there are a wide variety of useful measures available in the BCS70 for investigating the link between experiences of sport and exercise in childhood and adult exercise behaviour.

4.3 Quantitative methods

All the research presented in this thesis is based on quantitative analysis of the available BCS70 data. It makes use of a range of statistical methods. Broadly speaking, these can be split into those which seek to summarise the data (descriptive analysis), and those which seek to model associations in the data (path and latent variable analysis). The following two sections provide an overview of these methods.

4.3.1 Summarising the data

The methods used to summarise the data depend on the measurement level of the variables concerned. For continuous (interval/ratio) variables, summary statistics such as the arithmetic mean and standard deviation have been used. Also, in order to provide a visual indication of the distribution of such variables, histograms are presented. For binary, ordinal and nominal variables, the proportions of cohort members responding positively to each response category are presented. For variables measuring experiences of sport and exercise, these proportions are visually represented as simple bar charts within summary tables.

In some cases, variables have been recoded or derived for subsequent analysis. There are two reasons for this. Firstly, specific categories have been merged in some variables to improve the clarity of interpretation and simplify analysis. This has particularly been the case where the definition of a category is vague and/or the proportion of cohort members falling into that category is small. Secondly, where count variables are highly skewed and/or show evidence of zero-inflation, categorised (ordinal) versions have been derived. This approach simplifies modelling whilst also accounting for high levels of positive skew and zero-inflation (Min and Agresti, 2002).

As a preliminary step before specifying models, pairwise correlation matrices have been estimated between the main variables of interest. Although this is normally trivial for continuous data, it is less straightforward for the binary and ordinal variables used in this research. This is not solely due to their measurement levels, but also because they represent approximations of underlying, continuous variables.

For example, at age 10, the cohort members are asked whether they "do well" or "not so well" in games. Although they are only provided with two response options, one can see that their underlying perceptions of ability will lie on a continuum. If they feel that they do well enough – i.e. their perceptions cross a subjective threshold – they will answer using the first response option. Correlation coefficients have been estimated which explicitly account for binary or ordinal approximation through use of an underlying variable model.

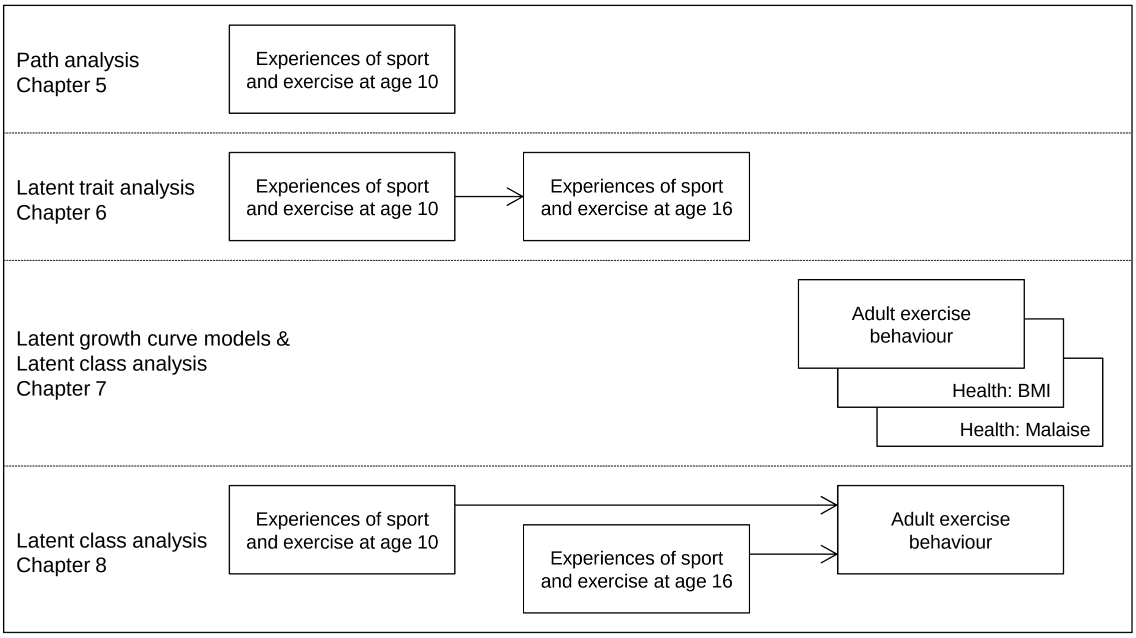
In effect, these coefficients provide an estimate of the correlation between the underlying continuous variables. Where both variables are binary, tetrachoric correlation coefficients are estimated (Digby, 1983). Where they are both ordinal or a combination of ordinal and binary, polychoric correlation coefficients are estimated (Olsson, 1979). Where the variables are a combination of binary and continuous, biserial correlation coefficients are estimated (Gupta, 1960). Where they are a combination of ordinal and continuous, polyserial correlation coefficients are estimated (Olsson et al., 1982).

Cohen's effect size conventions for the social sciences (Cohen, 1992) were employed as a useful yardstick against which to compare correlations. These state that a correlation of 0.5 is large, 0.3 is medium sized, and 0.1 is low. These are useful as simplistic guidelines but must be used intelligently – e.g. for policy makers, even small causal effects can be worthy of policy intervention (Coe, 2002). As previously mentioned (p.50), because of the importance of sex and gender to experiences of sport and exercise, the data were analysed separately by sex to enable comparisons to be made.

4.3.2 Modelling associations

This research has used the work of Bauman et al. (2002) to provide a general framework for the analysis of the BCS70 data. By doing so, it attempts to address the limitations with the evidence base previously identified (pp.58-64). Figure 4.1 shows a diagrammatic representation of the models estimated in each empirical chapter.

Figure 4.1: Representation of the general framework for the analysis of the BCS70 data



Path analysis – at age 10, path analysis has been used to compare cross-sectional models based on competing theories (policy assumptions, family socialisation and self-determination theory);

Latent trait analysis – at age 16, latent trait analysis has been used to exploit the large amount of categorical data available at this wave. Longitudinal models are then estimated, which link experiences at age 10 to those at age 16;

Latent growth curve modelling – latent growth curve modelling has been used to model BMI and malaise trajectories from childhood to adulthood, in order to validate the measure of adult exercise behaviour. BMI and malaise were chosen because these variables were collected at multiple waves in the BCS70, are relevant to young adults (<40 years old), and are associated with physical activity in the research literature (p.19); and

Latent class analysis – latent class analysis has been used to analyse the relatively simple measures of adult exercise behaviour available in the BCS70 at ages 29 and 34. In the final empirical chapter, the longitudinal associations of experiences of sport and exercise at ages 10 and 16 on adult exercise behaviour have been estimated.

These modelling techniques are collectively termed 'latent variable methods' and are commonly used in structural equation modelling (SEM, Loehlin, 2004; Kline, 2011; Byrne, 2011). Latent variables (or 'factors') cannot be measured directly. Instead, they are estimated using multiple 'indicators' – measured variables hypothesised to be caused by the latent variable or concept. Latent trait analysis and latent class analysis are defined by the measurement levels of the latent variable and indicators.

Table 4.2: Specifications of latent variable measurement models

		Latent variable	
		Continuous	Categorical
Measured variables	Continuous	Factor analysis	Latent profile analysis
	Categorical	Latent trait analysis	Latent class analysis

Note: Latent growth curve models can be specified using either factor analytic or latent trait analytic approaches

Table 4.2 (adapted from Bartholomew et al., 2002, p.146) shows how these methods are related to classical factor analysis with continuous indicators. Latent trait analysis is very similar to factor analysis, but makes use of categorical indicators. Latent growth curve modelling seeks to analyse change over time, and can make use of both latent trait and factor analytic models. Latent class analysis is a type of 'mixture modelling' (Li, 2008), and uses categorical indicators to estimate a categorical latent variable. Each of these methods make use of multiple indicators in order to more accurately measure a particular concept. By doing so, they aim to compensate for measurement error and the shortcomings of particular indicators.

Path analysis is somewhat different to these methods, in that it does not aim to estimate latent variables (Wright, 1934; Li, 1991). Historically, it was a precursor to the development of SEM, and provides a useful framework for the specification of structural models (paths between latent variables) in SEM. The strength of path analysis lies in the ability to specify complex paths between variables in order to compare and contrast models based on competing theories (Loehlin, 2004).

The main focus of this research is the development of longitudinal models of the cohort members' experiences of sport and exercise. The intention of this approach is to ensure that the temporal ordering of the modelled associations is correct, addressing the second criterion of Bauman et al. (2002) (see p.58). As with the descriptive analyses, the models are estimated separately by sex so that comparisons can be made. The final models presented in each chapter control for confounding by the correlates of physical activity.

The software used to estimate all models was Mplus 7 (Muthén and Muthén, 2012). The following sections in this chapter describe each of these methods in more detail, and explain why they have been chosen. It also includes smaller sections explaining important details of the modelling process and specifications. These include:

- measures of fit;
- modification indices;
- multigroup testing;
- Multi-Trait Multi-Method (MTMM) models;
- Multiple Indicators Multiple Causes (MIMIC) models;
- multinomial regression; and
- thresholds of statistical significance.

Path analysis

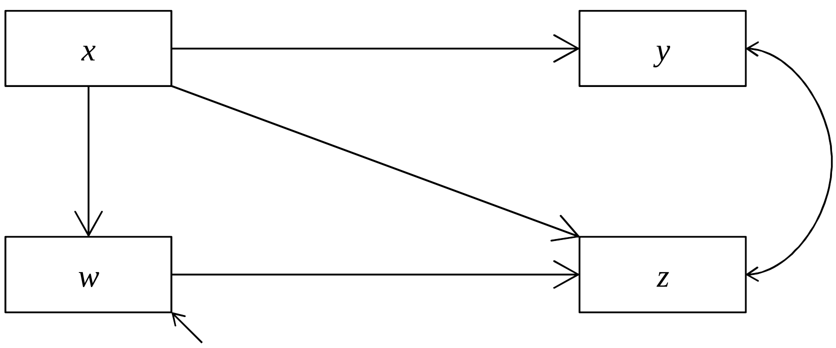
Path analysis is used to investigate experiences of sport and exercise at age 10. Despite there being relatively few variables which relate to experiences of sport and exercise at this wave, this method allows them to be exploited fully. It enables theoretically specified 'causal' paths to be compared against sample data (Loehlin, 2004; Kline, 2011).

In path analysis, hypothesised relationships between variables are defined as simultaneous equations, usually represented through a path diagram. Figure 4.2 shows an example of a path diagram. In this diagram, a main explanatory variable (x) is hypothesised to influence two outcome variables (y, z). However, x also influences another variable (w), which also influences z.

In path diagrams, measured variables are shown in rectangles; causal relationships as straight arrows going from explanatory to outcome variables; error terms as straight arrows with no explanatory variable; and correlations as curved, double-headed arrows. In this example, the curved arrow between y and z indicates that their remaining (residual/error) variance, after controlling for x and w, correlates.

All of the variables in the diagram are outcomes, except for x. As such, they are referred to as 'endogenous' variables, whereas x is an 'exogenous' variable. The endogenous variable w is also an explanatory variable for z. This diagram demonstrates how path analysis can be used to explicitly test complex theoretical models, including those involving mediation (where one variable (x) can influence another (z) indirectly, through a mediating variable (w) (Baron and Kenny, 1986; MacKinnon et al., 2007; Kenny, 2014)).

Figure 4.2: An example of a path diagram



It can be tempting to view the coefficients of a path model as true causal estimates. This is not the case. Any model based on observational data can only estimate statistical associations, not deterministic, causal relationships. A key advantage of path analysis is that competing model specifications, based on alternative theoretical relationships, can be tested against the sample data and compared with one another. These results can then be supplemented with theory and additional evidence to build a tentative, causal explanation (Loehlin, 2004; Kline, 2011).

All of the path analyses presented in this research use probit link functions (Long, 1997). This is because the outcome variables used are binary approximations of underlying, continuous variables. Probit models commonly assume that the underlying variable has a standard normal distribution, i.e. $y^* \sim N(0,1)$. Where the underlying variable has a value greater than zero, the binary indicator will be one; where it is less than or equal to zero, the binary indicator will be zero. The underlying variable (y^*) is a linear function of the covariates ($x_{1,2,...,k}$) and an independent, random error (ϵ):

$$
\begin{aligned}
y_i^* = & \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_k x_{ki} + \epsilon_i \\
& \text{where } \epsilon \sim N(0, \sigma^2) \\
& \text{for } i = 1, ..., n
\end{aligned}
\tag{4.1}
$$

$$
y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{if } y_i^* \leq 0 \end{cases}
$$

The probit model uses the cumulative distribution function of the standard normal distribution (Φ) to transform the continuous model shown on the right hand side of equation 4.1 to a probability:

$$
\begin{aligned}
Pr(y_i = 1) = & Pr(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_k x_{ki} + \epsilon_i > 0) \\
= & \Phi(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_k x_{ki})
\end{aligned}
\tag{4.2}
$$

Estimates of the coefficients (β) from a probit model can be interpreted as y^*-standardised partial regression coefficients (i.e. Z-scores – the change in y^*, measured in standard deviations, associated with a unit change in the explanatory variable, controlling for all other variables in the model). This is because the underlying variable (y^*) is standard normal, and so has a variance of one. For individual paths in the models, Z-tests of statistical significance are presented.

Path models have been estimated using a robust weighted least squares estimator (WLSMV) in Mplus (Muthén and Muthén, 2012, pp.33, 603). This method provides a rapid way to estimate these models, and has been found to produce stable and reliable estimates where sample sizes are large (N>1,000) (Asparouhov and Muthén, 2010b; Nussbeck et al., 2006). The only alternative to this estimator for the more complex models presented would have been numerical integration, which was found to be prohibitively slow.

Path analysis has been used in this research to identify whether the assertions typically found in government policy are supported by the BCS70 data at age 10. Comparison models are then developed using family socialisation and self-determination theory, in order to identify whether they provide a better explanation for the cohort members experiences at this age.

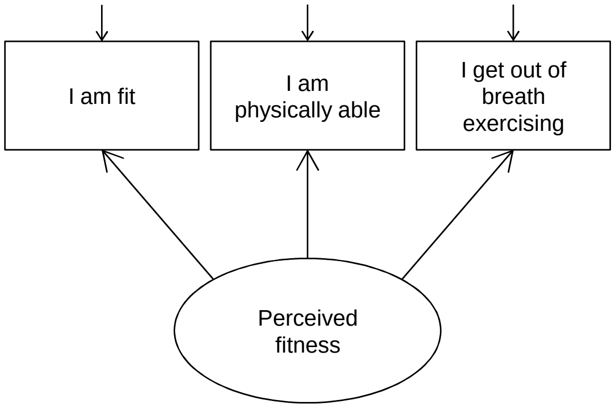
Latent trait analysis

In the BCS70 at age 16, there are a large number of variables measuring participation and subjective experiences of sport and exercise. These have been exploited using latent trait analysis (Bartholomew et al., 2002; Byrne, 2011; Kuha, 2012a). By using multiple indicators, a more precise estimate of a latent concept can be made. Measurement models are estimated which take into account both random error in the measured variables and the strength of their association with the latent variable (or 'factor').

A simple example, adapted from the age 16 analysis, is shown in Figure 4.3. In path diagrams, latent variables are represented in ellipses. The diagram shows that the latent variable 'Perceived fitness' causes the measured values on three indicators, which are all theoretically related to this concept. The residual arrows show that the model takes account of measurement error in the three variables. The paths from the latent variable to the indicators are usually referred to as the 'loadings' of the latent variable on the indicators.

Latent trait analysis is different from classical factor analysis in that the measured variables are binary or ordinal, not continuous. In effect, rather than exploiting the

Figure 4.3: An example of a latent trait measurement model



correlation between continuous measured variables, latent trait analysis exploits the correlation between the underlying variables (y^*) approximated by measured binary or ordinal variables. As with the path analyses, the latent trait models presented in this research make use of probit link functions.

Where the measured variables are ordinal, the probit model is adjusted to take this into account (Long, 1997). Rather than there being a single threshold ($\tau \Rightarrow y^* = 0$) where the approximation goes from zero to one, there are multiple thresholds ($\tau_{1,2,...,m}$) across the range of the underlying variable (y^*), which cause the ordinal approximation to go from one to two, two to three, etc. For example, if an ordinal indicator comprised 5-categories:

$$
\begin{aligned}
y_i^* = &\beta_0 + \beta_1 x_{1i} + ... + \beta_k x_{ki} + \epsilon_i \\
&\text{where } \epsilon \sim N(0, \sigma^2) \\
&\text{for } i = 1, ..., n
\end{aligned}
\tag{4.3}
$$

$$
y_i = \begin{cases} 1 & \text{if } -\infty \le y_i^* < \tau_1 \\ 2 & \text{if } \tau_1 \le y_i^* < \tau_2 \\ 3 & \text{if } \tau_2 \le y_i^* < \tau_3 \\ 4 & \text{if } \tau_3 \le y_i^* < \tau_4 \\ 5 & \text{if } \tau_4 \le y_i^* < \infty \end{cases}
$$

The probability of the ordinal approximation taking a particular value (m) is therefore the probability between the relevant thresholds (τ_m, τ_{m-1}) on the cumulative distribution function of the standard normal distribution, given the explanatory variables:

$$\begin{aligned} Pr(y_i = m) =& \Phi(\tau_m - \beta_0 - \beta_1 x_{1i} - ... - \beta_k x_{ki}) \\ & -\Phi(\tau_{m-1} - \beta_0 - \beta_1 x_{1i} - ... - \beta_k x_{ki}) \end{aligned} \tag{4.4}$$

In the example shown in Figure 4.3 there is only one (latent) explanatory variable for each binary or ordinal outcome. Therefore, equations 4.3 and 4.4 would simplify to include only one explanatory variable and associated coefficient ($\beta_1 x_{1i}$).

After estimating a measurement model, it is possible to calculate a score on the latent variable for each respondent (Kuha, 2012a). A factor score is an estimate of a respondent's value on the latent scale (y^*) given their responses on the indicators. Factor scores from the age 16 analysis have been employed in the final empirical chapter of this research. As with the path analyses, the robust weighted least squares estimator (WLSMV) in Mplus was used to estimate the latent trait analyses (Muthén and Muthén, 2012).

Latent trait analysis has been used in this research to exploit the large quantity of data available in the BCS70 which measures experiences of sport and exercise at age 16. Almost all of the variables are ordinal, and so classical factor analysis was not appropriate. The resulting measures make maximum use of the available data whilst accounting for how well different indicators measure the underlying concept (i.e. incorporating residual error and factor loading).

Latent growth curve models

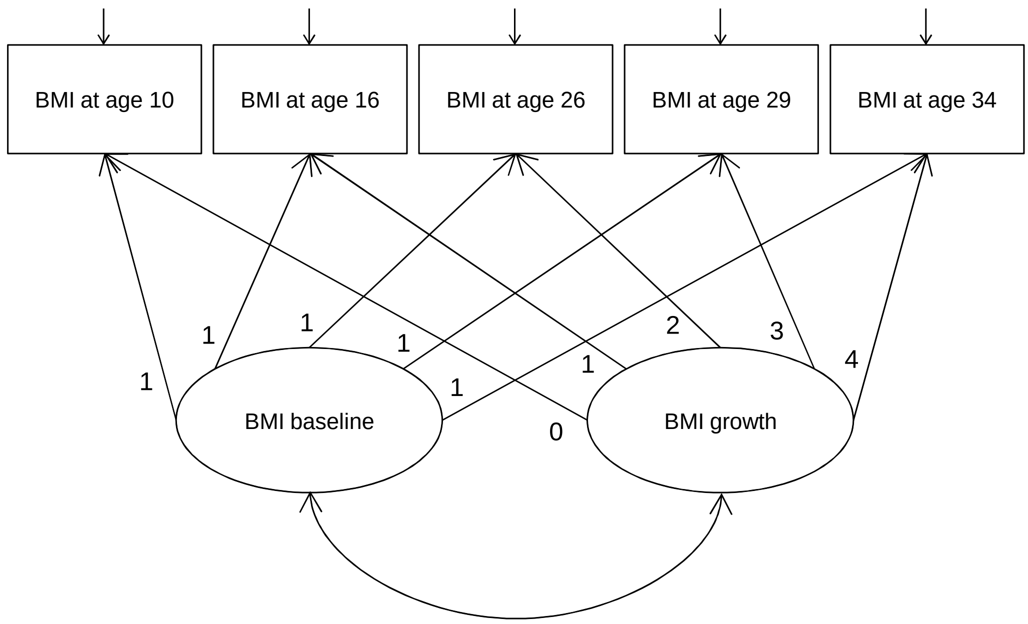
Latent growth curve models have been used to analyse change over time in two health outcomes: BMI and malaise. The models have been used to validate the measure of adult exercise behaviour, which is used as the main outcome of this research.

Latent growth curve models are an extension of factor analysis and latent trait analysis which enable individual growth trajectories to be modelled over time

(Duncan and Duncan, 2004; Duncan et al., 2006; Jung and Wickrama, 2008). Typically, factors for both the baseline (intercept) and growth process (slope) are estimated. This allows the model to estimate both the mean baseline and growth (known as ‘fixed effects’) as well as incorporating variation between individuals (known as ‘random effects’), through the estimated variances and covariances of the factors.

The shape of the growth curve is defined using the loadings of the slope factor onto the measured items at the various time points. Figure 4.4 shows a simple specification for a latent growth curve model for body mass index (BMI) between the ages of 10 and 34. The loadings for the intercept factor are constrained to one at all time points to produce an estimate of the initial latent mean BMI. The loadings for the slope factor are constrained to increase from zero to four in equal steps, indicating that the shape of the growth curve is described by a straight line. The mean of the slope factor can then be multiplied by the loadings to give the change in BMI over time.

Figure 4.4: An example of a simple latent growth curve model of BMI



The shape of the growth curve can be freely estimated by removing constraints from the slope factor loadings, e.g. by setting the first loading to zero and the last loading to one, with all other loadings freely estimated. The latent growth curve models presented in this thesis have taken this approach.

For malaise, a latent trait measurement model (with the WLSMV estimator) is used because the derived malaise indicator is ordinal. For BMI, the model is estimated using ordinary least squares with no link function – i.e. a classical factor model – because BMI is continuous. The distribution of BMI is positively skewed, which can bias measures of fit and standard errors of model parameters. To account for this, the robust maximum likelihood estimator (MLR) in Mplus has been used for BMI (Muthén and Muthén, 2012, p.603).

Latent growth curve models of BMI and malaise were used to validate the measure of adult exercise behaviour used as the main outcome of this research. The reason BMI and malaise (i.e. mental well-being) were chosen is that they have a well-established link with physical activity (p.19) and were consistently collected across waves in the BCS70. By identifying an association between the measure of adult exercise behaviour and change in these health outcomes, the latent growth curve models provide evidence for the validity of the adult exercise measure.

Measures of fit

In order to estimate or 'fit' a model, it must be 'identified', i.e. there must be sufficient data to estimate unique values for each of the parameters in the model. A simple analogy is that the equation $x + 3 = 5$ is identified, whereas $x + y = 5$ is not. In general, the more parameters there are in the model, the more variables are required to estimate it. The 'degrees of freedom' (df) of the model are calculated from the numbers of parameters and variables. If the degrees of freedom are negative, the model is not identified and cannot be estimated. If the degrees of freedom are zero, the model is just-identified, but the fit of the model to sample data cannot be tested. With one degree of freedom, the model can be tested but the test does not have high statistical power. With many degrees of freedom, the model is over-identified and the test will have high statistical power, providing a good indication of fit (Loehlin, 2004; Kline, 2011; Byrne, 2011).

Tests of fit involve comparing the pairwise correlations implied by the model to those of the sample correlation matrix. Generally, an identified model will not replicate the sample correlation matrix exactly. The difference between the two matrices can be used to statistically test how well the model fits the data. The fit of path and latent variable models is usually tested using several measures. The reason for this is that each one is somewhat imperfect, but taken together they provide a good indication of whether the model fits the sample data well (Byrne, 2011). The path analytic, latent trait and latent growth curve models presented in this research are tested using the χ^2 test, the root mean square error of approximation (RMSEA), the comparative fit index (CFI) and the Tucker-Lewis fit index (TLI). These measures of fit are widely used in the SEM literature and are provided by Mplus (Muthén and Muthén, 2012).

The χ^2 test is a measure of absolute fit and is sensitive to sample size, the number of parameters in the model (and resulting degrees of freedom) and the strength of associations. Sample sizes over N=400 generally result in a significant test, indicating poor fit, even when the model fits well (Byrne, 2011, pp.67-69). The sample sizes in the waves of the BCS70 are all much larger than this, and so this measure is reported alongside the RMSEA, CFI and TLI.

The RMSEA has the advantage of not being sensitive to sample size. It penalises model complexity, thus preferring a parsimonious model. Another advantage of the RMSEA is that it gives an indication of how well the model would fit the population from which the observed data has been sampled, not just the sample data itself. An RMSEA value of <0.05 is commonly thought to indicate good fit (Browne and Cudeck, 1992).

The CFI is a measure of incremental fit that compares the specified model with a null model where the variables are assumed to be uncorrelated. It also penalises model complexity. A CFI value of >0.95 is commonly thought to indicate good fit (Hu and Bentler, 1999). The TLI is also a measure of incremental fit which compares the specified model with a null model. It penalises the inclusion of additional parameters more than the CFI. A TLI value of >0.95 is commonly thought to indicate good fit (Hu and Bentler, 1999).

Where nested models are compared against one another, the χ^2 difference test has been employed to calculate a single measure of significance for multiple parameters being fixed to zero. When MLR is used, it is necessary to undertake any χ^2 testing of nested models using the Satorra-Bentler Scaled χ^2 value (Satorra and Bentler, 2001). This approach has been taken for the latent growth curve models of BMI.

It is important to note that these measures of fit are not applicable to latent class models. The measures of fit used to compare latent class models are described below.

Latent class analysis

Latent class analysis has been used to analyse the variables measuring exercise behaviour in adulthood (Bartholomew et al., 2002; Kuha, 2012a; UCLA: Statistical Consulting Group, 2015). It is a data-driven method that groups individuals into two or more classes, based on patterns of response to a set of questions with categorical (binary, ordinal or nominal) response options. The model estimates two sets of parameters (Kuha, 2012a). The first set are probabilities (π) of the responses (y) being in a particular response category (r) for each of the questions (q) given the class (c) of the latent variable (η):

$$\begin{aligned}\pi_{qr(c)} =& P(y_q = r|\eta = c) \\ & \text{for questions } q = 1,2,...,Q \\ & \text{for response categories } r = 1,2,...,R_q \\ & \text{for latent classes } c = 1,2,...,C\end{aligned} \tag{4.5}$$

The second set are the probabilities (α) that respondents will fall into each class (c) of the latent variable (η):

$$\begin{aligned}\alpha_c =& P(\eta = c) \\ & \text{for } c = 1,2,...,C\end{aligned} \tag{4.6}$$

Latent class analysis is appropriate where discrete groups of respondents are hypothesised to exist. The number of classes in the latent variable is usually identified by running models with $C = 2,3,4,...$ until a model is found where the addition of further classes does not improve fit significantly. Four measures of fit have been used for the latent class analysis of exercise behaviour in adulthood. The Bayesian Information Criterion (BIC, Bollen et al., 2014) is a measure based on the likelihood function, which penalises model complexity. In a comparison of several models, the model with the lowest BIC is generally preferred.

Two statistical tests that help identify the number of classes required are also reported: the Vuong-Lo-Mendell-Rubin (VLMR) and parametric bootstrapped likelihood ratio (PBLR) tests (Muthén and Muthén, 2012, pp.738, 739). Both aim to identify whether the use of one less class results in a significantly worse fitting model. Additionally, it is possible to examine the bivariate standardised residuals from the model. Individual residuals that are above four give an indication of poor fit, and the sum of all bivariate residuals can be compared to the χ^2 distribution to give a measure of whether the lack of fit is significant (Bartholomew et al., 2002).

A summary measure called 'entropy' indicates how well the model allocates respondents to classes. If this measure is ≥ 0.8 the model is generally regarded as being able to allocate respondents cleanly, with a low level of uncertainty (Celeux and Soromenho, 1996). The models use a logistic link function and have been estimated using the robust maximum likelihood estimator (MLR) in Mplus (Muthén and Muthén, 2012). After estimating the model, it is possible to make a prediction of which class each respondent is most likely to be assigned to (Kuha, 2012a). Predicted classes have been used in the chapter examining health outcomes.

Latent class analysis has been used in this research to create latent categorical measures of exercise behaviour in adulthood. The variables measuring adult exercise behaviour in the BCS70 at ages 29 and 34 are very simplistic, comprising only three questions. Rather than combine the questions in a pre-determined manner to create an arbitrary scale value of exercise behaviour, latent class analysis allows natural groupings of cohort members to emerge from the data based on their answers to the survey questions on exercise behaviour.

Modification indices

Modification indices predict which additional parameters could be included (i.e. freely estimated) in a latent variable model in order to reduce the χ^2 statistic, thereby improving model fit (Whittaker, 2012). It is widely accepted that adding parameters to models based on the information from modification indices should be done sparingly, and only where the added parameter makes sense substantively/theoretically (Loehlin, 2004; Byrne, 2011). In this research, modification indices have been used in this way to inform changes to latent variable model specifications, where the fit of the initial model to the data was inadequate.

Multigroup testing

When estimating latent variable measurement models, it is good practice to ensure that the concept being measured is equivalent between key groups of respondents by undertaking 'multigroup testing' (Byrne, 2011; Kuha, 2012b). If there is a significant difference in the parameters representing the paths of the model between groups, the concept represented by the latent variable is arguably not the same for both groups.

Wherever measurement models are developed in this research, multigroup testing has been carried out to determine whether there is 'measurement equivalence' between the sexes. In some cases, differences between groups can be acceptable, particularly where they make sense from a substantive or theoretical perspective. In these cases, *partial* measurement equivalence is said to be attained, and the latent variables can still be used to compare groups, whilst taking into consideration the parameters which are not equivalent (Byrne et al., 1989; Byrne, 2008).

Multi-Trait Multi-Method (MTMM) models

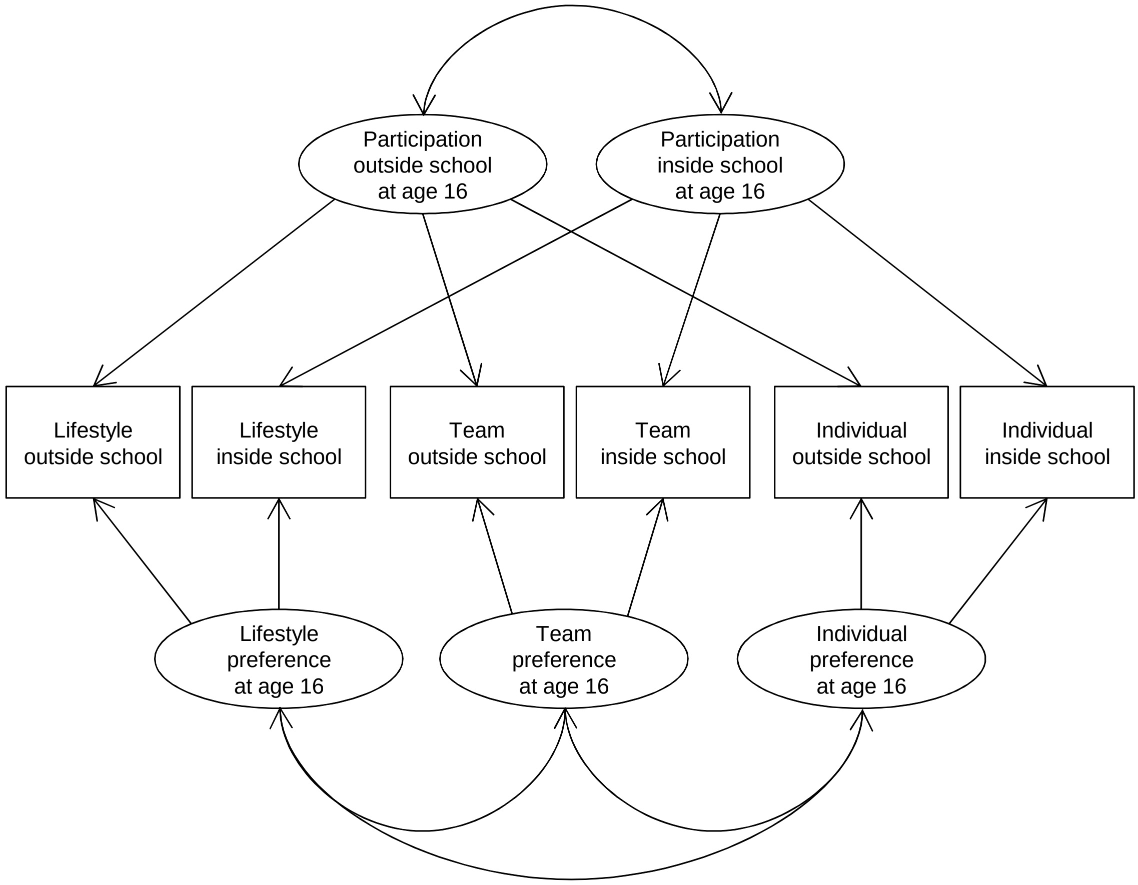
Multi-Trait Multi-Method (MTMM) models are used to estimate the influence of two separate processes – 'traits' and 'methods' – on the measured values of indicators (Campbell and Fiske, 1959; Lance et al., 2002). Figure 4.5 shows a classical MTMM model specification. There are two sets of factors, one set represents the traits of interest, and the other represents methods by which these traits are measured. A type of MTMM model has been used in this research to develop latent measures of participation in sport and exercise at age 16.

There is a very large amount of data measuring the activities the cohort members participated in at age 16, both inside and outside school. The activities have been grouped into types, and so both the context (inside/outside school) and preference for types of activity (lifestyle, team and individual competitive activities) can be investigated. These two processes, which both influence the measured values of the indicators, can be viewed as 'traits' *or* 'methods' in an MTMM model.

Several variations of MTMM models have been developed in the SEM literature:

- the original MTMM model (as shown below, Campbell and Fiske, 1959; Lance et al., 2002);
- the 'correlated uniqueness model' developed by Marsh (1989; 1991); and
- the 'multi-trait multi-method minus one model' (MTMM-1, Nussbeck et al., 2006).

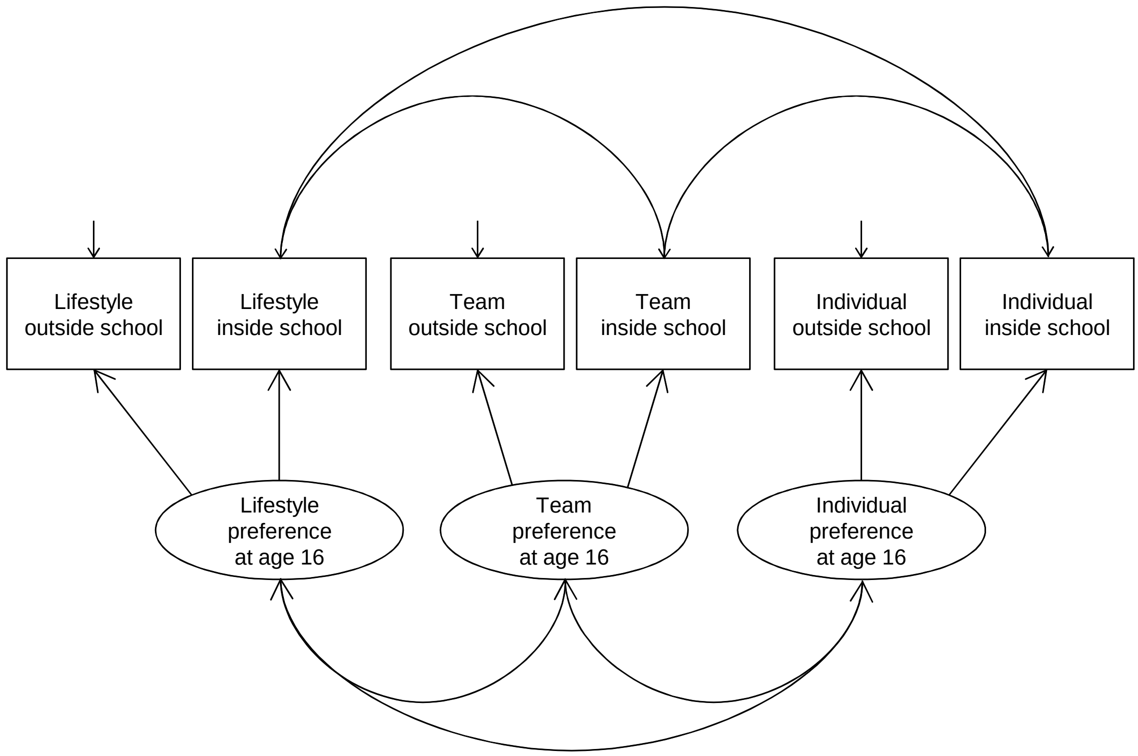
Figure 4.5: An example of a Multi-Trait Multi-Method (MTMM) model



The advantage of the last of these is that it allows the estimation of method factors, whilst avoiding problems relating to over-fitting common to traditional MTMM models (Nussbeck et al., 2006). A particular method factor is chosen as the reference, and factors are only included for the remaining methods (this approach is analogous to using two dummy variables in a basic regression model in order to include a three category explanatory variable).

In this research, a simpler, parsimonious version of this model has been preferred which combines the correlated uniqueness (i.e. correlated residuals) model of Marsh (1989) with the MTMM-1 model of Nussbeck et al. (2006). This allows simpler models to be estimated, which provide factors for both participation by setting and by activity type. Figure 4.6 shows how this model is specified. It incorporates residual correlations in place of the method factors, and follows the approach of Nussbeck et al. (2006) by specifying a reference method (in this case, participation outside school).

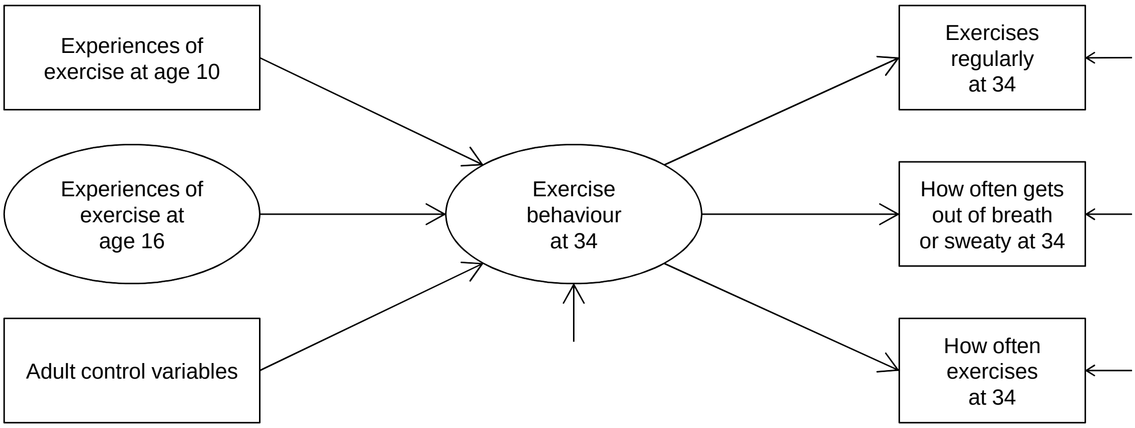
Figure 4.6: An example of a Multi-Trait Multi-Method-1 (MTMM-1) model incorporating 'correlated uniqueness'



Multiple Indicators Multiple Causes (MIMIC) models

Multiple Indicators Multiple Causes (MIMIC) models (Xue, 2007) involve the estimation of latent variables as outcome/endogenous variables. Figure 4.7 shows an example adapted from the final chapter of this thesis, whereby the latent variable is measured by multiple indicators and is hypothesised to have multiple causes – i.e. explanatory/exogenous variables. MIMIC models generally refer to classical factor analysis or latent trait analysis, but can also be specified as a latent class analogue (Yang, 2005; Clark and Muthén, 2009). They have been used in this research to specify longitudinal models of the influence of experiences at age 10 on those at age 16 (latent trait version), and the influence of experiences at ages 10 and 16 on adult exercise behaviour (latent class version). In effect, they are regression models with latent outcomes.

Figure 4.7: An example of a Multiple Indicators Multiple Causes (MIMIC) model



Multinomial logistic regression

When estimating the association between childhood experiences of sport and exercise and adult exercise behaviour (as in Figure 4.7), multinomial logistic regression has been used (Long, 1997). This is because latent class analysis results in a latent variable which is nominal. Multinomial logistic regression is very similar to binary logistic regression, in that it models the log-odds of a categorical outcome. The main difference is that rather than the outcome being binary, it has more than two (unordered) categories, and so a reference category is chosen against which the others are compared. For example, if a latent class variable has three categories (A, B, C), two models are estimated simultaneously:

$$\ln\left[\frac{Pr(A|x)}{Pr(C|x)}\right] = \beta_{0,A|C} + \beta_{1,A|C}x_1 + \ldots + \beta_{k,A|C}x_k \tag{4.7}$$

$$\ln\left[\frac{Pr(B|x)}{Pr(C|x)}\right] = \beta_{0,B|C} + \beta_{1,B|C}x_1 + \ldots + \beta_{k,B|C}x_k \tag{4.8}$$

In this example, C is the reference category. The estimates resulting from these models are presented as odds ratios (exponentiated coefficients). These can be interpreted as multiplicative changes in the odds of being in the modelled category, as opposed to the reference category, associated with a change in the explanatory variable (x) controlling for all other explanatory variables.

Thresholds of statistical significance

This research follows the standard convention of identifying statistically significant estimates using α=5%. In tables of estimates, asterisks are used as an indicative guide to the level of significance: *** $p \leq 0.1\%$ (0.001); ** $p \leq 1\%$ (0.01); and * $p \leq 5\%$ (0.05).

4.3.3 Missing data

As described previously (p.70), missing data is a problem in the BCS70. Although the target sample sizes are large, each wave suffers from some missing data, and there is a very large amount missing in the wave at age 16. When using data from multiple survey instruments in multiple waves, often administered at different times and locations to different respondents (cohort member, mother, teacher, etc.), the proportion of complete cases can fall rapidly. This leads to a loss of statistical power when basing analyses on complete cases. Also, any missing data has the potential to bias estimates, if that data is not missing at random.

There are several types of missing data described in the literature (Rubin, 1976; Buhi et al., 2008; Asparouhov and Muthén, 2010a):

- **Missing Completely At Random** (MCAR) – this means that the missing data is truly random, with no association with variables in the dataset. As a result, it does not lead to biased estimates. In practice, missing data is very rarely MCAR in social research;
- **Missing At Random** (MAR) – this means that data are missing at random once conditioned on covariates within the dataset. MAR has the potential to introduce bias if the relevant covariates are not controlled for in statistical analyses. In social research (as in this research), it is common for remedial approaches to missing data to be based on an assumption that it is MAR; and
- **Not Missing At Random** (NMAR) – this means that data are missing conditional on the variables suffering from missingness, and is the most problematic of missing data types because crucial information needed to control for missingness is itself missing.

Most methods used to compensate for missing data are based on an assumption of MAR. In order to make best use of the data available in the BCS70, methods have been used to compensate for missing data using the functionality available in Mplus (Muthén and Muthén, 2012) under this assumption. Two approaches have been used depending on the severity of the missing data problem.

For any analyses which do not incorporate control or explanatory variables from the particularly problematic wave at age 16, missing data has been adjusted for using variations on Full Information Maximum Likelihood (FIML, Graham, 2012). This procedure makes use of the available data in each observation to contribute to the likelihood function (Allison, 2012). In Mplus (Muthén and Muthén, 2012), the specific variation used depends on how the model has been estimated (WLSMV or MLR) and whether there are explanatory variables in the model.

For the path analyses, missing data are incorporated as a function of the explanatory variables (Muthén and Muthén, 2012, p.487). Latent trait measurement models are estimated using pairwise present analysis and, where explanatory variables have been included, missing data are incorporated as a function of these variables (Asparouhov and Muthén, 2010b). The same method has been used for the latent growth curve models of malaise. For the BMI growth models and the latent class analyses, unrestricted FIML is used. Essentially, these methods have allowed variables with partial missingness to be included in the analysis where they are specified as outcomes/endogenous/indicator variables in analyses.

Overlapping missingness became a substantial problem when variables from multiple age 16 survey instruments were included in models as control or explanatory variables. The FIML variations were not suitable, as they can only account for missing data on outcome variables. Therefore, multiple imputation (Rubin, 1987; Allison, 2012) was used to create several complete datasets which were analysed and combined using the functionality of Mplus for modelling using multiply-imputed datasets (Muthén and Muthén, 2012, pp.487, 512, 515-519).

Multiple imputation was undertaken using chained equations (Schafer and Olsen, 1998; Allison, 2000; Raghunathan et al., 2001; Royston, 2004). This uses a sequence of imputation models to predict values for the missing items. It is able to accommodate datasets containing a mixture of categorical, interval and continuous variables, and arbitrary patterns of missingness. Multiple, complete datasets are created by predicting missing items using an imputation model. Typically, the imputation model contains auxiliary variables in addition to those included in the model of interest, in order to improve the accuracy of imputation. Variation in the imputed values is then taken into account in subsequent analyses by combining model results from the imputed datasets using rules originally developed by Rubin (1987).

Each of these methods will give unbiased results under the assumption that the data are MAR (Rubin, 1987; Enders and Bandalos, 2001; Graham, 2012; Allison, 2012). Although the proportion of missing data is very high at the age 16 wave (due to the teachers' strikes), it is unlikely to bias model results greatly. This is because the strikes were unlikely to be strongly correlated with the cohort members' experiences of school sport and physical education. Strike action was generally determined by local branches of teachers' unions (Seifert, 1987) and influenced by the socioeconomic characteristics of schools. An analysis of missing data (Ketende et al., 2010) in the BCS70 has shown that cohort members who are male and/or of lower socio-economic status are more likely to become missing. Seeing as the final models presented in each empirical chapter of this research control for age, sex, socioeconomic status and many other correlates, we can be fairly confident that they meet the MAR criterion.

In summary:

1. Most of the variables used in this research are binary or ordinal. Methods have been specifically selected to accommodate this.
2. This research makes frequent use of tetrachoric and polychoric correlation, which assume a continuous underlying variable is responsible for the measured values of binary or ordinal variables.
3. The models presented in this research are estimated with Mplus 7, and make use of latent variable methods.
4. Latent variable methods make use of multiple indicators to more accurately measure concepts, to some extent compensating for measurement error and the shortcomings of specific indicators.
5. Path analysis is used to test complex theoretical relationships between individual variables using cross-sectional data at age 10.
6. Latent trait analysis is used to estimate latent variable measurement models using binary or ordinal indicators at age 16.

7. Latent growth curve models are used to model change over time in BMI and malaise. Factors for the baseline (intercept) and growth process (slope) can be estimated. The factor loadings define the shape of the growth curve.

8. Several measures of fit are reported for path, latent trait and latent growth curve models: χ^2, RMSEA, CFI and TLI. Separately, each one is imperfect, but together they provide good evidence of fit and are widely used in the SEM literature.

9. Latent class analysis is used to analyse adult exercise behaviour. It enables respondents to be grouped according to the pattern of their responses. The probability of class membership and response pattern for each class is estimated. Several measures of fit are reported: BIC, VLMR, PBLR and bivariate standardised residuals. Entropy is used to identify whether respondents are cleanly allocated to classes.

10. Modification indices have been used to inform alterations to measurement models in order to improve fit, where these alterations make sense substantively/theoretically.

11. Multigroup testing was undertaken to determine the measurement equivalence of models used to estimate latent variables. This provides reassurance that the same concept is being measured for both sexes.

12. A type of Multi-Trait Multi-Method (MTMM) model has been used in the analysis at age 16 in order to isolate two processes which influence participation in sport and exercise at age 16: (a) context (inside/outside school) and (b) preference for particular types of activity (lifestyle, team and individual competitive activities).

13. Multiple Indicators Multiple Causes (MIMIC) models are used to estimate the influence of explanatory and control variables on latent outcomes at age 16 and in adulthood.

14. Variations on Full Information Maximum Likelihood were used to allow for missing data on outcome variables in models which did not include explanatory or control variables from the age 16 wave.

15. Multiple imputation was used where models included explanatory or control variables from the age 16 wave. This creates several complete datasets and

resulting estimates are combined to take variation due to imputation into account.

16. Each of these missing data approaches will provide unbiased estimates under the assumption of MAR. In this case, it seems a plausible assumption.

Although this chapter has attempted to provide a thorough account of all of the methods used in this thesis, some specific details have been reserved for the relevant empirical chapters. The following chapter is the first of these, and presents cross-sectional analyses of the cohort members' experiences of sport and exercise when they were aged 10.

Chapter 5

Experiences of sport and exercise at age 10

5.1 Introduction

This empirical chapter presents a cross-sectional analysis of the cohort members' experiences of sport and exercise during primary school, when they were aged 10. It aims to answer the following main research questions:

- Is the amount of school sport and physical education at age 10 associated with positive experiences of sport and exercise?
- Is there evidence of family socialisation into sport and exercise at this age?

Recently, a spotlight has been shone on primary school sport and physical education in the UK, with government making new funding announcements (Department for Education, 2013) and undertaking consultations (House of Commons Education Committee, 2013; Parry, 2013a). This interest is driven by the desire to ensure a lasting legacy for the London 2012 Olympics and ongoing concerns that children are increasingly inactive and overweight. By shifting the focus of policy toward younger, primary aged children, it is thought that the policy impact will be maximised (Gibson, 2012; Department for Education, 2013; Prime Minister's Office et al., 2014). Short term, policy aims to increase participation and develop physical literacy. Long term, it aims to encourage lifelong participation in sport and exercise. Policies have consistently argued that 'high quality' school sport and physical education provides a way in which to do this, but recently – since the coalition government came to power – there has been a renewed drive to get children participating *competitively* at an earlier age (Gove, 2010; Press Association, 2012; Department for Culture Media and Sport, 2012b; Department for Education, 2013).

In contrast, the academic literature suggests that parental and family influences are the main drivers of childhood participation in sport and exercise (Moore et al., 1991; Fredricks and Eccles, 2003; Haycock and Smith, 2012). Those children who are encouraged and supported to be active by their parents develop fundamental motor skills earlier, are more able, and thus more likely to enjoy and do well at school sport and physical education (Kay, 2004; Kirk, 2005; Van Der Horst et al., 2007). Qualitative evidence suggests that a focus on competition in school can discourage less able children (Penney and Evans, 1997; Green, 2004; Allender et al., 2006), leading to negative self-perceptions of competence and adverse effects on enjoyment and motivation. Interviews with adults suggest that negative childhood experiences in school have long lasting impacts on future participation (Coakley and White, 1992; Thompson et al., 2003; Allender et al., 2006; Strean, 2009). In effect, primary school provision could simply exacerbate pre-existing differences in participation, skill and enjoyment.

The analysis presented in this chapter identifies whether school provision was associated with positive outcomes for the cohort members at age 10; this would provide support for the assertions of government policy today. It goes on to identify whether models based on academic theories provide a better explanation of cohort members' experiences. The two main research questions are supplemented by the following additional questions:

- Are differences between the sexes in experiences of sport and exercise already apparent by age 10? Are these differences indicative of gender stereotypes?
- Does perceived ability mediate enjoyment of school sport and physical education at age 10, as might be expected from self-determination theory?
- In what ways are the correlates of physical activity associated with experiences of sport and exercise at age 10?

The following sections are included in this chapter:

Variables – describes the measures used in the analyses;

Analytical strategy – describes the approach used to answer the research questions;

Preliminary analysis – presents cross-tabulations, histograms and pairwise correlations to provide a preliminary understanding of the data;

Path analysis – presents several path analytic models used to test whether particular relationships are supported in the BCS70; and

Conclusions – summarises the findings of this chapter.

5.2 Variables

A certain degree of pragmatism was necessary in identifying measures for particular concepts, and so some act as proxies and must be treated with a degree of caution. The main variables of interest measure experiences of sport and exercise:

Enjoyment – measured using a categorical variable asking the cohort member whether they like team games. This was the only measure of enjoyment available at age 10. Almost all children would have played team games inside school (Department of Education and Science, 1978). Enjoyment is an indicator of intrinsic motivation (McAuley et al., 1989; Ryan and Deci, 2000b; Teixeira et al., 2012);

Perceived ability – measured using two binary variables asking the cohort member if they do well in (a) games and (b) gymnastics. Almost all schools at the time included educational gymnastics in their physical education provision (Department of Education and Science, 1978) alongside team games. Perceived ability is an indicator of physical self-concept (Marsh, 1996a,b) and a determinant of intrinsic motivation (Ryan and Deci, 2000b);

Participation outside school – measured using three ordinal variables asking the mother of the cohort member how often their child (a) plays sports (b) rides a bike or (c) swims in their spare time; and

Participation inside school – measured using an interval variable asking the class teacher how many hours a week the cohort member is engaged in 'PE/movement/games' during school periods.

Additional variables were included in order to control for physiological, socio-economic and school environment factors. Measures used to control for cohort member physiology included:

Weight status – binary indicators of underweight, overweight and obesity were derived. Measures of height and weight recorded as part of the medical examination form were used to calculate Body Mass Index (BMI)[1]. The binary indicators were derived using an approach similar to that used by the WHO in their 2007 growth reference (Dinsdale et al., 2011). BMI>1 standard deviation below the mean was classed as underweight, BMI>1 standard deviation above the mean was classed as overweight, and BMI>2 standard deviations above the mean was classed as obese. Unlike the WHO growth reference, the derivations were not calculated separately by sex. The reason for this is that practically all children were taught in mixed sex classes at this age, and so relative weight status compared to *all* peers is more applicable as a physiological control than that compared only to same-sex peers. Also, physiological differences between the sexes at this age are less dramatic than during or after adolescence;

Maturation – measured using a binary variable and recorded as part of the medical examination form, this indicated whether the medic had noticed signs that the child had begun to go through puberty;

Disability – measured using a binary variable indicating whether the child has a physical or mental disability which interferes with everyday life and might be a problem at school, answered by a parent (usually the mother) during the parental interview; and

Motor coordination – used as a proxy measure for innate (inherited) physical ability, motor coordination was measured using four binary indicators of ability to balance on one leg, recorded over two tests administered during the medical examination. The child was asked to stand on the right leg with the left foot against the knee of the right leg and hands on hips. The child

[1]BMI is also known as the Quetelet index and is calculated from weight in kilograms (w) and height (h) in metres: BMI=w/h^2

was then told to try to hold the position for 30 seconds (test 1). The medic recorded whether the hands or feet moved out of position within the 30 seconds. The test was then repeated with the child standing on the left leg (test 2). Evidence suggests that relative differences in coordination between children remain stable over time, despite generally improving with age (Vandorpe et al., 2012), and so these measures should serve as a reasonable proxy for innate physical ability.

Measures used to control for socioeconomic factors included:

Parental income – measured using an ordinal variable with six categories representing ranges of gross weekly parental income (including all earned and unearned income of both the mother and father before deductions for national insurance and tax, excluding income from other household members and child benefit), answered by a parent (usually the mother) during the parental interview;

Social class – measured using a variable with six categories representing the father's occupation, based on the Registrar General's classification (Rose and Pevalin, 2001), answered by a parent (usually the mother) during the parental interview; and

Parental education – measured using two variables, each with five categories, representing the level of the highest educational qualifications attained by the mother and father, answered by a parent (usually the mother) during the parental interview.

Measures used to control for the school environment included:

Class size – measured by the number of pupils in the cohort member's class, answered by the class teacher as part of the educational pack; and

School social mix – measured using an estimate of the percentage of pupils' fathers whose occupations were either professional/managerial (social class I) or clerical and other 'white collar' workers (social class II) in the cohort member's school, answered by the headmaster as part of the educational pack.

5.3 Analytical strategy

The analytical strategy for this chapter comprised two main stages:

1. **Preliminary analysis**
   (a) all variables were analysed by sex using cross-tabulation, bar charts and histograms in order to determine any interesting features in the data and compare the sexes; and
   (b) the variables measuring enjoyment, perceived ability and participation were used to estimate a pairwise correlation matrix to give a preliminary indication as to whether they were associated with one another, as might be expected according to the assertions of policy and the theories put forward in the academic literature.
2. **Path analysis**
   Several models were constructed in order to test whether:
   (a) participation in school sport and physical education was significantly associated with the positive outcomes commonly asserted by government policy;
   (b) participation in sport and exercise outside school was significantly associated with better experiences inside school, as suggested by family socialisation theory;
   (c) perceived ability mediated the relationship between participation and enjoyment, as suggested by self-determination theory; and
   (d) controlling for physiological, socioeconomic and school environment factors moderated the associations between the variables of interest.

5.4 Preliminary analysis

5.4.1 Experiences of sport and exercise

Research has consistently found that there are disparities in levels of physical activity between the sexes (Bauman et al., 2002; Biddle et al., 2011), with males generally being more active and participating in more sport and exercise than females. This disparity increases with age and is not present in very early childhood (<6 years, Hinkley et al., 2008). By adolescence, it becomes a consistent phenomenon across studies (Sallis et al., 2000). In order to identify whether this disparity had emerged by age 10 for the cohort members, the available data on enjoyment, perceived ability and participation were cross-tabulated by sex (Table 5.1).

Table 5.1: Cross-tabulation of measures relating to enjoyment, perceived ability and participation at age 10, by sex

<table>
<tr><th>Variable</th><th>Value</th><th>Female (%)</th><th></th><th>Male (%)</th><th></th></tr>
<tr><td>Likes team games</td><td>Yes</td><td>90.9</td><td>||||||||||||||||||</td><td>94.3</td><td>||||||||||||||||||</td></tr>
<tr><td></td><td>No</td><td>6.4</td><td>|</td><td>4.0</td><td></td></tr>
<tr><td></td><td>Don’t know</td><td>2.7</td><td></td><td>1.7</td><td></td></tr>
<tr><td>Does well in games</td><td>Well</td><td>84.5</td><td>||||||||||||||||</td><td>92.0</td><td>||||||||||||||||||</td></tr>
<tr><td></td><td>Not so well</td><td>15.5</td><td>|||</td><td>8.0</td><td>|</td></tr>
<tr><td>Does well in gymnastics</td><td>Well</td><td>49.2</td><td>|||||||||</td><td>41.9</td><td>||||||||</td></tr>
<tr><td></td><td>Not so well</td><td>50.8</td><td>||||||||||</td><td>58.1</td><td>|||||||||||</td></tr>
<tr><td>Plays sports in spare time</td><td>Often</td><td>41.7</td><td>||||||||</td><td>67.0</td><td>|||||||||||||</td></tr>
<tr><td></td><td>Sometimes</td><td>47.6</td><td>|||||||||</td><td>28.1</td><td>|||||</td></tr>
<tr><td></td><td>Never</td><td>10.7</td><td>||</td><td>4.9</td><td></td></tr>
<tr><td>Rides a bike in spare time</td><td>Often</td><td>50.9</td><td>||||||||||</td><td>69.0</td><td>|||||||||||||</td></tr>
<tr><td></td><td>Sometimes</td><td>38.4</td><td>|||||||</td><td>24.6</td><td>||||</td></tr>
<tr><td></td><td>Never</td><td>10.7</td><td>||</td><td>6.4</td><td>|</td></tr>
<tr><td>Swims in spare time</td><td>Often</td><td>54.9</td><td>||||||||||</td><td>56.3</td><td>|||||||||||</td></tr>
<tr><td></td><td>Sometimes</td><td>37.2</td><td>|||||||</td><td>34.7</td><td>||||||</td></tr>
<tr><td></td><td>Never</td><td>7.9</td><td>|</td><td>8.9</td><td>|</td></tr>
<tr><td></td><td></td><td>Female</td><td></td><td>Male</td><td></td></tr>
<tr><td>Hours PE per week</td><td>Mean</td><td>1.91</td><td></td><td>1.93</td><td></td></tr>
<tr><td></td><td>Std. dev.</td><td>0.68</td><td></td><td>0.72</td><td></td></tr>
</table>

Note: sample sizes on which figures are based vary between 5,559 and 6,502 per sex

Almost all of the cohort members enjoyed games at this age; with 90.9% of girls and 94.3% of boys reporting that they like team games. The measure of perceived ability in games presented a similar picture to the variable measuring enjoyment, with the vast majority of girls (84.5%) and boys (92.0%) reporting a high perceived ability. Nevertheless, twice as many girls did not have a high perceived ability in games (15.5%) compared to boys (8.0%). Perceived ability in gymnastics was far lower for both sexes: only 49.2% of girls and 41.9% of boys reported high perceived ability. This suggests there was something particular to gymnastics that affected perceptions of ability. The way in which it was taught in schools at the time could have been responsible for this dramatic difference. Games comprised team sports with little or no formal assessment of performance, and no obvious or precise way for children to compare ability. In contrast, gymnastics required children to perform in front of their classmates.

A national curriculum specification from 1989 supports this notion, stating that "children should have had experiences which enable them to: [...] perform sequences [...] copy sequences devised by others [...and...] reproduce some specific movement patterns, for example, in named skills such as handstands" by the age of 11 (Department of Education and Science, 1989). By emphasising individual performance and attainment, gymnastics exposed the cohort members to explicit comparisons of their abilities with those of their peers – a relative assessment that might be expected to result in half the children assessing themselves as worse than average and half as better than average.

In 1980, British culture exposed children to gender stereotypes which were arguably more polarised than today (Collins and Kay, 2003, pp.102-107). These would have encouraged boys' engagement and sporting identities whilst discouraging girls'. At 10 years of age, the children in the BCS70 may have reached a point in their lives where they became increasingly sensitive to these cultural norms. The measures of enjoyment and perceived ability seem to support this notion. In gymnastics, which is traditionally perceived as feminine, girls reported higher perceived ability than boys[2]. For team games, more commonly regarded as masculine activities, boys reported higher perceived ability and enjoyment. Unfortunately, there was no question in the BCS70 on enjoyment of gymnastics at age 10 for comparison.

Participation outside school was measured by asking cohort members' mothers what activities their children did in their spare time. Mothers were more likely to answer that boys 'often' play sports (67.0%) than girls (41.7%), with girls more than twice as likely to 'never or hardly ever' play sports (10.7%) compared to boys (4.9%). The proportions relating to the question on riding a bike were very similar to playing sports for boys, but for girls, more were reported to ride a bike often (50.9%) than play sports (41.7%). Girls were still less likely than boys (69.0%) to ride a bike often, however. The proportions who swam were approximately equal

[2] Girls also performed better on motor coordination tests (p.107), which would have offered an advantage in gymnastics.

across the two sexes, thus being the most frequent activity of the three for girls, and the least frequent for boys.

The mothers' answers suggested that sports participation outside school was highly gendered and, to a lesser degree, so was riding a bike. In contrast, there was no gender disparity for swimming. This may have been due to the perceived importance of swimming as a life skill for all. Local Education Authorities of the time were very active in promoting swimming (Department of Education and Science, 1978), with lessons often provided at local swimming pools.

The categories of the variables measuring participation outside school were somewhat vague, with 'sometimes' and 'often' not being defined explicitly. In an attempt to reduce error in the measures and increase the clarity of interpretation, simpler binary versions were derived indicating whether the cohort members participated in the activities 'often' or not. These binary variables were then used to identify whether cohort members frequently took part in combinations of these activities (Table 5.2). This analysis demonstrated further differences between the sexes. The most common combination of responses for girls described participation in none of the activities often (19.3%); for boys, only 7.6% had this combination of responses. The second most common combination for girls described participation in all of the activities often (17.8%); this was the most common combination for boys (32.3%). For both sexes, there was a large minority that were reported as participating often in only a single activity (around 25% of boys and 30% of girls).

Table 5.2: Cross-tabulation of activities the cohort member does 'often' in spare time at age 10, by sex

<table>
<tr><th>Activities</th><th>Female</th><th>(%)</th><th>Male</th><th>(%)</th></tr>
<tr><td>none</td><td>19.3</td><td>|||||||||||||||||||</td><td>7.6</td><td>|||||||</td></tr>
<tr><td>sports only</td><td>6.2</td><td>||||||</td><td>9.3</td><td>|||||||||</td></tr>
<tr><td>swim only</td><td>13.2</td><td>|||||||||||||</td><td>4.6</td><td>||||</td></tr>
<tr><td>bicycle only</td><td>12.3</td><td>||||||||||||</td><td>10.9</td><td>||||||||||</td></tr>
<tr><td>sports & swim</td><td>10.3</td><td>||||||||||</td><td>9.6</td><td>|||||||||</td></tr>
<tr><td>sports & bicycle</td><td>7.2</td><td>|||||||</td><td>15.9</td><td>|||||||||||||||</td></tr>
<tr><td>bicycle & swim</td><td>13.7</td><td>|||||||||||||</td><td>9.9</td><td>|||||||||</td></tr>
<tr><td>all</td><td>17.8</td><td>|||||||||||||||||</td><td>32.3</td><td>||||||||||||||||||||||||||||||||</td></tr>
</table>

Note: Female N=6,065; Male N=6,459

A count of how many of these activities each cohort member frequently participated in was derived (Table 5.3). It clearly demonstrated greater participation by boys. Because of the obvious limitations of these indicators, it is not possible to be absolutely certain that boys were more active than girls, but the data strongly indicate they tended to be.

Table 5.3: Cross-tabulation of how many of the activities the cohort member does 'often' in their spare time at age 10, by sex

<table>
<tr><th>Number of activities</th><th>Females</th><th>(%)</th><th>Males</th><th>(%)</th></tr>
<tr><td>0</td><td>19.3</td><td>||||||||||</td><td>7.6</td><td>||||</td></tr>
<tr><td>1</td><td>31.7</td><td>||||||||||||||||</td><td>24.7</td><td>||||||||||||</td></tr>
<tr><td>2</td><td>31.2</td><td>||||||||||||||||</td><td>35.3</td><td>||||||||||||||||||</td></tr>
<tr><td>3</td><td>17.8</td><td>|||||||||</td><td>32.3</td><td>||||||||||||||||</td></tr>
</table>

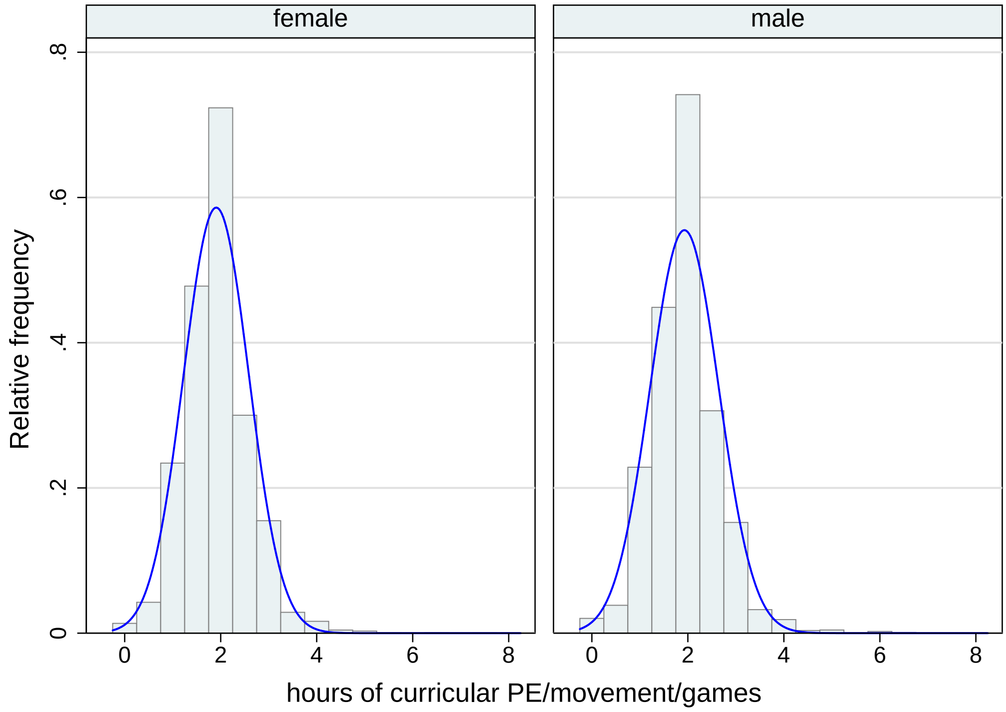
Note: Female N=6,065; Male N=6,459

Teachers' estimates of how many hours of curricular 'PE/movement/games' (hours of PE) the cohort members were engaged in per week were used to measure participation inside school. The mean curricular provision was just under two hours per week (1.92 hours), but there was quite a lot of variation, the standard deviation being 0.70 hours. The measured range was zero to eight hours per week. Histograms were plotted (Figure 5.1) showing that the distribution did not appear to differ by sex and was approximately normal, apart from being limited at zero, quite peaky (kurtosis 6.763), and having some positive skew (skewness 0.763).

The vast majority of cohort members (93.5%) experienced between 1 and 3 hours per week[3]. Primary schools at the time generally taught children in mixed sex classes (97.4% of cohort members in the BCS70 at age 10 were in schools that were mixed), and this was also true of school sport and physical education (Department of Education and Science, 1978); therefore, girls and boys would have participated with and against one another in team games and gymnastics.

[3]It is striking that the average curricular provision was around 2 hours per week in 1980. Over 20 years later, *Game Plan* (Department for Culture Media and Sport and Strategy Unit, 2002) included the aim of "ensuring that 75% of 5-16 year olds [are] spending at least 2 hours of high quality physical education and sport per week in *and beyond* the school curriculum by 2006" (emphasis added, Department for Culture Media and Sport and Strategy Unit, 2002, p.57) – i.e. in curricular *and* extra-curricular time.

Figure 5.1: Histograms of how many hours of curricular PE/movement/games the cohort member is engaged in per week during school periods at age 10, by sex



Note: Female N=5,645; Male N=5,995

5.4.2 Correlates of physical activity

Several of the commonly identified correlates of physical activity were available in the BCS70 data at age 10. Because differences in experiences between the sexes could have been caused by variation in these correlates, it was important to investigate them alongside the variables of interest. Table 5.4 shows the available data cross-tabulated by sex.

There were some notable differences between the sexes for the physiological factors. Slightly more girls than boys were underweight, overweight or obese. To some extent, this is due to the differing ages of maturation for boys and girls. The question on maturation showed that only a small minority of boys (4.7%) were showing signs of puberty, whereas over one quarter of girls (26.5%) were, and so, rather than being overweight or obese, some of these girls may have started their growth spurt and sexual development. Slightly more boys (8.8%) were also reported to suffer a disability than girls (6.7%). The girls were more likely to perform well in the motor coordination tests, with around 8% to 10% more boys

Table 5.4: Cross-tabulation of correlates of physical activity at age 10, by sex

Variable	Value	Female (%)	Male (%)
weight status	underweight	13.2	11.5
	normal weight	68.9	77.4
	overweight	11.7	7.5
	obese	6.2	3.6
maturation	yes	26.5	4.7
disabled	yes	6.7	8.8
motor coordination	test 1 moved foot	31.1	41.5
	test 1 moved hands	22.5	30.5
	test 2 moved foot	33.9	42.3
	test 2 moved hands	24.0	32.6
parental income	under £50/week	7.0	7.1
	£50 to £99 per week	30.4	29.5
	£100 to £149 per week	34.2	35.0
	£150 to £199 per week	16.0	16.9
	£200 to £249 per week	6.8	5.7
	£250+ per week	5.7	5.9
social class	I	6.0	6.2
	II	24.3	23.7
	III non-manual	9.0	9.1
	III manual	44.4	44.8
	IV	12.5	12.1
	V	3.8	4.1
mother's education	no qualifications	55.1	54.3
	trade apprentice	16.3	16.1
	O-levels	20.3	21.2
	A-levels	5.6	5.6
	degree	2.8	2.9
father's education	no qualifications	39.7	39.1
	trade apprentice	20.2	21.1
	O-levels	17.4	16.9
	A-levels	10.0	10.3
	degree	12.7	12.7
		Female	Male
class size	mean (no. pupils)	29.4	29.0
	standard deviation (no. pupils)	4.9	5.3
school social mix	mean (% of school)	35.7	35.2
	standard deviation (% of school)	25.3	25.3

Note: sample sizes on which figures are based vary between 5,426 and 6,467 per sex moving their hands or feet in each test to retain their balance. In contrast, the statistics for socioeconomic factors were very similar for both sexes, as were those for the school environment.

5.4.3 Pairwise correlations

A preliminary step in identifying whether enjoyment, perceived ability and participation were associated with one another in the BCS70 was to estimate simple pairwise correlations between the variables (Table 5.5). Where categorical variables had more than one category, derived binary versions were used. For the measure of enjoyment, this was a binary indicator for liking games. For the variables identifying participation outside school, these were the previously derived binary indicators of participating 'often' in spare time. Where the correlated measures were binary, tetrachoric correlations were estimated; biserial correlations were estimated where variables were correlated with the measure of participation inside school (hours of PE).

Table 5.5: Pairwise correlation matrix of experiences of sport and exercise at age 10, by sex – correlations for females are in the upper right triangle, correlations for males are in the lower left triangle

	1	2	3	4	5	6	7
1 enjoyment (games)	1	0.53	0.21	0.22	0.09	0.12	-0.03
2 perceived ability (games)	0.59	1	0.43	0.31	0.11	0.13	-0.03
3 perceived ability (gym.)	0.15	0.34	1	0.29	0.05	0.12	0.00
4 plays sports outside sch.	0.45	0.47	0.10	1	0.24	0.32	0.05
5 rides a bike outside sch.	-0.02	0.09	0.06	0.14	1	0.22	-0.03
6 swims outside school	0.07	0.12	0.05	0.26	0.22	1	0.08
7 hours of PE	0.01	0.02	-0.04	0.03	0.03	0.10	1

Note: Female N=4,948; Male N=5,206; table contains tetrachoric and biserial correlation coefficients, depending on the measurement level of the variables used to calculate the correlation

For girls, enjoyment and perceived ability correlated reasonably strongly. In comparison to Cohen's effect size conventions for the social sciences (Cohen, 1992), enjoyment of games was strongly correlated with perceived ability in games (0.53). Perceived ability in games was also strongly correlated with perceived ability in gymnastics (0.43), suggesting that girls' ability and perceptions of ability generalised across activity types inside school – i.e. girls who were good at games were also likely to be good at gymnastics. In terms of associations of experiences in school with participation outside school, there were small to medium sized correlations of enjoyment and perceived ability with playing sports (0.22 to 0.31) and small correlations of enjoyment and perceived ability with swimming (0.12 to 0.13) and riding a bike (0.05 to 0.11).

Considering that provision in schools tended to comprise mostly competitive, sport based activities, as opposed to recreational activities, this makes sense. The correlations amongst the various activities outside school (0.22 to 0.32) suggested that they were not entirely independent behaviours. Most notably, there seemed to be near-zero correlations (-0.03 to 0.08) between hours of PE and all other measures, suggesting that the amount of curricular provision was not an important determinant of experiences at age 10.

For boys, as with girls, enjoyment and perceived ability were correlated. Perceived ability in games was more strongly correlated with enjoyment for boys (0.59) than for girls (0.53). The correlation between perceived ability in games and gymnastics was slightly weaker for boys (0.34) than for girls (0.43). There were higher correlations of enjoyment and perceived ability in games with playing sports outside school for boys (0.45 and 0.47) as compared to girls (0.22 and 0.31), but only a low correlation with perceived ability in gymnastics (0.11), which was much higher for girls (0.29). As with girls, there were low correlations with swimming (0.05 to 0.12) and riding a bike outside school (-0.02 to 0.09), and medium sized correlations amongst the activities outside school (0.14 to 0.26), suggesting they were not entirely independent behaviours. There were near-zero correlations (-0.04 to 0.10) between hours of PE and all other measures for boys, as was the case for girls.

For both boys and girls, the strong associations between enjoyment and perceived ability in games mirrored the relationship between intrinsic motivation and competence proposed in self-determination theory (Ryan and Deci, 2000b). Playing sports outside school was associated with perceived ability and enjoyment inside school, providing some preliminary support for family socialisation theory (Fredricks and Eccles, 2003). The correlations of riding a bike and swimming with perceived ability and enjoyment were far smaller than those for playing sports outside school. It seems it was important to school experiences for children to develop sports skills, not simply be active. For girls, it seemed that perceived ability in gymnastics was a stronger correlate than for boys overall. This added to the evidence for stereotypically gendered experiences of sport and exercise. For both boys and girls, the hours of PE provided in school did not seem to be a strong correlate of any of the other measures, suggesting that primary school sport and physical education did not affect cohort members' experiences of sport and exercise generally.

In summary:

1. At age 10, most girls and boys enjoyed and had high perceived ability in games, but girls were around twice as likely not to enjoy games or report low perceived ability.

2. Low perceived ability was much more common in gymnastics, with around half the cohort members (and more boys than girls) reporting low perceived ability.

3. Participation in activities outside school varied greatly by sex. Boys were more likely to ride bikes and play sports often. In contrast, swimming was just as common amongst girls as boys.

4. The hours of PE in school were identical for boys and girls because nearly all schools and classes were mixed at age 10.

5. Girls were more likely to show signs of maturation than boys. More girls were underweight, overweight and obese, and they tended to have better motor coordination than the boys.

6. On average, there was little difference between the sexes in socioeconomic factors and school environment.

7. There were strong correlations between perceived ability and enjoyment for both sexes. Both were also correlated with playing sports outside school, highly for boys (except for perceived ability in gymnastics) and moderately for girls.

8. Low correlations of riding a bike and swimming with enjoyment and perceived ability suggested playing sports outside school was more beneficial to experiences inside school.

9. All of the correlations with hours of PE were near zero (except for swimming, which was low), suggesting school provision did not generally affect enjoyment, perceived ability or participation outside school.

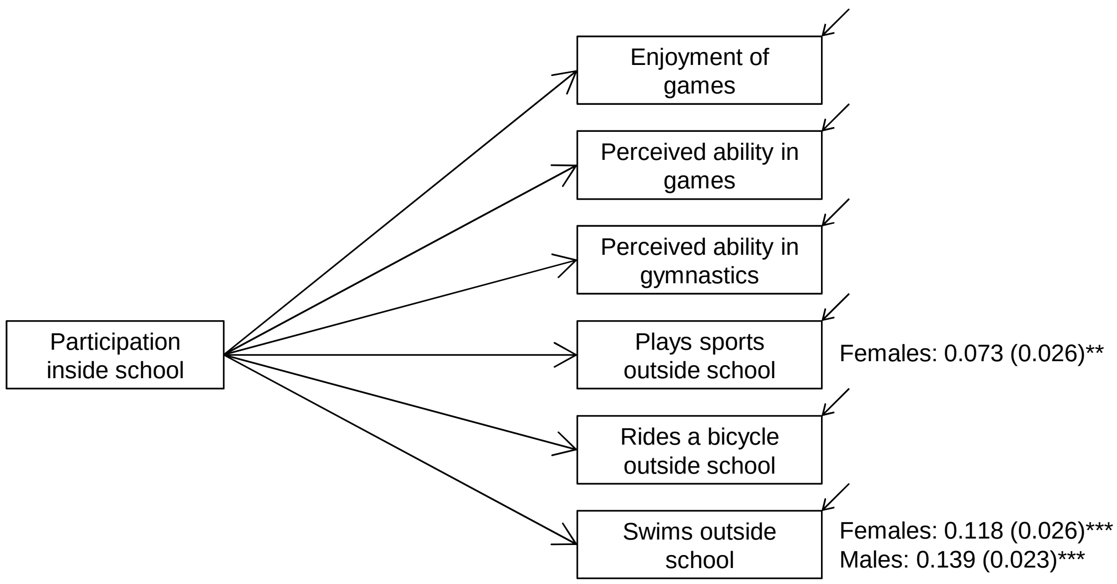
5.5 Path analysis

5.5.1 The effect of primary school sport and PE

Although the correlations suggested that hours of PE in school was only very weakly associated with the other measures, some of these associations may have been statistically significant and of interest to policy makers (Coe, 2002). A simple path model was created using hours of PE as a cause of enjoyment and perceived ability inside school, and participation outside school, in order to identify whether any of the associations were significant.

It is important to note that physical education generally aims to improve the *objective* skills and ability of children rather than perceived ability *per se*. In the BCS70, there is no direct measure of ability at age 10. Instead, the measures of perceived ability were used in the analysis because of their relevance to physical self-concept and intrinsic motivation. Nevertheless, one might expect perceived ability to closely match the relative ability of a child within their class. A diagram of the model showing the significant estimates is presented in Figure 5.2.

Figure 5.2: Path model used to identify the effect of participation inside school (hours of PE) on enjoyment, perceived ability, and participation outside school at age 10, by sex



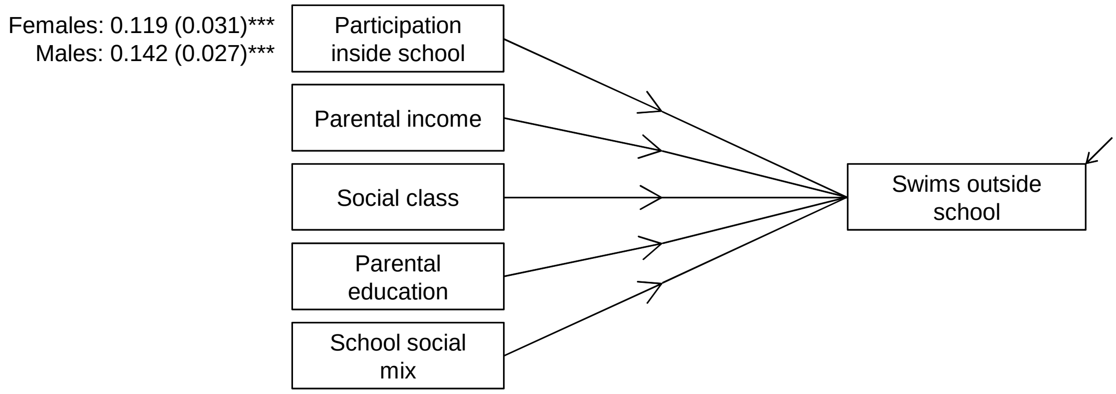
Note: Female N=5,634, Male N=5,978; probit estimates are followed by standard errors in parentheses

Hours of PE provision in school was significantly associated with swimming for both girls (0.118, p=0.000) and boys (0.139, p=0.000). For girls, it was also significantly associated with playing sports outside school (0.073, p=0.005). No significant associations were found between hours of PE and enjoyment of games, perceived ability in games or gymnastics, riding a bike and, for boys, playing sports outside school. Predicted probabilities of swimming and (for girls) playing sports outside school were calculated, comparing 1 hour of PE per week with 3 hours per week. For boys, the model predicted that 1 hour per week would be associated with 51.5% swimming 'often' outside school, whereas 3 hours would result in 62.4% swimming often. For girls, 1 hour per week was associated with 50.9% swimming often, and 60.2% for 3 hours per week.

Despite the effects being small, the resulting difference is large enough to be of interest to policy makers and suggests school provision had an impact on how many cohort members swam outside school. At this age, a large proportion of children in the sample would have received swimming lessons. Teaching children to swim was a common objective of Local Education Authorities at the time. The HMIS survey of schools in 1978 (Department of Education and Science, 1978) found that swimming provision increased with age, with two thirds of children at age 9 having swimming lessons in primary school, growing to 90% at age 11. For girls, the model made a more modest prediction for the change in probability of playing sports often outside school, with 1 hour of PE per week being associated with 37.7% playing often and 3 hours per week associated with 43.4% playing often – a difference of 5.7%.

The association of hours of PE with swimming could have been spurious, reflecting socioeconomic differences in school provision and family swimming. Cohort members attending schools where the social mix of the intake was high would also be more likely to come from high socioeconomic status families. These schools may have had access to more school sport and physical education, increasing the likelihood of swimming in spare time. Alternatively, parents of high socioeconomic status may have been more likely to take their children swimming regardless of school provision. Additional models were estimated that included controls for socioeconomic factors in an attempt to isolate these from the association of interest. Figure 5.3 shows a diagram of the model with the estimates relating to hours of PE shown.

Figure 5.3: Path model used to identify whether participation inside school (hours of PE) is significantly associated with swimming outside school controlling for socioeconomic factors at age 10, by sex



Note: Female N=3,725, Male N=4,098; probit estimates are followed by standard errors in parentheses

The addition of the control variables made no difference to the estimates, providing support for a causal explanation of the association of school provision with swimming outside school by cohort members. Tables containing all estimates from the models are presented in appendix A.

5.5.2 Socialisation into sport by the family

The previous analysis found that the hours of PE provided was not associated with enjoyment or perceived ability. An alternative model, based on family socialisation theory (Fredricks and Eccles, 2003), was specified. At age 10, the cohort members would have been largely dependent on their parents' support to be active (Welk et al., 2003; Brockman et al., 2009). This model posited that participation outside school may be related to positive experiences inside school, due to socialisation into sport by the parents and family – i.e. children who are active outside school develop physical skills and abilities which enable them to do well at and enjoy competitive school sports and physical education. A path diagram for this model is shown in Figure 5.4.

The three binary indicators for activity outside school (playing sports, riding a bike and swimming) were included in the path model simultaneously – i.e. each of the estimated coefficients control for participation in the other activities. For the sake of clarity, interactions between the activities were not included in the model.

Figure 5.4: Path model used to identify whether participation outside school is significantly associated with perceived ability and enjoyment inside school at age 10

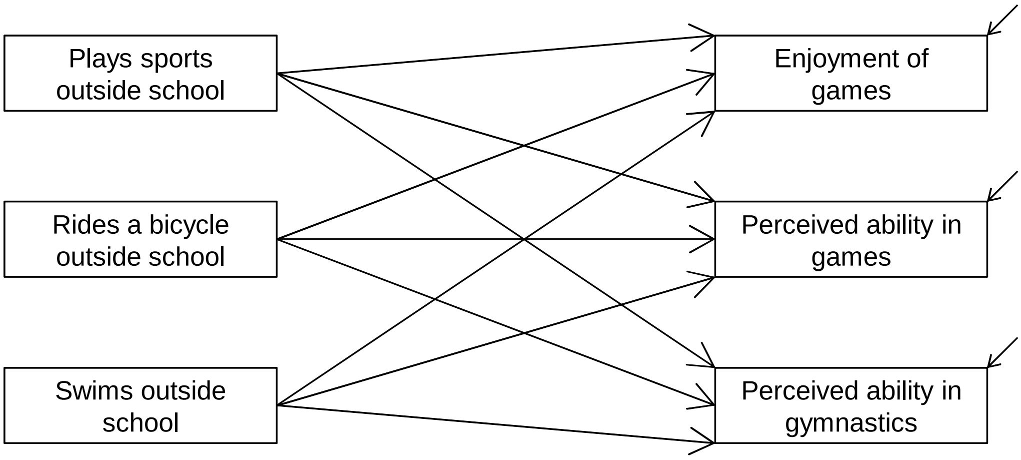


Table 5.6: Estimates for path model used to identify whether participation outside school is significantly associated with enjoyment and perceived ability inside school at age 10, by sex

Outcome	Explanatory variable	Estimate	S.E.	P-Value	
Females					
enjoyment (games)	← rides a bike	0.073	0.051	0.153	
	← swims	0.133	0.050	0.008	**
	← plays sports	0.323	0.054	0.000	***
perceived ability (games)	← rides a bike	0.092	0.044	0.037	*
	← swims	0.100	0.044	0.024	*
	← plays sports	0.491	0.048	0.000	***
perceived ability (gym.)	← rides a bike	0.006	0.036	0.861	
	← swims	0.107	0.037	0.004	**
	← plays sports	0.465	0.037	0.000	***
Males					
enjoyment (games)	← rides a bike	-0.106	0.066	0.112	
	← swims	-0.028	0.063	0.660	
	← plays sports	0.791	0.063	0.000	***
perceived ability (games)	← rides a bike	0.083	0.056	0.137	
	← swims	0.048	0.053	0.365	
	← plays sports	0.793	0.053	0.000	***
perceived ability (gym.)	← rides a bike	0.077	0.038	0.045	*
	← swims	0.042	0.036	0.245	
	← plays sports	0.154	0.038	0.000	***

Note: Female N=5,168, Male N=5,481

The resulting estimates are shown in Table 5.6. For girls, there were small significant associations of swimming outside school on enjoyment and perceived ability (0.100 to 0.133), and riding a bike on perceived ability in games (0.092). By far the strongest associations were for playing sports outside school on enjoyment and perceived ability inside school (0.323 to 0.491). For boys, apart from a borderline significant association of riding a bike with perceived ability in gymnastics (0.077, p=0.045), the only significant associations were for playing sports. These associations were very large for enjoyment (0.791, p=0.000) and perceived ability in games (0.793, p=0.000). For perceived ability in gymnastics, however, the association was quite small (0.154, p=0.000).

In each case, the coefficients for playing sports were much larger than those for swimming and riding a bike, a similar pattern to the correlations previously estimated (Table 5.5). It seemed that cohort members who frequently played sports outside school transferred these skills and interests into the school environment. The estimates again supported a stereotypical gender bias. Considering the size of the effects of playing sports outside school on enjoyment and perceived ability in games for boys, the effect on perceived ability in gymnastics was very low (0.154), and far lower than for girls (0.465). The largest effects for girls (0.465, 0.491) were also far smaller than those for boys (0.791, 0.793).

Table 5.7 shows predicted probabilities related to differences in playing sports outside school. The probability of having high perceived ability in gymnastics for girls was 18.4% greater for those who played sports compared to those who did not, and probability of high perceived ability in games was 12.0% greater. For boys, those that played sports had a 14.1% greater predicted probability of high perceived ability in games and an 8.5% greater probability of enjoying games. Playing sports outside school seemed to have a smaller effect on enjoyment of games for girls (5.7%) and perceived ability in gymnastics for boys (5.9%). There was a very big gender disparity in the predicted probabilities of high perceived ability in gymnastics. Boys who played sports often were not much more likely to have high perceived ability in gymnastics than those who did not. For girls, playing sports was associated with a much greater probability of reporting high perceived ability.

Table 5.7: Predicted probabilities of high perceived ability and enjoyment inside school associated with playing sports outside school at age 10, by sex

	Females (%)			*Males* (%)		
	sport	no sport	effect	sport	no sport	effect
enjoyment (games)	92.4	86.7	5.7	98.0	89.5	8.5
perceived ability (games)	89.1	77.1	12.0	95.4	81.3	14.1
perceived ability (gym.)	57.6	39.2	18.4	40.8	34.9	5.9

Note: the 'effect' columns shows the absolute difference between the predicted probabilities associated with frequently playing sports outside school ('sport') or not ('no sport')

Overall, this analysis provided considerable support for family socialisation theory. The cohort members' experiences of sport outside school seemed to largely determine whether they had positive experiences inside school. Considering the amount of curricular time given to school sport and physical education (1-3 hours per week), this is perhaps not very surprising. It seems unlikely this little provision would have much of an impact over and above participation by active children outside school and in school breaks. Conversely, it is unlikely to have provided inactive children with sufficient opportunity to catch up with active peers, especially considering they would be participating together in a competitive environment. For those children who were less active and less able, it is possible school provision entrenched negative self-perceptions, resulting in the kinds of detrimental childhood experiences reported in qualitative studies by adults (Coakley and White, 1992; Thompson et al., 2003; Strean, 2009).

An important caveat to this model regards the imposition of a direction of causality to the estimated effects. It is quite possible that a child might have positive experiences inside school and, as a result, increase their participation outside school. However, several arguments can be made for a preference for the direction of causality shown in the model:

1. the hours of PE provided in school were not convincingly associated with experiences of sport and exercise;
2. the amount of time spent engaging in school sport and physical education (approximately 2 hours per week on average) was likely not much compared with the amount of time active cohort members played sports outside school;
3. access to opportunities to play sports outside school can require transport and financial support by parents, acting as a potential barrier to participation regardless of perceived ability and enjoyment inside school; and

4. perceived ability is unlikely to cause increased participation outside school without the mediation of enjoyment, i.e. children of this age are unlikely to seek out opportunities to engage in activities they do not enjoy.

In summary:

1. The only consistent effect of hours of PE on experiences of sport and exercise at age 10 seemed to be on swimming outside school. The predicted probability of swimming often increased by ∼10% when comparing 1 to 3 hours of PE per week.
2. This effect was robust to the inclusion of socioeconomic controls, increasing support for a causal explanation: more school provision was responsible for more swimming outside school by cohort members.
3. For girls, there was also a small but significant effect of hours of PE on playing sports outside school. The predicted probability of playing sports increased by 5.7% when comparing 1 to 3 hours of PE per week.
4. In contrast, participation outside school (particularly in sports) had strong effects on experiences inside school. Playing sports often resulted in 12.0% more girls and 14.1% more boys predicted to have high perceived ability in games.
5. For girls, the largest effect of playing sports was on perceived ability in gymnastics; the predicted probability being 18.4% higher for those who played sports often. The effect for boys was far smaller, giving an increase in predicted probability of only 5.9%.
6. Overall, the analysis provided strong support for family socialisation theory.
7. It is possible that competitive school provision entrenched negative self-perceptions in less able and active children.

5.5.3 Mediation of enjoyment by perceived ability

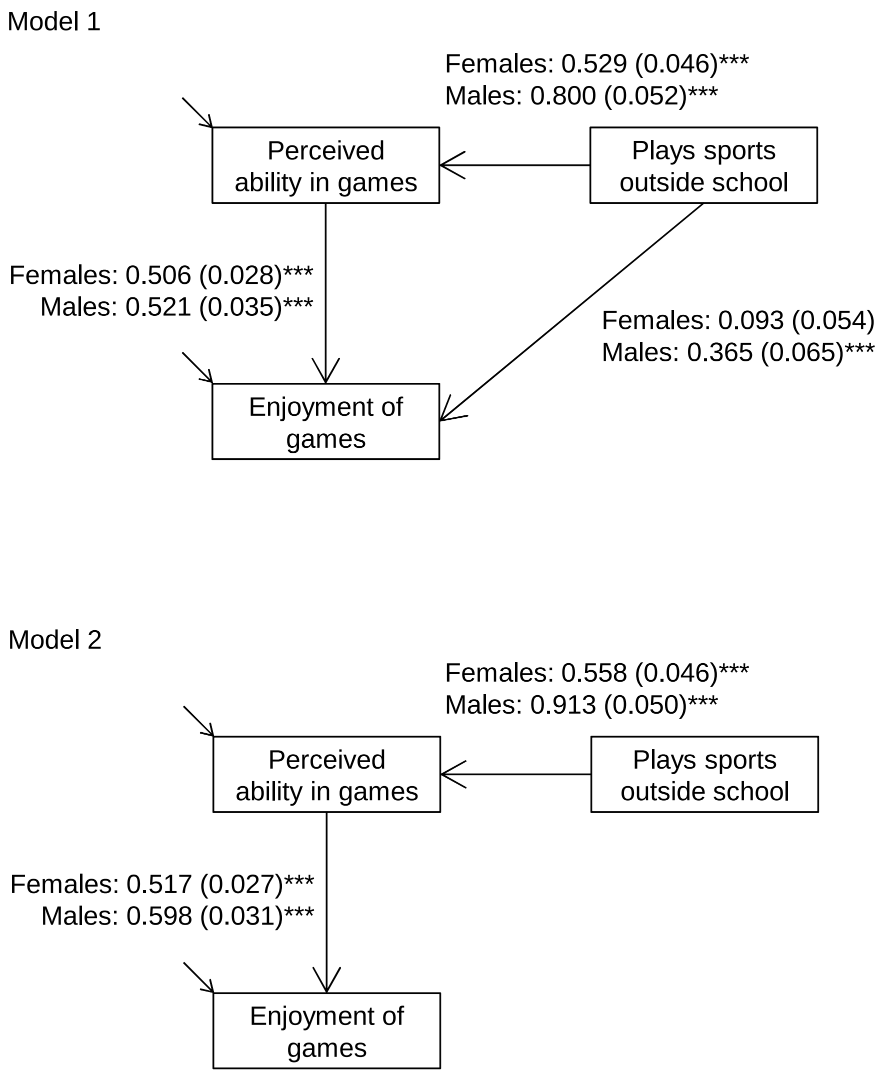
Self-determination theory suggests that perceived ability is an important mediator of the relationship between participation and enjoyment, i.e. people enjoy activities they feel competent at, and conversely, feelings of incompetence can reduce enjoyment (Ryan and Deci, 2000a,b). The pairwise correlation matrix (Table 5.5) had identified a strong association between perceived ability and enjoyment of games inside school. In Table 5.6, playing sports outside school had been found to have a strong effect on perceived ability in games inside school. Thus, perceived ability may have been acting as a mediator between playing sports outside school and enjoyment of games inside school. Path models were estimated to identify whether this mediation model was supported.

Two models were compared in order to test whether the mediation by perceived ability was partial or complete. Diagrams of the models, along with resulting parameter estimates, are shown in Figure 5.5. Complete mediation would mean that the association of playing sports outside school with enjoyment inside school was entirely due to associated changes in perceived ability, i.e. perceived ability was crucial to enjoyment and, without high perceived ability, playing sports frequently outside school did not result in enjoyment inside school.

For girls, estimates from Model 1 showed that the direct path from playing sports outside school to enjoyment of games was not significant, and this was confirmed with a χ^2 test of the nested models ($\chi^2(1)=2.913$, p=0.0879). This provided support for a model of complete mediation for girls, indicating that enjoyment of games was only associated with playing sports outside school through its association with perceived ability in games (as shown in Model 2). For boys, this was not the case, with the direct effect of playing sports on enjoyment being highly significant (0.365, p=0.000), i.e. playing sports was associated with enjoyment even when controlling for perceived ability. A χ^2 test of nested models confirmed this ($\chi^2(1)=31.473$, p=0.000).

In both cases, the indirect effect of playing sports on enjoyment was fairly large and highly significant, supporting the mediation hypothesis (0.288, p=0.000 for girls, and 0.417, p=0.000 for boys). The female model fitted the data well, with a $\chi^2(1)=2.913$ (p=0.0879), an RMSEA of 0.019 (90% CI: 0.000 to 0.046), a CFI of 0.996 and a TLI of 0.989. It was not possible to produce fit statistics for the preferred male model when freely estimated, due to there being no remaining degrees of freedom when the direct path from playing sports to enjoyment was included. A constraint was added to the model by fixing the path from playing sports to perceived ability to 0.8, thereby liberating a degree of freedom to test model fit. This model fitted the data perfectly, with a $\chi^2(1)=0.000$ (p=0.9899), an RMSEA of 0.000 (90% CI: 0.000 to 0.000), a CFI of 1.000 and a TLI of 1.005.

Figure 5.5: Models for testing whether perceived ability mediates the association of participation outside school with enjoyment inside school at age 10, by sex



Note: Female N=5,202, Male N=5,511; probit estimates are followed by standard errors in parentheses

For girls, these models suggested that playing sports outside school only affected enjoyment inside school through perceived ability. In contrast, boys who played sports outside school were more likely to enjoy games inside school regardless of their perceived ability. This may have been due to the general appeal of sports for boys due to cultural norms and gender stereotypes. The effect of playing sports on perceived ability was much higher for boys (0.800) than girls (0.558), implying that experience of sports outside school was more likely to transfer into high perceived ability inside school for boys. In both cases, perceived ability was found to be a crucial mediator of the relationship between participation outside school and enjoyment inside school.

5.5.4 Controlling for the correlates of physical activity

The mediation models estimated above were simplistic in the sense that they did not control for any of the correlates of physical activity commonly identified in the academic literature. This could have inflated the associations between the variables of interest. Also, playing sports outside school was treated as an exogenous variable, and so was assumed to be measured without error. In order to deal with these two limitations, additional control variables were included and tested according to how they were expected to influence experiences of sport and exercise.

Three sets of control variables were tested (see p.98 for descriptions of the variables):

Physiological factors – weight status, maturation, disability and motor coordination were hypothesised to be associated with playing sports outside school, and enjoyment and perceived ability in games inside school;

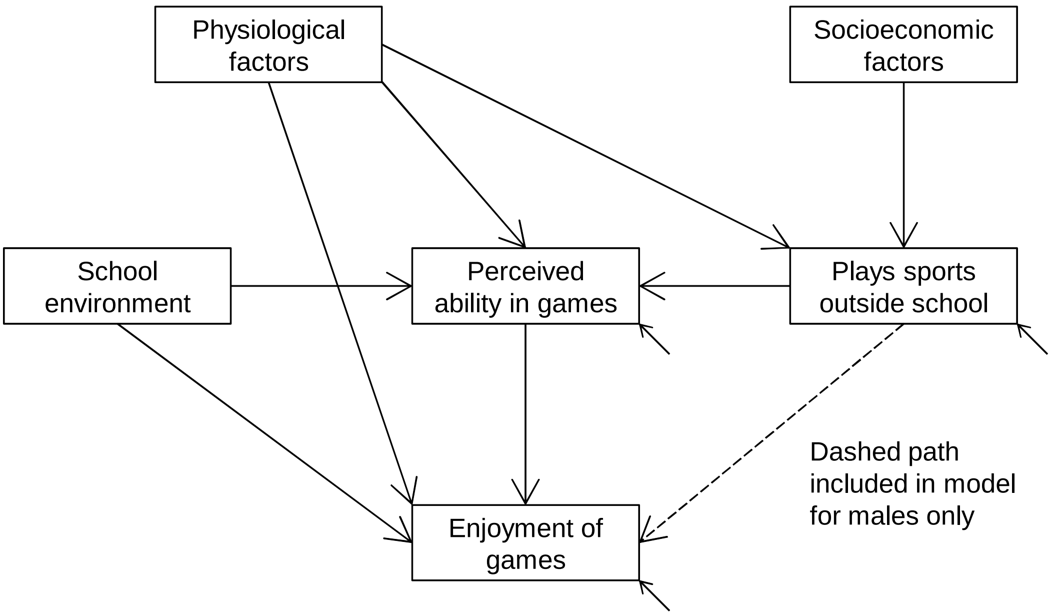
Socioeconomic factors – parental income, social class and parental education were hypothesised to be associated with playing sports outside school; and

School environment – class size and school social mix were hypothesised to be associated with enjoyment and perceived ability in games inside school.

Although four binary indicators of motor coordination were available, only a single indicator (for moving the foot during test 1) was used to measure motor coordination in subsequent analyses. The indicators were highly correlated, suggesting they represented manifestations of underlying motor coordination. In order to estimate this latent variable, a latent trait measurement model was constructed. The same model fit the data for both sexes and demonstrated strong measurement equivalence. As the final model indicated an almost perfect loading of the latent trait onto the first indicator (for moving the foot during test 1), it was decided to simplify the path models by using this single indicator as the measure of motor coordination. For further details of this latent trait analysis, see appendix B.

Figure 5.6 shows a diagram of the associations that were tested in the path analysis. The dashed path between playing sports outside school and enjoyment of games inside school was included only for boys, as the mediation analysis had determined. Backward selection based on χ^2 difference testing was used to remove non-significant paths in order to arrive at a parsimonious model.

Figure 5.6: Mediation model controlling for physiological, socioeconomic and school environment factors at age 10



For girls, the paths from the physiological factors to perceived ability and enjoyment were dropped ($\chi^2(12)$=11.864, p=0.4567), and the path between maturation and playing sports was also dropped ($\chi^2(1)$=1.191, p=0.2752). Tests of the socioeconomic factors resulted in the paths from parental income ($\chi^2(5)$=3.882, p=0.5665), social class ($\chi^2(5)$=7.123, p=0.2117), and parental education (mother: $\chi^2(4)$=6.832, p=0.1450; father: $\chi^2(4)$=6.825, p=0.1454) to playing sports being dropped. For the school environment, the paths from class size to perceived ability and enjoyment were dropped ($\chi^2(2)$=4.457, p=0.1077). The measure of participation inside school (hours of PE) was reintroduced to determine if it was associated with experiences of sport and exercise in this controlled model. For enjoyment, the association was not significant ($\chi^2(1)=1.013$, p=0.3143), but for playing sports (0.086, p=0.002) and perceived ability (-0.077, p=0.043) it was.

The estimates for the final model are shown in Table 5.8. The model fitted the data well, with a $\chi^2(13)=15.610$ (p=0.2708), RMSEA of 0.007 (90% CI: 0.000 to 0.017), a CFI of 0.996 and a TLI of 0.992.

Table 5.8: Estimates for mediation model for females controlling for physiological and school environment factors at age 10

Outcome	Explanatory variable	Estimate	S.E.	P-Value	
plays	← underweight	-0.131	0.058	0.025	*
sports	← overweight	-0.186	0.062	0.003	**
outside	← obese	-0.261	0.084	0.002	**
school	← disability	-0.239	0.087	0.006	**
	← motor coordination	0.164	0.042	0.000	***
	← hours of PE	0.086	0.028	0.002	**
perceived	← plays sports	0.364	0.033	0.000	***
ability	← school social mix	-0.263	0.098	0.007	**
(games)	← hours of PE	-0.077	0.038	0.043	*
enjoyment	← perceived ability (games)	0.652	0.048	0.000	***
(games)	← school social mix	0.349	0.130	0.007	**

Note: N=4,460; $\chi^2(13)=15.610$ (p=0.2708), RMSEA=0.007 (90% CI: 0.000 to 0.017), CFI=0.996, TLI=0.992; reference category for weight status is normal weight

The model suggested that physiological factors (weight status, disability and motor coordination) were important correlates of playing sports outside school for girls. The effect of being obese (-0.261) was comparable to that of disability (-0.239). Overweight and obesity may have made sport and exercise less appealing and more difficult, but low levels of activity can also lead to weight gain (Viner and Cole, 2006; Parsons et al., 2006). Additionally, both low activity and high weight could have been a result of parental influences, i.e. socialisation into poor health behaviour. Disability would have been a barrier to participation outside school due to access issues, as it is today (Beresford and Clarke, 2009; London Assembly, 2012). Motor coordination was associated with playing sports outside school (0.164), suggesting that those with innate physical ability may have been more likely to participate, though this effect was smaller than that of weight status or disability. Interestingly, physiological factors were not associated with perceived ability and enjoyment inside school, controlling for playing sports outside school.

This suggests that any effect of these factors on enjoyment and perceived ability was through their association with playing sports outside school.

School social mix was associated with perceived ability and enjoyment, with higher social class mixes being associated with lower perceived ability (-0.263) and more enjoyment (0.349). The opposite directions of these effects may have been due to it acting as a proxy for two correlated aspects of the school environment: quality of facilities and sporting ethos. It is possible that better facilities would provide more enjoyable and varied opportunities to participate, but a strong sporting ethos could have a detrimental effect on perceived ability. Small opposing effects were estimated for hours of PE, with more hours being associated with lower perceived ability (-0.077) and more participation in sports outside school (0.086). Again, more provision inside school could have reflected a stronger sporting ethos, detrimentally affecting perceived ability but also exposing the girls to a wider variety of sporting activities which could promote participation outside school, but these effects were relatively small.

Compared to the mediation model without controls, the association of playing sports with perceived ability was lower (0.364 compared to 0.558), suggesting that the school environment had an important impact on perceived ability. The association of perceived ability with enjoyment was higher (0.652 compared to 0.517), emphasising its importance as a crucial mediator of enjoyment. Parental income, social class and parental education were not associated with playing sports for girls, suggesting that access to opportunities to play sports outside school was not associated with parents' financial support or social background at this age. Of course, this does not negate the possibility that other forms of parental support (such as interest, encouragement and investment of time) were important to girls' participation.

For boys, as with girls, enjoyment was not associated with the physiological factors ($\chi^2(6)=4.520$, p=0.6067). The associations of motor coordination with perceived ability and playing sports ($\chi^2(2)=3.522$, p=0.1718), disability with perceived ability ($\chi^2(1)=2.580$, p=0.1082), and maturation with playing sports ($\chi^2(1)=2.645$, p=0.1039) were also dropped. For the socioeconomic factors, the associations of playing sports with income ($\chi^2(5)=8.635$, p=0.1245) and parental education (father: $\chi^2(4)=3.144$, p=0.5341; mother: $\chi^2(4)=6.790$, p=0.1474) were dropped, but social class was retained ($\chi^2(5)=23.991$, p=0.0002). In terms of the school environment, the association of class size with enjoyment was not significant ($\chi^2(1)=1.691$, p=0.1934). The separate associations of school social mix with perceived ability (-0.260, p=0.087) and enjoyment (-0.306, p=0.062) were not significant when included in the model simultaneously, but were retained as a χ^2 test showed that they did significantly improve the fit of the model (χ^2(2)=9.697, p=0.0078). Hours of PE per week was reintroduced to determine if it was now significantly associated with experiences of sport and exercise in this controlled model. A χ^2 test showed that it was still not significant (χ^2(3)=4.272, p=0.2336). The estimates for the final model are shown in Table 5.9. The model fitted the data well, with a χ^2(20)=31.707 (p=0.0465), RMSEA of 0.012 (90% CI: 0.002 to 0.019), a CFI of 0.980 and a TLI of 0.962.

Table 5.9: Estimates for mediation model for males controlling for physiological, socioeconomic and school environment factors at age 10

Outcome	Explanatory variable	Estimate	S.E.	P-Value	
plays sports outside school	← underweight	-0.064	0.063	0.312	
	← overweight	-0.219	0.078	0.005	**
	← obese	-0.475	0.107	0.000	***
	← disability	-0.453	0.074	0.000	***
	← social class II	0.100	0.092	0.273	
	← social class III non-manual	0.244	0.106	0.021	*
	← social class III manual	0.234	0.089	0.009	**
	← social class IV	0.198	0.104	0.057	
	← social class V	0.107	0.136	0.429	
perceived ability (games)	← plays sports	0.541	0.046	0.000	***
	← underweight	-0.110	0.104	0.288	
	← overweight	-0.197	0.119	0.098	
	← obese	-0.348	0.155	0.024	*
	← maturation	-0.302	0.152	0.047	*
	← class size	-0.019	0.008	0.011	*
	← school social mix	-0.260	0.152	0.087	
enjoyment (games)	← plays sports	0.304	0.057	0.000	***
	← perceived ability (games)	0.517	0.059	0.000	***
	← school social mix	-0.306	0.164	0.062	

Note: N=4,147; χ^2(20)=31.707 (p=0.0465), RMSEA=0.012 (90% CI: 0.002 to 0.019), CFI=0.980, TLI=0.962; reference categories are normal weight and social class I

Physiological factors were associated with both perceived ability and playing sports for boys. As with girls, weight status and disability had a dramatic effect on playing sports, with the effect of being obese (-0.475) comparable to the effect of disability (-0.453). Unlike for girls, weight status also had an effect on perceived ability. A perception of games as masculine may have made competition between boys more pronounced, causing weight status to have a more noticeable impact on both ability and perceived ability. Interestingly, motor coordination was not associated with playing sports for boys. Perhaps, as playing sports was more common amongst boys, any innate advantage of motor coordination could have been superseded by skills acquired through practice by this age.

Social class was associated with playing sports for boys, with social class III non-manual (0.244) and manual (0.234) occupations being associated with an increased likelihood of playing sports outside school as compared to the reference category of social class I (professional occupations). This pattern of association was unexpected and could be spurious – participation in sport and exercise is generally expected to be more common in high social classes. As for girls, the school social mix was associated with both perceived ability (-0.260) and enjoyment (-0.306), but both associations were negative, which was not the case for girls. It is possible that boys were more competitive than girls, and that this effect was more pronounced in schools with a high social class mix, impacting negatively on enjoyment for boys, but this difference between the two sexes is not easily explained.

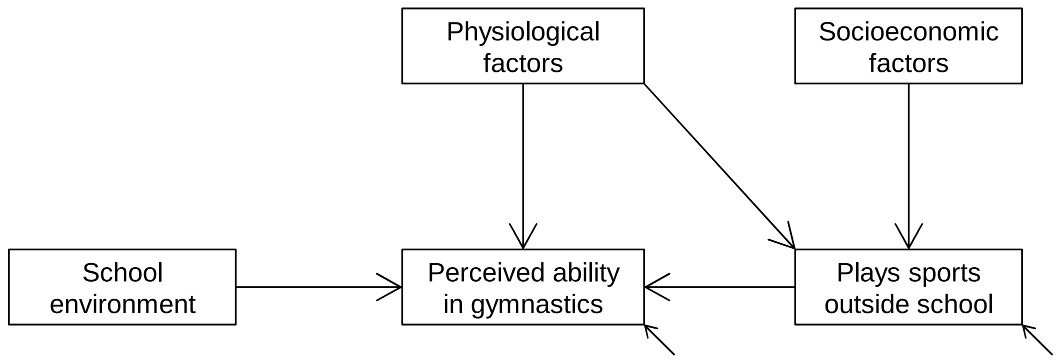
Class size was associated with perceived ability (-0.019) for boys, with larger class size associated with lower perceived ability. Frame of reference effects, commonly identified in the self-concept literature (Chanal et al., 2005; Seaton et al., 2009, 2010), offer a possible explanation for this. As class size increases, perception of ability tends to decrease because children compare their performance to the most able children. The more children there are in a class, the less likely an individual child will be amongst the most able. Research in the self-concept literature on class size effects in physical education is sparse, but a study on academic self-concept has found similar effects (Thijs et al., 2010), and the inherent importance of relative performance in competitive sport may compound this effect.

Compared to the mediation model without controls, the association of playing sports with perceived ability was lower (0.541 compared to 0.800), highlighting the importance of the physiological and school environment controls. The associations of perceived ability with playing sports and enjoyment were not significantly different. As with girls, the lack of association with parental income and education suggested that socioeconomic factors were not particularly important in providing opportunities for boys to play sports outside school. As with the previous analyses, there was no evidence that the hours of PE provision in school had any impact on experiences of sport and exercise for boys at age 10.

5.5.5 Modelling girls' perceived ability in gymnastics

Previously (p.114), it was found that there was a strong association of playing sports outside school with perceived ability in gymnastics inside school for girls. The predicted probability of high perceived ability for those who frequently played sports was 18.4% higher than for those who did not (Table 5.7). This supports the notion that gender stereotypes caused gymnastics to be more salient to girls than games. In order to investigate how this association was affected by inclusion of the correlates of physical activity, a similar modelling process was undertaken as above using the model shown in Figure 5.7. Unfortunately, there was no question on enjoyment of gymnastics in the BCS70 at age 10, and so it was not included in the model.

Figure 5.7: Model focusing on perceived ability in gymnastics for females, controlling for physiological, socioeconomic and school environment factors at age 10



For the physiological factors, disability ($\chi^2(1)$=1.342, p=0.2467) and motor co-ordination ($\chi^2(1)$=2.081, p=0.1492) were not associated with perceived ability, and maturation was not associated with playing sports ($\chi^2(1)$=2.244, p=0.1341) and so these were dropped. For the socioeconomic factors, the associations of parental income ($\chi^2(5)$=4.641, p=0.4612) and social class ($\chi^2(5)$=4.579, p=0.4693) with playing sports were not significant and were dropped, but the association with mother's education was retained ($\chi^2(4)$=12.345, p=0.0150). For the school environment, the association of school social mix with perceived ability was dropped ($\chi^2(1)$=2.835, p=0.0922). As before, hours of PE per week was reintroduced to the model. The association with perceived ability was not significant ($\chi^2(1)$=0.002, p=0.9607), but with playing sports it was (0.091, p=0.002).

The estimates for the final model are shown in Table 5.10. The model fitted the data well, with a $\chi^2(9)$=6.956 (p=0.6417), RMSEA of 0.000 (90% CI: 0.000 to

Table 5.10: Estimates for path model focusing on perceived ability in gymnastics for females, controlling for physiological, socioeconomic and school environment factors at age 10

Outcome	Explanatory variable	Estimate	S.E.	P-Value	
plays	← underweight	-0.080	0.060	0.181	
sports	← overweight	-0.143	0.064	0.025	*
outside	← obese	-0.206	0.090	0.022	*
school	← disability	-0.259	0.090	0.004	**
	← motor coordination	0.196	0.044	0.000	***
	← mother's educ. - trade appr.	0.155	0.056	0.006	**
	← mother's educ. - o-levels	0.059	0.052	0.259	
	← mother's educ. - a-levels	0.046	0.087	0.601	
	← mother's educ. - degree	-0.033	0.128	0.797	
	← hours of PE	0.091	0.030	0.002	**
perceived	← plays sports	0.309	0.027	0.000	***
ability	← underweight	0.114	0.061	0.060	
(gym.)	← overweight	-0.246	0.067	0.000	***
	← obese	-0.415	0.093	0.000	***
	← maturation	-0.184	0.049	0.000	***
	← class size	-0.012	0.004	0.006	**

Note: N=4,149; $\chi^2(9)=6.956$ (p=0.6417), RMSEA=0.000 (90% CI: 0.000 to 0.014), CFI=1.000, TLI=1.022; reference categories are normal weight and mother's education - no qualifications

0.014), a CFI of 1.000 and a TLI of 1.022. Unlike with the games focused model, physiological factors were associated with both playing sports and perceived ability in gymnastics. Interestingly, the variables retained in the model were similar to the model focusing on boys' perceived ability in games. This provides support for the notion that gymnastics was more salient for girls.

Weight status was associated with both playing sports and perceived ability in gymnastics. Previously, negative effects had been identified for being any weight other than the normal category. For gymnastics, this was no longer the case, with underweight being positively associated with high perceived ability (0.114, p=0.060), although the effect was of borderline significance. This is striking considering that gymnastics typically favours slender and flexible individuals. Maturation was negatively associated with perceived ability (-0.184), suggesting that those girls who had entered puberty may have been more self-conscious or less able to perform gymnastic activities. The association of disability with playing sports outside school was negative (-0.259), and for motor coordination was positive (0.196), as before.

Mother's education was not associated with playing sports, except for those for which a trade apprenticeship was the highest qualification held (0.155). As with social class in the model for boys, this effect is difficult to explain and could be spurious. Class size was negatively associated with perceived ability (-0.012), supporting the idea that frame of reference effects were at work. Hours of PE was positively associated with playing sports outside school (0.091), though the effect was small. The inclusion of controls reduced the association of playing sports with perceived ability (0.309 compared to 0.465) estimated previously (p.114), providing further support for the importance of physiological and school environment influences on experiences of sport and exercise. Again, the socioeconomic factors were not found to be important correlates. In contrast to the models focusing on perceived ability in games, the association of school social mix was not significant. Potential explanations for this include the possibility that primary school gymnastics was less dependent on equipment and facilities than team games, and/or that the school sporting ethos did not extend to gymnastics provision.

In summary:

1. Perceived ability mediated the association of participation outside school with enjoyment inside school for both sexes, as proposed by self-determination theory. For girls, complete mediation was supported.

2. There were some small associations of hours of PE with experiences of sport and exercise for girls, but not boys. Again, the hours of PE provided did not seem to be an important influence on experiences of sport and exercise.

3. Socioeconomic factors were not found to be important correlates of sport and exercise experiences.

4. Physiological factors were important correlates for both sexes. The effect of being obese on playing sports outside school was similar to being disabled. Disabled children may have had limited opportunities to play sports outside school.

5. Disability was not associated with perceived ability or enjoyment inside school, controlling for playing sports outside school, suggesting schools were relatively inclusive of disabled children.

6. For girls, motor coordination was associated with playing sports outside school. For boys, this was not the case. It is possible that their accumulated experience of sports superseded the influence of innate motor coordination.

7. The model focusing on perceived ability in games for boys exhibited similar effects to that focusing on perceived ability in gymnastics for girls. This supports the notion that gymnastics was more salient for girls, and games for boys.

8. The school social mix may have acted as a proxy for better facilities and a stronger sporting ethos. Girls enjoyment benefited, whereas their perceived ability suffered. Both suffered for boys. The greater salience of games for boys may have made a strong sporting ethos detrimental.

9. In the gymnastics model, there was some evidence that girls who were underweight had higher perceived ability, possibly because gymnastics favours slender, flexible individuals.

5.6 Conclusions

The analyses presented in this chapter sought to answer the following research questions:

- Is the amount of school sport and physical education at age 10 associated with positive experiences of sport and exercise?
- Is there evidence of family socialisation into sport and exercise at this age?
- Are differences between the sexes in experiences of sport and exercise already apparent by age 10? Are these differences indicative of gender stereotypes?
- Does perceived ability mediate enjoyment of school sport and physical education at age 10, as might be expected from self-determination theory?
- In what way are the correlates of physical activity associated with experiences of sport and exercise at age 10?

There was little evidence that the amount of sport and physical education provided in primary school was associated with positive experiences of sport and exercise at age 10. Considering that school provision averaged only 2 hours per week, this is not particularly surprising. Compared to the amount of time active young cohort members may have spent engaged in sport and exercise informally and outside school – e.g. in informal play during school breaks and at home or in leisure time – formal school provision was insignificant. The only notable, but small, effect was on swimming.

In contrast, there was strong evidence supporting the family socialisation theory. Playing sports frequently outside school was strongly associated with perceived ability and enjoyment inside school for both boys and girls. Parents' support seemed to play a crucial role in early engagement with sport. There was evidence that being active outside school was not enough on its own: the independent associations of riding a bike and swimming with experiences inside school were quite weak. Those cohort members with extensive experience of playing sports would have developed skills and ability in the types of activities commonly found in school provision – traditional, competitive sports – and this would lead to them having positive experiences in school.

There was extensive evidence of gender disparities at age 10. Outside school, boys were more active than girls, particularly in terms of playing sports. Swimming was an exception, where participation rates were practically identical. This is probably because of the importance of swimming as a life skill, and its heavy promotion by Local Education Authorities. Inside school, disparities were less pronounced because classes were generally mixed sex. Levels of enjoyment and perceived ability were also similar, but there was some evidence of the gender bias: perceived ability was higher in gymnastics for girls and games for boys. The path models revealed consistent evidence of these gender disparities, with gymnastics and games appearing more salient for girls and boys, respectively.

The relationships proposed in self-determination theory were supported by the path models: perceived ability played a crucial role in mediating enjoyment. For girls, the influence of playing sports outside school on enjoyment inside school was completely mediated by perceived ability, whereas for boys the mediation was partial, i.e. girls who had negative perceptions of their ability were less likely to enjoy games compared to those with positive perceptions of ability, regardless of whether they played sports outside school; for boys, although perceived ability was still very important, playing sports outside school was independently associated with enjoyment of games, even if they had negative perceptions of their ability inside school. This difference may have been due to the sheer popularity of sports amongst boys.

The associations estimated in the mediation models were relatively robust to the inclusion of correlates of physical activity. The association of playing sports outside school with perceived ability inside school was moderated somewhat in the controlled models. Physiological factors were found to be important correlates of experiences of sport and exercise at age 10. Weight status was a severe impediment to playing sports outside school for both girls and boys, and also affected perceived ability (in games for boys and gymnastics for girls).

The effect was large – the estimates for obesity were comparable to those of disability. The association with perceived ability demonstrates that overweight and obese cohort members were more likely to have negative experiences of sport and exercise in primary school, even if they played sports frequently outside school. These estimates suggest the possibility of a self-exacerbating situation: children who were overweight were more likely to have negative experiences of sport and exercise at school, potentially discouraging them from being active.

Disability was negatively associated with playing sports outside school, but not with perceived ability or enjoyment inside school. This suggests that school provision was relatively inclusive of disabled children, whereas opportunities outside school were more limited. Motor coordination was associated with playing sports outside school for girls, but not boys. As with the partial mediation of enjoyment, this may have been because of the popularity of sports for boys. Skills acquired though accumulated experience may have overridden the influence of innate motor coordination.

The effect of the school environment differed for girls and boys. For girls, school social mix was associated with lower perceived ability and more enjoyment, but for boys both effects were negative. It seems that a strong sporting ethos had a more pronounced negative effect for boys. High social class school mixes may have reflected more competitive, high pressure sporting environments, which particularly affected boys (assuming the measure acted as a reasonable proxy for sporting ethos). Interestingly, socioeconomic factors did not seem to play an important role in the models, suggesting that opportunities to participate in sports outside school were not strongly determined by family social class or financial support at age 10 in the BCS70.

Almost all the cohort members felt they did well at and enjoyed sport (team games) at this age. But the analyses presented in this chapter suggest that, even at such an early age, school provision was emphasising performance and encouraging peer comparisons of ability. Overweight and obese children may have been particularly susceptible to these effects, not only through the school environment, but also due to their lower levels of participation outside school. From a policy perspective, it is possible that school provision was counter-productive – discouraging the least active and exacerbating differences in participation that already existed outside of school. By subtly emphasising performance over participation, children with less skill and experience may have been discouraged from taking part.

Little evidence was found for the wide-ranging benefits of school sport and physical education commonly asserted in government policy today. In contrast, academic theory and research findings were strongly supported. Both family socialisation and self-determination theory provide good explanations for the estimated associations. The correlates of physical activity were also in evidence, with the associations corresponding well with those commonly found in the research literature (Biddle et al., 2011).

The following empirical chapter moves on from age 10 to analyse the cohort members' experiences of sport and exercise during secondary school, when they were aged 16. It first presents a thorough cross-sectional analysis, before examining the longitudinal association of their experiences at age 16 with those at age 10.

Chapter 6

Experiences of sport and exercise at age 16

6.1 Introduction

This empirical chapter first presents a cross-sectional analysis of the cohort members' experiences of sport and exercise during secondary school, when they were aged 16. It then goes on to identify how these experiences were longitudinally associated with those previously analysed, at age 10. It aims to answer the following main research questions:

- How does participation in sport and exercise inside school compare to that outside school at age 16?
- Is the amount of participation associated with positive experiences at this age?
- Are experiences of sport and exercise at age 16 associated with those at age 10?
- Is their further evidence of family socialisation into sport and exercise at age 16?

At a very young age, boys and girls tend to be equally active and enjoyment of physical activity is almost universal. Around age 6, they begin to diverge (Hinkley et al., 2008), with girls becoming less active than boys (Sallis et al., 2000;

Biddle et al., 2011). The analyses presented in the previous chapter identified corresponding differences between the sexes in the BCS70 at age 10. It was suggested that one of the reasons for this might be the stereotypically gendered nature of sport and exercise in UK culture, which has typically been reproduced by secondary school provision.

Historically, there has been a strong focus on getting children to participate in traditional, competitive sports (Donovan et al., 2006). This focus tends to strengthen throughout secondary school as children mature. Schools are generally keen to develop sporting talent, frequently provide opportunities for intra-school competition, and celebrate success in inter-school sports competitions. Competitive sports are seen to improve health, build 'character', lay the foundations of an active lifestyle, and enable talented children to make their way into elite sport. This characterisation of school sport, influenced by an elite sport discourse, has been common to government policies over the last 20 to 30 years (Department of National Heritage, 1995; Department for Culture Media and Sport, 2000; Department for Culture Media and Sport and Strategy Unit, 2002; Department for Children Schools and Families, 2008) and has recently undergone a resurgence (Gove, 2010; Department for Culture Media and Sport, 2012b).

This focus has been criticised as being counter-productive in the long term. Academic researchers have proposed that not only does a competitive focus reduce enjoyment for many (Coakley and White, 1992; Penney and Evans, 1997; Strean, 2009), but these experiences in school may also have detrimental consequences for participation throughout the lifecourse (Thompson et al., 2003; Green, 2004; Allender et al., 2006). Recent research has found that children can find the choice of activities on offer at school restrictive; many do not appreciate the focus on team games, and find the gendered availability of activities particularly frustrating (Smith et al., 2009).

The analysis presented in this chapter identifies and compares which activities the cohort members participated in inside and outside school at age 16. It looks at whether participation was associated with positive experiences of sport and exercise (in terms of intrinsic motivation and physical self-concept) and prepares a range of measures for use in the final empirical chapter, which looks at the links between childhood and adult experiences of sport and exercise. The analysis is then extended longitudinally, by looking at the influence of primary school experiences on those at age 16. The models investigate whether further evidence of family socialisation is provided by the cohort members' experiences at age 16. The main research questions are supplemented by the following additional questions:

- Was school provision focused on traditional, competitive sport?
- Were schools complicit in gender stereotyping of sport and exercise?
- Were there differences between the sexes in participation, intrinsic motivation and physical self-concept?
- Did the correlates of physical activity have an influence on experiences of sport and exercise?

The following sections are included in this chapter:

Variables – describes the measures used in the analyses;

Analytical strategy – describes the approach used to answer the research questions;

Cross-sectional analysis – presents descriptive and latent trait analyses of variables measuring participation, intrinsic motivation and physical self-concept relating to sport and exercise at age 16;

Longitudinal analysis – extends the analysis longitudinally, by identifying how experiences of sport and exercise at age 10 are associated with those at age 16, whilst controlling for the correlates of physical activity;

Conclusions – summarises the findings of this chapter.

6.2 Variables

A certain degree of pragmatism was necessary in identifying measures for particular concepts, and so some act as proxies and must be treated with a degree of caution. The main variables of interest relate to experiences of sport and exercise at age 16:

School sports environment – measured using a series of 16 binary or categorical variables, asking school headteachers whether PE and games were compulsory, if extra-curricular sports and team games were available at school, and which of 12 physical activities were compulsory, optional or not available at their school;

Participation – measured by cohort members answering a check list of 34 physical activities, identifying which sports they had played (when in season) during the past year both inside and outside school, giving 68 categorical variables. The response options were limited to either (a) at least once per week (≥1/wk) or (b) at least once per month (≥1/mth); no response implying very infrequent or non-participation;

Intrinsic motivation – measured using three categorical variables asking cohort members whether they were interested in physical fitness, keen on sports, and liked outdoor games;

Physical self-concept – measured using eight ordinal variables asking cohort members to compare themselves to an average teenager of the same age and sex. The questions identified the cohort members' self-perceptions of fitness, physical ability, whether they get out of breath when exercising, how often they take exercise, how often they do sport, the physical condition of their body, whether they look healthy, and their body shape; and

Sport ability – measured using a binary variable asking cohort members whether they had represented their school in any sporting activities during the last year. This variable was used as a proxy indicator for perceived ability (which is a sub-domain of physical self-concept), with those in school teams assumed to perceive themselves as more able. This proxy must be treated with caution as it is does not measure perceived ability *per se*, and neither is it a true measure of objective ability. The likelihood of representing a school at sport would be influenced by a multitude of other factors, such as the number of school teams, the size of the school, the range of activities for which there were teams, the average ability level in the school, the sporting ethos of the school, etc.

The main explanatory variables of interest were those measuring experiences of sport and exercise at age 10, included in the longitudinal analysis: (a) enjoyment of games, perceived ability in (b) games and (c) gymnastics, (d) playing sports often outside school, and (e) hours of PE inside school (see p.98 for more detail).

Additional variables were included in order to control for the influence of common correlates of physical activity. Variables measuring physiological factors, family socialisation into sport, socioeconomic factors, and aspects of the school environment were included. Measures used to control for physiological factors included:

Weight status – binary indicators of underweight, overweight and obesity at age 10 were derived. Data from age 10 was used in order to remove the risk of endogeneity – i.e. the influence of physical activity on weight status, rather than weight status on physical activity. The derived measures were calculated using the same approach used by the WHO in their 2007 growth reference (Dinsdale et al., 2011). This derivation differs to that used in the previous chapter, being calculated separately by sex. This method was chosen because secondary school sport and physical education classes were much more likely to be single sex at age 16, and there would be a far greater difference in the physiology of the sexes by this age;

Maturation – the same measure was used as in the previous chapter, a binary variable indicating whether the cohort member had begun to go through puberty at age 10;

Disability – measured using a binary variable indicating whether the child has a physical or mental disability which interferes with everyday life and might be a problem at school at age 10 and/or age 16, answered by a parent (usually the mother);

Motor coordination – the same measure was used as in the previous chapter, a binary indicator for moving the foot during the first motor coordination test at age 10;

Smoking – measured using a categorical variable asking the cohort member how frequently they smoked at age 16. Smoking was included because it affects lung function and is associated with other health related behaviours (Trost et al., 2002).

Measures used to control for family socialisation into an active lifestyle were collected during the age 16 wave and included:

Family recreation – measured using an ordinal variable asking the cohort member how often they do outdoor recreations with their parents (examples given were “play tennis, go jogging, swimming, etc.”);

Parental activity – measured using two binary variables indicating whether the mother and father exercise. The exercises included running/jogging, keep fit exercise, weight training or other exercise (excluding walking), answered by the mother; and

Parental values – measured using two binary variables, the first asking whether the mother thought physical fitness should be taught to teenagers at school; the second identifying whether the mother thought physical fitness was amongst the three most important in a list of 25 health and well-being related topics that should be taught to teenagers at school.

Measures used to control for socioeconomic factors were collected during the age 16 wave and included:

Parental income – measured using an ordinal variable with 11 categories representing ranges of gross weekly parental income (including all earned and unearned income of both the mother and father before deductions for national insurance and tax, excluding income from child benefit), answered by a parent (usually the mother) during the parental interview;

Social class – measured using a variable with six categories representing the father's occupation, based on the Registrar General's classification (Rose and Pevalin, 2001), answered by a parent (usually the mother) during the parental interview; and

Parental education – measured using two variables recording the ages at which the mother and father left full-time education, answered by a parent (usually the mother) during the parental interview. The ages were then grouped into five categories: <15, 15, 16, 17-20 and 21+.

Measures used to control for the school environment were collected during the age 16 wave and included:

School size – measured by the number of pupils (recoded to hundreds) in the cohort member's year, answered by the headteacher;

School social mix – measured using an estimate of the percentage of pupils' fathers whose occupations were professional/managerial (social class I) or clerical and other 'white collar' workers (social class II) in the cohort member's school, answered by the headteacher; and

Compulsory and extra-curricular provision – measured using the same questions used to measure 'School sports environment' described above (see p.135).

6.3 Analytical strategy

The analytical strategy for this chapter comprised three main stages:

1. **Cross-sectional analysis of participation**
   (a) a preliminary analysis of the headteachers' data relating to school provision and the cohort members' self-report of participation in physical activities (inside and outside school) was undertaken using histograms, cross-tabulation and bar charts, in order to examine how participation varied inside and outside school;
   (b) a pairwise correlation matrix was estimated using variables derived from the cohort members' participation data in order to identify whether different types, locations and frequencies of participation were associated with one another; and
   (c) latent trait measurement models of participation were developed in order to reduce the data, account for measurement error and compare the sexes on the latent measures.
2. **Cross-sectional analysis of intrinsic motivation and physical self-concept**
   (a) a preliminary analysis of the cohort members' self-report of their intrinsic motivation and physical self-concept was undertaken using cross-tabulation and bar charts in order to determine any interesting features in the data and identify disparities between the sexes;
   (b) a pairwise correlation matrix was estimated in order to identify whether the associations provided evidence of motivational factors and the subdomains of physical self-concept proposed in the academic literature (p.44); and
   (c) latent trait measurement models were developed in order to reduce the data, account for measurement error and compare the sexes on the latent measures.

3. **Longitudinal analysis from age 10 to age 16**
   (a) a preliminary analysis was undertaken by regressing the latent measures at age 16 on experiences of exercise at age 10;
   (b) additional variables were then included to control for physiological factors, family socialisation into an active lifestyle, socioeconomic factors and the school environment. Due to overlapping patterns of missing data substantially reducing the available sample size, this analysis was conducted on a multiply imputed dataset.

6.4 Cross-sectional analysis of participation

6.4.1 Provision of physical activities in school

Unfortunately, response to the wave at age 16 by headteachers was poor (providing coverage of N=4,215 cohort members). Also, it only partially overlapped the data on cohort members' participation in sport and exercise (combined coverage of N=2,765 cohort members). Despite this, the data offers a useful indication of how provision was generally structured in schools. Table 6.1 shows the percentage of these schools for which games and PE were compulsory, and the percentage that provided extra-curricular sports and team games. Games was compulsory in 60% and PE in 85% of the schools. Practically all schools provided extra-curricular sports and team games, according to the headteachers, although in around a third of the schools provision was suspended due to the teacher strikes occurring at the time. The headteacher dataset also contained variables identifying whether particular activities were optional or compulsory. Table 6.2 presents the responses to these questions.

Availability varied by activity. In the majority of the schools offering these activities, they were optional. Along with games being compulsory in only 60% of schools (Table 6.1), this suggests that most schools provided a degree of choice for their students. A cursory investigation into the patterns of response to the activity questions showed that the vast majority of schools offered choices, with only specific activities being compulsory, if at all. Only 34% of responding headteachers identified any activities as compulsory; and on average for these schools, around half of the activities in Table 6.2 were compulsory.

Table 6.1: Percentage of schools where games and PE were compulsory, and where extra-curricular sport and team games were available, for schools where the headteacher responded to the wave at age 16

Variable	Response	Percent
games compulsory	yes	59.8
PE compulsory	yes	85.5
extra-curricular sports	yes - available now	64.7
	yes - but suspended	34.7
	no - not available	0.7
extra-curricular team games	yes - available now	61.1
	yes - but suspended	37.9
	no - not available	1.1

Note: N∼1,250 schools, covering N∼4,150 cohort members

Table 6.2: Percentage of schools for which certain activities were compulsory, optional or not available, for schools where the headteacher responded to the wave at age 16

Activity	Compulsory	Optional	Not available
swimming	9.5	78.0	12.5
basketball	15.1	78.7	6.2
soccer	22.4	67.9	9.7
hockey	13.8	62.8	23.4
netball	17.7	55.9	26.4
rounders	21.4	71.6	7.0
rugby	16.7	71.6	11.8
volleyball	22.2	74.6	3.2
athletics	17.2	70.8	12.0
gymnastics	12.1	81.5	6.4
table tennis	3.1	87.4	9.5
tennis	23.2	68.8	7.9

Note: N∼1,100 schools, covering N∼4,000 cohort members

This supports the findings of the survey undertaken by Her Majesty's Inspectors of Schools between 1975 and 1978 (p.69), which found that more than 90% of schools included physical education and games as part of their core curricula. In most of the remaining schools, where it was an optional part of the curriculum, almost all children still took part. Generally, around three or four school periods per week were taken up by games, sports and physical education. It seems highly likely that the vast majority of cohort members participated in some form of both PE and games whilst at school at age 16.

The amount of time in the curriculum for physical education and school sport was greater on average at age 16 than at age 10. At age 10, the average was two hours per week (p.106), although there was quite a lot of variation around this. It seems likely that there would be a lot of variation at age 16 too, with schools varying in the amount of facilities and equipment they have available, as well as the amount of focus they put on sport in the curriculum and sporting ethos.

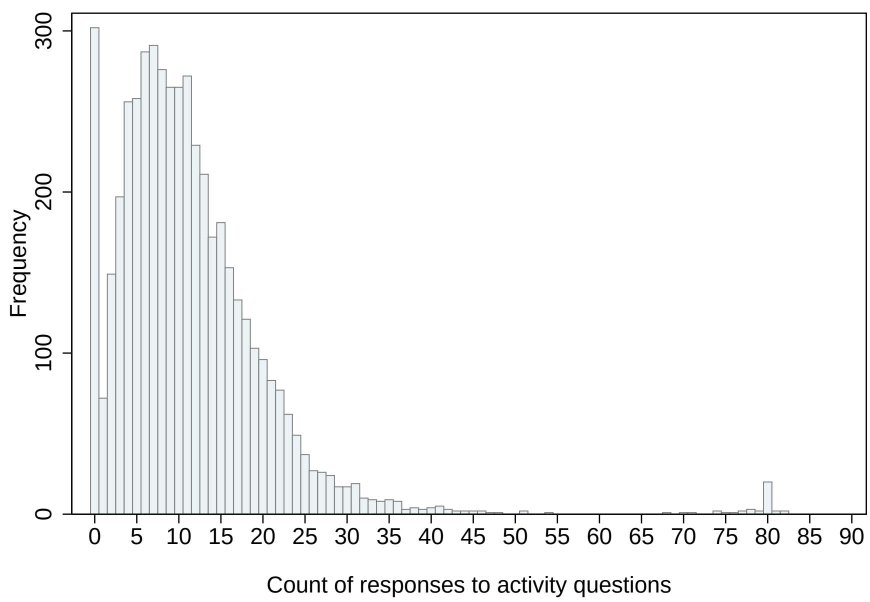
6.4.2 Participation inside and outside school

There was originally a total of 43 activities in the check list at age 16. Cohort members could answer with respect to participation both inside and outside school. The response options were limited to either (a) at least once per week (≥1/wk) or (b) at least once per month (≥1/mth), when the activity was in season; with no response implying very infrequent or non-participation. The set of questions included not only physical activities such as cycling, walking, football and tennis, but also other games and recreational activities, such as fishing, pool and snooker. Additionally, there were open responses allowed for 'other' activities respondents could include.

It seemed highly unlikely that any respondents would participate in none of the activities at all over the last year. There was a risk that non-response to this large set of questions, which was contained on one page of the survey instrument, would not be identifiable – as non-response would be recorded in the same way as a response indicating very infrequent or non-participation. In order to assess the likelihood of this, a histogram of the total number of responses to the entire set of questions was plotted (Figure 6.1).

It showed a zero-inflation that is likely to have been primarily caused by respondents missing the set of questions out. There was also some evidence of implausibly high levels of participation (>60 activities), typical of 'satisficing' (Krosnick et al., 1996), where the respondent has ticked everything because they have not responded seriously to the survey instrument. As a result, both of these sets of cases were recoded as missing items on the activity questions (6.2% of the available sample where no response was recorded, and 0.8% with implausibly high response).

Figure 6.1: Histogram of total number of responses to activity questions at age 16



Note: N=4,844

Tables 6.3 and 6.4 show the percentages of the remaining available sample answering that they participated in each of the *physical* activities, for girls and boys respectively, broken down by inside/outside school and the frequency of participation. The activities were grouped into 'lifestyle', 'team', 'individual' and 'adventure' activities as follows:

- **Lifestyle activities** – defined as those physical activities which are "individual, flexible, non-competitive and fitness-oriented" (Coalter, 1999), they are popular with both children and adults and do not generally form a large part of school provision. It has been suggested that experience of lifestyle activities in childhood may encourage lifelong participation in physical activity (Green, 2002a, 2004). Aerobics, cycling, dancing, jogging, fitness exercise, swimming, walking, weight training and roller/ice skating were identified as lifestyle activities by this definition (roller/ice skating was included on the assumption that most answers to this question would probably relate to roller skating as opposed to ice skating). Although swimming may have been competitively focused in school, it is included here because of its relevance to non-competitive leisure time participation.

- **Team activities** – defined as any sport where teams compete against one another. These sports are characteristically competitive, have traditionally formed a core part of school provision, and require the participation of many individuals (e.g. two teams of 11 players). They require significant organisation, facilities, and often referees or other auxiliary participants (linesmen, umpires, scorers, etc.) Baseball, basketball, cricket, football, hockey, netball, rounders, rugby, volleyball, and 'other' team activities were identified as fitting with this definition.

- **Individual activities** – these activities are differentiated from lifestyle activities because of their competitive focus. They are also generally less flexible than lifestyle activities, requiring appropriate facilities and equipment. They involve direct competition between two individuals, two pairs of individuals or many individuals competing against one another. Individual performance and success is central to participation, which is why they are conceptually different from team activities. Track & field, cross country, gymnastics, badminton, squash, table tennis and tennis were identified as fitting this definition.

- **Adventure activities** – water sports and outdoor/adventure activities were included in this definition. Generally, these are activities that require access to appropriate terrain or natural water bodies and also necessitate the use of specialised and expensive equipment; they are often non-competitive but are not flexible or primarily fitness-orientated. Canoeing, rowing, sailing, scrambling, skiing, water skiing and wind surfing were identified as fitting this definition.

As well as the open question for 'other' team activities, there was also an open question for 'other' individual activities. This could not be safely added to any of the groups defined above and so is presented separately at the bottom of Tables 6.3 and 6.4.

The contrast between participation inside and outside school was striking for both sexes. For girls, participation in lifestyle activities seemed to be considerably more

Table 6.3: Percentage of female cohort members participating in particular activities inside and outside school at age 16

<table>
<tr><td colspan="8">Females (N=2,539)</td></tr>
<tr><td></td><td colspan="3">Inside school (%)</td><td colspan="3">Outside school (%)</td><td>Difference</td></tr>
<tr><td>Activity</td><td>≥1/mth*</td><td>≥1/wk</td><td>bar chart</td><td>≥1/mth*</td><td>≥1/wk</td><td>bar chart</td><td>(%)</td></tr>
<tr><td>Lifestyle activities</td><td>30.2</td><td>46.1</td><td>61.5</td><td>52.5</td><td>68.6</td><td>83.4</td><td>-21.9</td></tr>
<tr><td>aerobics</td><td>10.6</td><td>17.9</td><td>|||||||</td><td>7.4</td><td>14.8</td><td>|||||</td><td>6.3</td></tr>
<tr><td>cycling</td><td>1.2</td><td>2.0</td><td></td><td>7.9</td><td>14.9</td><td>|||||</td><td>-19.6</td></tr>
<tr><td>dancing</td><td>5.1</td><td>8.8</td><td>|||</td><td>7.2</td><td>17.5</td><td>||||||</td><td>-10.8</td></tr>
<tr><td>jogging</td><td>6.4</td><td>6.3</td><td>|||</td><td>10.7</td><td>13.3</td><td>||||||</td><td>-11.3</td></tr>
<tr><td>fitness exercise</td><td>10.8</td><td>17.1</td><td>||||||</td><td>9.7</td><td>24.6</td><td>||||||||</td><td>-6.4</td></tr>
<tr><td>swimming</td><td>9.8</td><td>14.1</td><td>|||||</td><td>27.3</td><td>18.9</td><td>|||||||||||</td><td>-22.3</td></tr>
<tr><td>walking</td><td>1.8</td><td>15.6</td><td>||||</td><td>7.2</td><td>38.5</td><td>|||||||||||</td><td>-28.3</td></tr>
<tr><td>weight training</td><td>2.9</td><td>3.9</td><td>|</td><td>3.1</td><td>3.5</td><td>|</td><td>0.2</td></tr>
<tr><td>roller/ice skating</td><td>3.0</td><td>2.4</td><td>|</td><td>15.0</td><td>7.7</td><td>|||||</td><td>-17.3</td></tr>
<tr><td>Team activities</td><td>41.4</td><td>57.7</td><td>77.1</td><td>13.9</td><td>14.8</td><td>25.1</td><td>52.0</td></tr>
<tr><td>baseball</td><td>3.3</td><td>2.0</td><td>|</td><td>1.4</td><td>0.2</td><td></td><td>3.7</td></tr>
<tr><td>basketball</td><td>12.8</td><td>17.6</td><td>|||||||</td><td>2.1</td><td>1.7</td><td></td><td>26.6</td></tr>
<tr><td>cricket</td><td>1.9</td><td>0.6</td><td></td><td>2.0</td><td>0.8</td><td></td><td>-0.3</td></tr>
<tr><td>football</td><td>3.2</td><td>2.2</td><td>|</td><td>4.8</td><td>4.6</td><td>||</td><td>-4.0</td></tr>
<tr><td>hockey</td><td>17.0</td><td>31.2</td><td>||||||||||||</td><td>2.0</td><td>3.2</td><td>|</td><td>43.0</td></tr>
<tr><td>netball</td><td>20.8</td><td>34.7</td><td>|||||||||||||</td><td>1.9</td><td>3.9</td><td>|</td><td>49.7</td></tr>
<tr><td>rounders</td><td>18.6</td><td>31.6</td><td>||||||||||||</td><td>5.0</td><td>4.4</td><td>||</td><td>40.8</td></tr>
<tr><td>rugby</td><td>1.5</td><td>1.0</td><td></td><td>0.8</td><td>0.3</td><td></td><td>1.4</td></tr>
<tr><td>volleyball</td><td>15.8</td><td>19.9</td><td>||||||||</td><td>2.5</td><td>1.4</td><td></td><td>31.8</td></tr>
<tr><td>other team</td><td>0.8</td><td>2.7</td><td></td><td>0.6</td><td>1.1</td><td></td><td>1.8</td></tr>
<tr><td>Individual activities</td><td>38.1</td><td>55.7</td><td>73.3</td><td>25.4</td><td>29.4</td><td>46.4</td><td>26.9</td></tr>
<tr><td>track & field</td><td>13.0</td><td>16.8</td><td>|||||||</td><td>2.0</td><td>3.2</td><td>|</td><td>24.6</td></tr>
<tr><td>cross country</td><td>12.1</td><td>9.3</td><td>|||||</td><td>2.4</td><td>2.8</td><td>|</td><td>16.2</td></tr>
<tr><td>gymnastics</td><td>5.4</td><td>6.6</td><td>|||</td><td>1.7</td><td>1.9</td><td></td><td>8.4</td></tr>
<tr><td>badminton</td><td>16.6</td><td>35.9</td><td>|||||||||||||</td><td>8.8</td><td>9.5</td><td>||||</td><td>34.2</td></tr>
<tr><td>squash</td><td>4.9</td><td>8.1</td><td>|||</td><td>5.2</td><td>4.3</td><td>||</td><td>3.5</td></tr>
<tr><td>table tennis</td><td>8.6</td><td>10.7</td><td>||||</td><td>6.0</td><td>5.3</td><td>||</td><td>8.0</td></tr>
<tr><td>tennis</td><td>11.9</td><td>22.4</td><td>||||||||</td><td>9.5</td><td>13.7</td><td>|||||</td><td>11.1</td></tr>
<tr><td>Adventure activities</td><td>2.9</td><td>2.8</td><td>5.6</td><td>9.1</td><td>5.1</td><td>13.3</td><td>-7.7</td></tr>
<tr><td>canoeing</td><td>1.7</td><td>0.9</td><td></td><td>2.5</td><td>1.2</td><td></td><td>-1.1</td></tr>
<tr><td>rowing</td><td>0.2</td><td>0.2</td><td></td><td>1.3</td><td>0.5</td><td></td><td>-1.4</td></tr>
<tr><td>sailing</td><td>0.3</td><td>0.5</td><td></td><td>2.0</td><td>1.0</td><td></td><td>-2.2</td></tr>
<tr><td>scrambling</td><td>0.1</td><td>0.1</td><td></td><td>0.7</td><td>0.4</td><td></td><td>-0.9</td></tr>
<tr><td>skiing</td><td>0.8</td><td>0.7</td><td></td><td>2.1</td><td>1.1</td><td></td><td>-1.7</td></tr>
<tr><td>water skiing</td><td>0.3</td><td>0.4</td><td></td><td>1.2</td><td>1.2</td><td></td><td>-1.7</td></tr>
<tr><td>wind surfing</td><td>0.2</td><td>0.4</td><td></td><td>1.6</td><td>0.8</td><td></td><td>-1.8</td></tr>
<tr><td>other individual</td><td>0.4</td><td>2.0</td><td></td><td>0.6</td><td>1.3</td><td></td><td>0.5</td></tr>
</table>

Note: *columns ≥1/mth and ≥1/wk are mutually exclusive, the remainder from 100% represents no participation ≥1/mth when the activity is in season; rows with italicised headings show percentages participating in at least one of the activities in that type; bar charts represent any participation ≥1/mth (i.e. inclusive of ≥1/wk); last column shows the sum of inside school participation minus the sum of outside school participation; 'other' individual activities is presented separately at the bottom because it could not be placed safely within a group

Table 6.4: Percentage of male cohort members participating in particular activities inside and outside school at age 16

<table>
<tr><td colspan="8">Males (N=1,965)</td></tr>
<tr><th></th><th colspan="3">Inside school (%)</th><th colspan="3">Outside school (%)</th><th>Difference</th></tr>
<tr><th>Activity</th><th>≥1/mth*</th><th>≥1/wk</th><th>bar chart</th><th>≥1/mth*</th><th>≥1/wk</th><th>bar chart</th><th>(%)</th></tr>
<tr><td>Lifestyle activities</td><td>22.2</td><td>38.9</td><td>50.8</td><td>40.2</td><td>62.4</td><td>75.2</td><td>-24.4</td></tr>
<tr><td>aerobics</td><td>1.5</td><td>0.9</td><td></td><td>0.5</td><td>0.5</td><td></td><td>1.4</td></tr>
<tr><td>cycling</td><td>2.5</td><td>5.9</td><td>||</td><td>8.0</td><td>27.3</td><td>||||||||</td><td>-26.9</td></tr>
<tr><td>dancing</td><td>0.9</td><td>1.5</td><td></td><td>1.9</td><td>3.3</td><td>|</td><td>-2.8</td></tr>
<tr><td>jogging</td><td>5.6</td><td>7.9</td><td>|||</td><td>8.1</td><td>16.2</td><td>||||||</td><td>-10.8</td></tr>
<tr><td>fitness exercise</td><td>5.6</td><td>13.3</td><td>||||</td><td>4.7</td><td>21.4</td><td>||||||</td><td>-7.2</td></tr>
<tr><td>swimming</td><td>9.1</td><td>13.9</td><td>|||||</td><td>19.6</td><td>18.0</td><td>|||||||||</td><td>-14.6</td></tr>
<tr><td>walking</td><td>2.0</td><td>11.6</td><td>|||</td><td>6.7</td><td>24.4</td><td>|||||||</td><td>-17.5</td></tr>
<tr><td>weight training</td><td>6.6</td><td>11.2</td><td>||||</td><td>7.0</td><td>18.3</td><td>||||||</td><td>-7.5</td></tr>
<tr><td>roller/ice skating</td><td>1.8</td><td>1.2</td><td></td><td>6.5</td><td>4.0</td><td>||</td><td>-7.5</td></tr>
<tr><td>Team activities</td><td>47.0</td><td>66.7</td><td>81.9</td><td>29.1</td><td>49.7</td><td>64.7</td><td>17.2</td></tr>
<tr><td>baseball</td><td>9.8</td><td>7.9</td><td>||||</td><td>3.9</td><td>1.3</td><td>|</td><td>12.5</td></tr>
<tr><td>basketball</td><td>22.4</td><td>27.1</td><td>||||||||||||</td><td>4.5</td><td>3.6</td><td>||</td><td>41.4</td></tr>
<tr><td>cricket</td><td>17.4</td><td>23.2</td><td>||||||||||</td><td>9.4</td><td>15.1</td><td>||||||</td><td>16.1</td></tr>
<tr><td>football</td><td>16.1</td><td>49.4</td><td>||||||||||||||||</td><td>14.5</td><td>39.6</td><td>|||||||||||||</td><td>11.4</td></tr>
<tr><td>hockey</td><td>10.4</td><td>12.4</td><td>|||||</td><td>2.2</td><td>1.8</td><td>|</td><td>18.8</td></tr>
<tr><td>netball</td><td>2.4</td><td>0.3</td><td></td><td>0.8</td><td>0.2</td><td></td><td>1.7</td></tr>
<tr><td>rounders</td><td>6.2</td><td>3.1</td><td>||</td><td>2.4</td><td>1.3</td><td></td><td>5.6</td></tr>
<tr><td>rugby</td><td>13.6</td><td>21.1</td><td>||||||||</td><td>3.9</td><td>6.7</td><td>||</td><td>24.1</td></tr>
<tr><td>volleyball</td><td>11.9</td><td>13.5</td><td>||||||</td><td>2.6</td><td>1.9</td><td>|</td><td>20.9</td></tr>
<tr><td>other team</td><td>0.7</td><td>3.3</td><td>|</td><td>0.6</td><td>3.7</td><td>|</td><td>-0.3</td></tr>
<tr><td>Individual activities</td><td>37.9</td><td>50.1</td><td>68.1</td><td>29.8</td><td>35.7</td><td>52.1</td><td>16.0</td></tr>
<tr><td>track & field</td><td>15.3</td><td>19.0</td><td>||||||||</td><td>4.0</td><td>5.0</td><td>||</td><td>25.3</td></tr>
<tr><td>cross country</td><td>12.9</td><td>13.7</td><td>||||||</td><td>4.2</td><td>5.4</td><td>||</td><td>17.0</td></tr>
<tr><td>gymnastics</td><td>1.8</td><td>2.3</td><td>|</td><td>0.5</td><td>0.4</td><td></td><td>3.2</td></tr>
<tr><td>badminton</td><td>14.6</td><td>24.6</td><td>|||||||||</td><td>8.6</td><td>10.1</td><td>||||</td><td>20.5</td></tr>
<tr><td>squash</td><td>4.0</td><td>8.0</td><td>|||</td><td>7.6</td><td>7.0</td><td>|||</td><td>-2.6</td></tr>
<tr><td>table tennis</td><td>10.6</td><td>15.0</td><td>||||||</td><td>8.4</td><td>10.9</td><td>||||</td><td>6.3</td></tr>
<tr><td>tennis</td><td>9.1</td><td>14.6</td><td>|||||</td><td>9.8</td><td>14.4</td><td>||||||</td><td>-0.5</td></tr>
<tr><td>Adventure activities</td><td>5.5</td><td>5.5</td><td>10.2</td><td>14.2</td><td>12.6</td><td>24.2</td><td>-14.0</td></tr>
<tr><td>canoeing</td><td>3.1</td><td>1.9</td><td>|</td><td>5.1</td><td>2.6</td><td>|</td><td>-2.7</td></tr>
<tr><td>rowing</td><td>0.5</td><td>0.9</td><td></td><td>1.5</td><td>1.1</td><td></td><td>-1.2</td></tr>
<tr><td>sailing</td><td>0.4</td><td>1.2</td><td></td><td>2.8</td><td>1.3</td><td>|</td><td>-2.5</td></tr>
<tr><td>scrambling</td><td>0.3</td><td>0.9</td><td></td><td>2.3</td><td>4.7</td><td>|</td><td>-5.8</td></tr>
<tr><td>skiing</td><td>1.4</td><td>1.1</td><td></td><td>4.0</td><td>1.7</td><td>|</td><td>-3.2</td></tr>
<tr><td>water skiing</td><td>0.5</td><td>0.4</td><td></td><td>1.4</td><td>2.6</td><td>|</td><td>-3.1</td></tr>
<tr><td>wind surfing</td><td>0.5</td><td>0.6</td><td></td><td>1.6</td><td>1.6</td><td></td><td>-2.1</td></tr>
<tr><td>other individual</td><td>0.5</td><td>1.6</td><td></td><td>1.1</td><td>4.4</td><td>|</td><td>-3.4</td></tr>
</table>

Note: *columns ≥1/mth and ≥1/wk are mutually exclusive, the remainder from 100% represents no participation ≥1/mth when the activity is in season; rows with italicised headings show percentages participating in at least one of the activities in that type; bar charts represent any participation ≥1/mth (i.e. inclusive of ≥1/wk); last column shows the sum of inside school participation minus the sum of outside school participation; 'other' individual activities is presented separately at the bottom because it could not be placed safely within a group common outside than inside school – between 10% and 28% more girls participated outside in cycling, dancing, jogging, swimming, walking and roller/ice skating than inside school. The most dramatic contrasts between inside and outside school were in relation to team activities. A very high proportion of girls participated in team activities inside school, with basketball, hockey, netball, rounders and volleyball being quite common. Outside, however, only a very small minority participated in any team activities, resulting in a difference in participation rates of up to 50%. There were also some marked differences for the individual activities. Track & field and badminton were far more common inside school. Overall, 55.7% of girls participated in one or more of the individual activities at least once per week inside school, whereas outside only 29.4% did. The adventure activities were participated in by a small minority of the girls, and mostly infrequently.

For boys, a similar picture emerged but with some notable differences. As with girls, lifestyle activities were much more common outside than inside school, with cycling, jogging, swimming and walking being participated in by between 11% and 27% more boys outside than inside. Team activities were again the most commonly participated in inside school. However, whereas for girls there had been very little participation in any team activities outside school, many boys participated in football (39.6% at least once per week) and a large minority in cricket (15.1% at least once per week) outside school. Baseball, basketball, hockey, rugby and volleyball were also participated in inside school, but only a very small minority participated in these activities outside school. Of the individual activities, track & field, cross country and badminton were again much more common inside school, with participation being 17% to 25% higher than outside school. More boys participated in the adventure activities than girls but, as with girls, only a small minority participated in each one.

It seemed that the cohort members diversified in the activities they pursued between ages 10 and 16. At age 10, $\sim$90% of cohort members swam and cycled outside school. At age 16, this had reduced to 20-50%. This is probably a result of an increase in the variety of sporting opportunities available as the cohort members got older, allowing personal preferences to develop. Indeed, the difference in participation inside and outside school at age 16 is striking. Much of the participation outside school involved lifestyle activities, with some individual activities and, for boys, football and cricket.

There are several possible explanations for the high participation in lifestyle activities outside school:

- by definition, lifestyle activities are individual, accessible, convenient and flexible (Coalter, 1999), and so are easy to access and participate in spontaneously outside school, without the need for much in the way of equipment, facilities, organisation or the involvement of other people;
- it is possible that these activities were simply favoured by the cohort members over the alternatives because they are enjoyed and/or rewarding to participate in, are non-competitive, do not involve adult oversight, and are fitness orientated; and
- participating in certain (particularly team) activities frequently inside school may have caused the cohort members to seek out other activities outside school, simply for the sake of variety.

Comparing the two sexes, it is apparent that the activities were heavily gendered. Girls did not do weight training, play cricket, football or rugby. Boys did not do aerobics or dancing, play netball, and very few played rounders. Clearly gender stereotypes regarding sport and exercise were pervasive both inside and outside school during the 1980s. This builds on the indications of early gender disparities at age 10, where boys seemed to be more active in general in their spare time, and particularly in terms of playing sports (p.101). Comparing the BCS70 data to the most recent PE and Sport Survey (Quick et al., 2010), suggests there has been progress in the intervening years in terms of gender stereotyping. Schools report that football, cricket and rugby are now commonly made available to girls, and dance and rounders to boys (Quick et al., 2010, p.34). Of course, this does not mean that actual participation is as gender neutral as these statistics suggest.

Participation inside school appears to have been dominated by traditional team games and individual activities. The reasons for this are likely to be both practical and historical: team games allow a large number of children to participate with minimal supervision in a controlled environment; competitive sports are part of the cultural history of the country and have formed the core of school physical activity provision since the 1920s (Donovan et al., 2006); school prestige is frequently linked to success in inter-school competitions in these sports; elite sport is very popular; and many teachers of physical education have backgrounds in elite sports competition, bringing these values and preferences with them into the education system (Green, 2000, 2002b). In these respects, lifestyle activities may have been (and continue to be) of limited appeal to both PE teachers and their schools. It is interesting to note that provision inside school at age 10 was focused on gymnastics and games (p.34). This compares with a very small minority of cohort members taking part in gymnastics inside school at age 16 (12% of girls and 4% of boys), whereas around 80% of cohort members still took part in team games at age 16.

The two frequencies of participation recorded in the activity data represent different modes of participation. Whereas participating monthly in an activity suggests an irregular, opportunistic or casual form of participation, participating weekly indicates regularity and/or dedication to participate. These contrasting modes of participation can be juxtaposed with Côté's *Developmental Model of Sport Participation* (Côté, 1999; Côté et al., 2007), which describes 'sampling' as an infrequent mode of participation with little commitment or performance focus, and 'specialisation' as a more committed mode of participation, involving training for performance improvement in relatively few activities (p.39).

In practice, these phases can occur concurrently (e.g. children who are specialising in two or three activities may also continue to sample other activities that are made available to them). Comparing Côté's phases to the BCS70 data at age 16, infrequent participation (≥1/month) could be seen as analogous to sampling, and frequent participation (≥1/week) analogous to specialisation. Highly active cohort members would be more likely to specialise than less active cohort members (although it is possible to imagine a scenario where highly active cohort members 'invest' in only one or two activities – e.g. future elite sportsmen and women – this would be rare).

Sampling of activities would generally have little effect on activity levels, health and fitness, as compared to specialisation. Therefore, the analysis focused on the frequent participation data (≥1/week), which were reduced to create derived measures of sport and exercise participation. These were based on how many activities the cohort members frequently participated in at age 16, inside and outside school by each activity type. Only a small minority of cohort members participated in adventure activities, and so these were excluded. Because the resulting variables were all highly skewed, they were categorised to simplify the data structure and make substantive interpretation clearer (Min and Agresti, 2002). Table 6.5 shows the derived variables by sex.

Table 6.5: Derived sport and exercise participation variables at age 16 inside and outside school, by activity type and sex

<table>
<tr><th></th><th>Activity type</th><th>Count</th><th>Female</th><th></th><th>Male</th><th></th></tr>
<tr><td>Inside school</td><td>Lifestyle activities</td><td>none</td><td>53.9</td><td>|||||||||||||</td><td>61.1</td><td>|||||||||||||||</td></tr>
<tr><td></td><td></td><td>1</td><td>23</td><td>|||||</td><td>22.1</td><td>|||||</td></tr>
<tr><td></td><td></td><td>2+</td><td>23</td><td>|||||</td><td>16.8</td><td>||||</td></tr>
<tr><td></td><td>Team activities</td><td>none</td><td>42.3</td><td>||||||||||</td><td>33.3</td><td>||||||||</td></tr>
<tr><td></td><td></td><td>1 or 2</td><td>31.2</td><td>|||||||</td><td>40.3</td><td>||||||||||</td></tr>
<tr><td></td><td></td><td>3+</td><td>26.6</td><td>||||||</td><td>26.4</td><td>||||||</td></tr>
<tr><td></td><td>Individual activities</td><td>none</td><td>44.4</td><td>|||||||||||</td><td>49.9</td><td>||||||||||||</td></tr>
<tr><td></td><td></td><td>1 or 2</td><td>41.2</td><td>||||||||||</td><td>37.9</td><td>|||||||||</td></tr>
<tr><td></td><td></td><td>3+</td><td>14.4</td><td>|||</td><td>12.2</td><td>|||</td></tr>
<tr><td>Outside school</td><td>Lifestyle activities</td><td>none</td><td>31.4</td><td>|||||||</td><td>37.6</td><td>|||||||||</td></tr>
<tr><td></td><td></td><td>1 or 2</td><td>45.5</td><td>|||||||||||</td><td>43.6</td><td>||||||||||</td></tr>
<tr><td></td><td></td><td>3+</td><td>23.1</td><td>|||||</td><td>18.8</td><td>||||</td></tr>
<tr><td></td><td>Team activities</td><td>none</td><td>85.2</td><td>|||||||||||||||||||||</td><td>50.3</td><td>||||||||||||</td></tr>
<tr><td></td><td></td><td>1+</td><td>14.8</td><td>|||</td><td>49.7</td><td>||||||||||||</td></tr>
<tr><td></td><td>Individual activities</td><td>none</td><td>70.6</td><td>|||||||||||||||||</td><td>64.3</td><td>||||||||||||||||</td></tr>
<tr><td></td><td></td><td>1+</td><td>29.4</td><td>|||||||</td><td>35.7</td><td>||||||||</td></tr>
</table>

Note: for females N=2,539; for males N=1,965

Inside school, girls were more likely to participate in lifestyle activities than boys, with more participating in two or more (23.0% compared to 16.8%) and fewer participating in none (53.9% compared to 61.1%, respectively). Girls were less likely than boys to participate in team activities inside school, with 42.3% participating in none, compared to 33.3% of boys. The same proportion of girls and boys participated in three or more, however (26.6% and 26.4%, respectively). In terms of individual activities inside school, the proportions were very similar for both sexes. Girls seemed slightly more likely to participate than boys, with fewer responding that they did not participate (44.4% compared to 49.9%).

Outside school, again more girls than boys participated in lifestyle activities, with more boys not participating (37.6% compared to 31.4%). Participation in lifestyle activities was clearly more common outside school than inside for both boys and girls. In contrast, team activities were more common inside school, and for girls the difference was striking, with only 14.8% of girls participating outside school. The popularity of football and cricket amongst boys (p.146) was responsible for their team participation outside school. In terms of individual activities, again they were much more common inside school. Outside school, slightly more boys participated in them (35.7%) than girls (29.4%).

Additional analysis of the data for infrequent participation (≥1/month) is available in Appendix C. This found similar patterns in participation by activity type and sex, but that fewer activities in general were sampled than specialised in. The total number of activities experienced (irrespective of frequency) was also analysed. This found that more activities were experienced inside than outside school on average, and there was a large amount of variation in the number experienced by the cohort members. Interestingly, there was a minority who experienced no activities in both settings, but practically none irrespective of setting – i.e. those who were not active in one setting were in the other (p.272).

Using the derived variables shown in Table 6.5, a pairwise polychoric correlation matrix (shown in Table 6.6) was estimated in order to identify:

- whether participation in the different types of activity either inside or outside school were associated with one another, suggesting that cohort members who were active in a particular location tended to participate largely irrespective of activity type;
- whether participation in a particular type of activity inside school was associated with participation in that type of activity outside school, suggesting preference for participation in a particular type of activity; and
- whether the associations were different across the sexes, providing evidence for gender disparities at age 16.

Again, Cohen's effect size conventions for the social sciences (Cohen, 1992) were employed as a useful yardstick against which to compare correlations. These state that a correlation of 0.5 is large, 0.3 is medium sized, and 0.1 is low.

Table 6.6: Polychoric correlation matrix of derived sport and exercise participation variables at age 16, by setting, activity type and sex – correlations for females are shown in the upper right triangle, males in the lower left

		Inside school			Outside school		
		Lifestyle	Team	Individual	Lifestyle	Team	Individual
Inside school	Lifestyle		0.36	0.49	0.24	0.17	0.15
	Team	0.42		0.58	0.12	0.30	0.18
	Individual	0.48	0.55		0.11	0.22	0.32
Outside school	Lifestyle	0.43	0.17	0.23		0.24	0.36
	Team	0.19	0.39	0.18	0.32		0.39
	Individual	0.27	0.26	0.43	0.42	0.40	

Note: Female N=2,539, Male N=1,965

The highest correlations amongst variables related to whether participation was inside or outside school. For girls, the correlations inside school varied between 0.36 and 0.58. For boys, these correlations varied between 0.42 and 0.55. Outside school, the correlations for girls varied between 0.24 and 0.39. For boys, these correlations varied between 0.32 and 0.42. These estimates strongly suggest that those cohort members who were more active in a particular setting tended to be more active across all activity types.

The correlations between participation inside and outside school within activity types were also moderate to high. For girls, the within-activity correlations varied from 0.24 to 0.32. For boys, these correlations varied between 0.39 and 0.43. These estimates suggest that cohort members may also have been exercising preferences for particular types of activity – i.e. participation inside school in a particular activity type was associated with participation in the same activity type outside school.

The difference in correlations between the sexes were generally small. The biggest difference between the sexes involved the correlation between participation inside and outside school in lifestyle activities, which was higher for boys (0.43) than girls (0.24). This may have been due to lifestyle activities being a popular choice amongst girls outside school even if they did not participate in those activities within the school environment.

Additional analysis of correlations, including measures derived from the infrequent participation (≥1/month) data, is available in Appendix C. As well as identifying similar patterns of association as above, this analysis also found that frequent participation (≥1/week) was generally independent of infrequent participation (≥1/month), with most correlations near zero. This corresponds well with Côté's *Developmental Model of Sport Participation* (1999; 2007), which states that sampling and specialisation can occur concurrently.

In summary:

1. PE was compulsory in most schools (85%), whereas games was less likely to be compulsory (60%).

2. Headmasters reported that most activities were optional, despite participation generally being compulsory.

3. A survey of schools conducted 10 years before (Department of Education and Science, 1979) had found that where physical education and games were optional, almost all children still took part.

4. There seemed to be more curricular time available for school sport and physical education at age 16 (3 to 4 periods/hours per week) than at age 10 (1 to 3 hours per week) on average.

5. Extra-curricular activities were available in all schools, though in many they had been suspended at the time of the survey because of the teachers' strike.

6. For both sexes, participation in lifestyle activities was much more common outside than inside school. This may have been due to convenience, preference and/or lack of provision.

7. Team activities were much more common inside than outside school. Outside school only a small minority of girls took part, whereas many boys played football or cricket.

8. Individual activities were more common inside than outside school for both boys and girls. Track & field, cross country and badminton were much more common inside school.

9. At age 10, practically all cohort members would have participated in gymnastics, whereas very few did at age 16. Team games were practically universal at age 10 and remained common at age 16. There was greater variety at age 16 due to the introduction of individual competitive activities at school.

10. The activities were heavily gendered both inside and outside school at age 16. Cohort members did not take part in gender atypical activities. Boys did not take part in aerobics, dance, netball, rounders and gymnastics. Girls did not take part in weight training, cricket, football and rugby.

11. Outside school, boys appeared to participate more than girls, except in lifestyle activities. Inside school, participation was broadly similar, although boys were more likely to participate in team activities, and girls in lifestyle and individual activities.

12. Frequent participation in activities (≥1/week) was generally uncorrelated with infrequent particiation (≥1/month) for both boys and girls. This suggests that sampling or recreational participation was largely independent of specialisation or investment participation.

13. The derived participation variables correlated strongly within settings (inside/outside school). This suggests that cohort members mostly participated in a particular setting irrespective of activity type.

14. The correlations within activity types (across settings) were also moderate to high, however. This suggests that cohort members may have been able to exercise preferences for particular activities, to some extent.

15. The correlations were similar for boys and girls, suggesting that there were not large gender disparities in the way participation in different settings and activity types covaried.

6.4.3 Constructing latent trait measures of participation

The patterning of correlations in Table 6.6 implied two processes underlying the cohort members' participation:

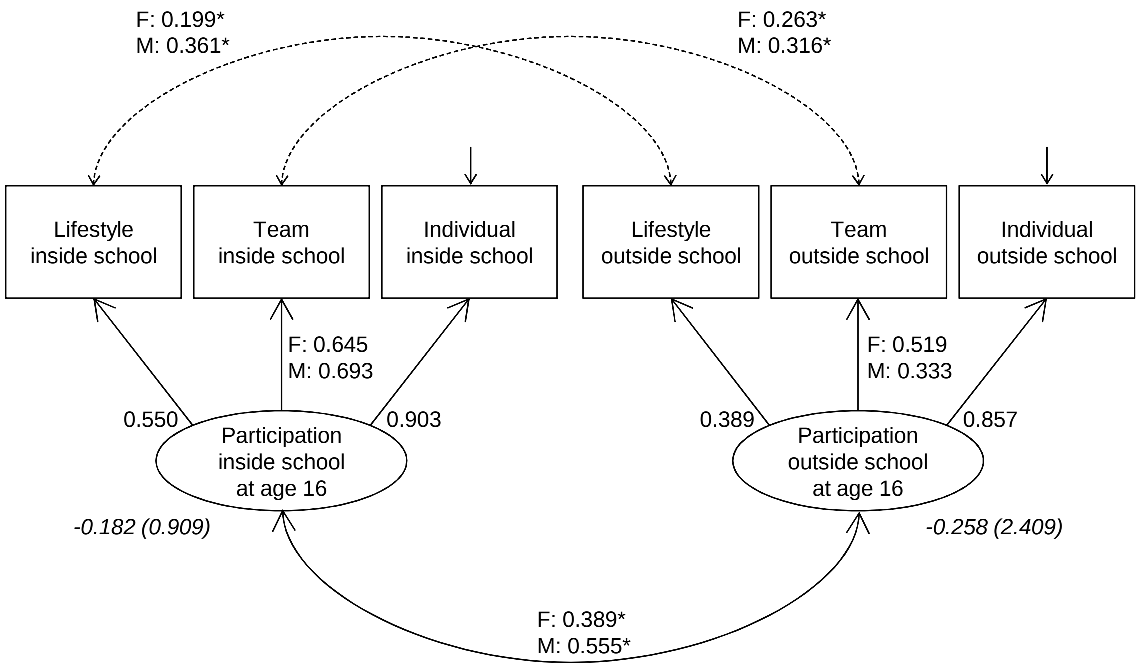
1. **Participation inside/outside school** – cohort members who participated more in a particular setting were more likely to participate there irrespective of activity type; and
2. **Participation in particular activity types** – cohort members who participated more in a particular activity type were more likely to participate in that type irrespective of setting.

In order to draw out these two processes from the activity data, two latent trait models of participation were specified in order to isolate the variance attributable to each process. Only the variables derived from the frequent participation data (≥1/week) were used as indicators of the latent traits. This is because cohort members would participate frequently in more activities if they were (a) more active, and/or (b) preferred a particular activity type. Conversely, infrequent participation (sampling) could occur irrespective of activity level, and would not be expected to demonstrate strong preferences. The initial specification for participation inside/outside school (along with the results of the final model) is shown in Figure 6.2.

The model fitting and testing is described in detail in Appendix C.2. In order to fit the data well, the residuals between the items measuring team and lifestyle activity were allowed to correlate in both the male and female models. This provided evidence that both processes (activity by setting and preference) were underlying the measured associations. Multigroup testing by sex was undertaken to determine whether the models were equivalent. Strict measurement equivalence was not supported as the items measuring team activity varied by sex. Considering only a minority of girls participated in team activities outside school, and more boys participated inside school, this is not particularly surprising. Once these items were allowed to vary between the sexes, the model demonstrated good (i.e. 'partial') equivalence (Byrne et al., 1989; Byrne, 2008).

It was apparent that the final specification was a form of 'multi-trait multi-method (MTMM) model'. In this case, there are two participation traits (settings), and

Figure 6.2: Path diagram showing initial measurement model of participation inside and outside school at age 16 (solid paths) and final model with added residual correlations (dashed paths) and estimates from multigroup testing for males (M) and females (F)



Note: Female N=2,539, Male N=1,965; estimates in italics are latent means and (variances) for males, these are constrained to 0 and 1 for females, respectively; estimates marked with an asterisk are standardised/correlations; χ^2(15)=63.997 (p=0.0000), RMSEA 0.038 (90% CI: 0.029 to 0.048), CFI 0.989, TLI 0.978

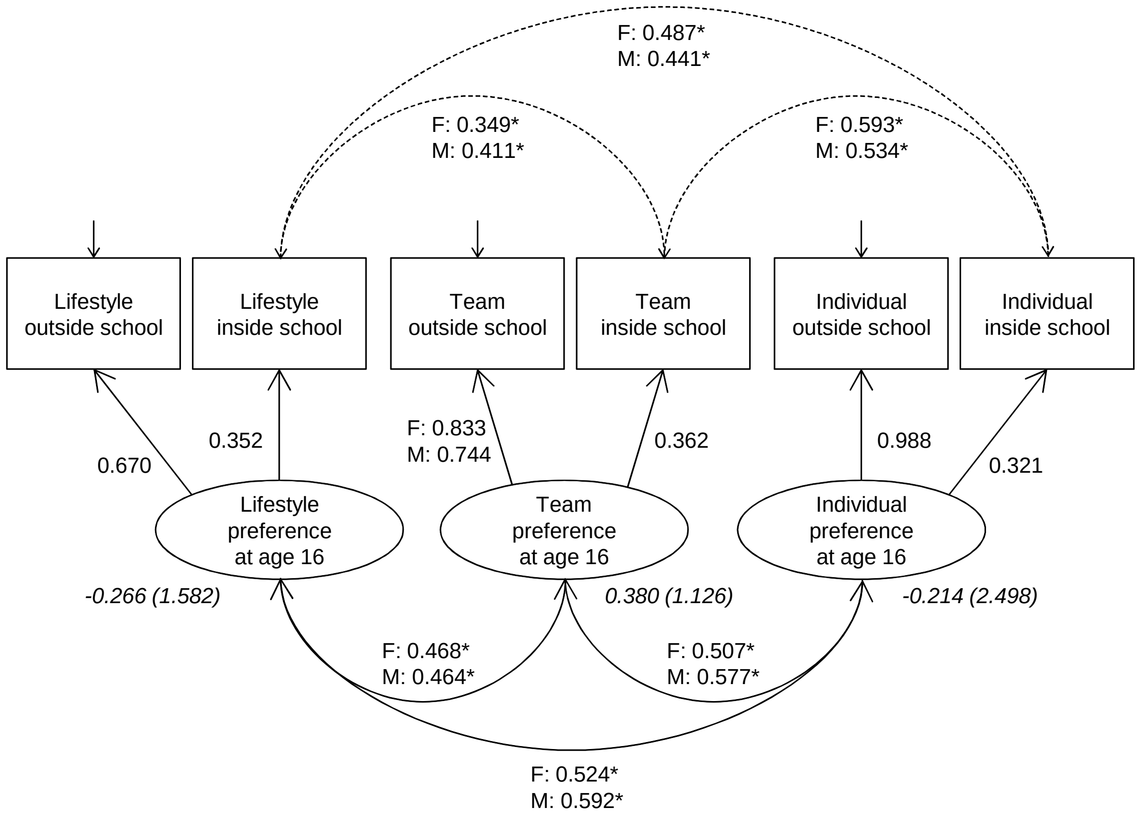
three methods (activity types), which together explain the variance in the measured items. A variety of models have been developed in the literature for these types of process: the original MTMM model (Campbell and Fiske, 1959; Lance et al., 2002), the 'correlated uniqueness model' developed by Marsh (1989; 1991) and the 'multi-trait multi-method minus one model' (MTMM-1, Nussbeck et al., 2006). The advantage of the last of these is that it allows the estimation of method factors, whilst avoiding problems relating to over-fitting in traditional MTMM models. The model shown in Figure 6.2 is a more parsimonious version of an MTMM-1 model which, like the correlated uniqueness model, allows residuals to correlate instead of including method factors (p.87).

The latent parameters of the model suggested that mean participation was lower for boys (-0.182 inside and -0.258 outside) than girls, but the differential functioning of team activity affected this result. Girls did participate in more lifestyle and individual activities inside school, however (p.150), and so the latent difference inside school is more plausible. The variance of the factor for participation outside school was much larger for boys (2.409) than for girls, suggesting a much greater degree of variability amongst boys in this setting. The variance of the factor for participation inside school was not significantly different between sexes, suggesting that opportunities to participate in activity *per se* were not gendered (despite the specific activities being gendered). The correlations between the factors were reasonably high for both boys (0.555) and girls (0.389). This suggests that those cohort members who participated more in one setting also tended to participate more in the other setting, this association being stronger for the boys. Nevertheless, a large amount of variation in each factor remained unaccounted for.

Models were also fitted according to the second specification, which focused on participation in particular activity types. The initial specification and results of the final model are shown in Figure 6.3. The model fitting and testing is described in detail in Appendix C.2. In order to fit the data well, the residuals between the items measuring participation inside school were allowed to correlate in both the male and female models, again supporting a dual process/MTMM model structure. Multigroup testing by sex was undertaken to determine whether the models were equivalent. Strict measurement equivalence was not supported as full constraint caused the estimated variance of team activity outside school to be negative. Again, the striking difference between the sexes in participation in team activities (outside school, in this case) was responsible. Allowing this item to vary between groups resulted in a well-fitting model with a proper solution and good equivalence.

The latent parameters of the model suggested that mean participation in lifestyle activities was lower for boys (-0.266) than for girls, whereas participation in team activities was higher (0.380). The difference for individual activities was only just significant at the 5% level, and so not particularly convincing. These results mirrored those presented previously, in Table 6.5. The variances of the lifestyle and individual factors were much higher for boys (1.582 and 2.498, respectively) than for girls. The team factor was susceptible to the differential item functioning of team activity outside school, and so is not reliable. The correlations between the factors, which were equivalent across the sexes, varied between 0.46 and 0.59. This suggests that cohort members tended to participate irrespective of activity type. As with the previous model, there remained sizeable scope for additional factors to influence participation in particular activity types.

Figure 6.3: Path diagram showing initial measurement model of participation in different types of activity at age 16 (solid paths) and final model with added residual correlations (dashed paths) and estimates from multigroup testing for males (M) and females (F)



Note: Female N=2,539, Male N=1,965; estimates in italics are latent means and (variances) for males, these are constrained to 0 and 1 for females, respectively; estimates marked with an asterisk are standardised/correlations; $\chi^2(9)=31.736$ (p=0.0002), RMSEA 0.033 (90% CI: 0.021 to 0.047), CFI 0.995, TLI 0.983

In summary:

1. The latent trait models supported the notion that two processes (participation by setting and activity type) were underlying the indicators.

2. The models demonstrated good measurement equivalence, except where team activity outside school was concerned. This was because girls did not tend to participate in these activities outside school.

3. The means of the factors suggested participation inside school was higher for girls. Lifestyle activity was higher for girls, whereas team activity was lower.

4. The variance of the factor for participation outside school was much larger

for boys than girls, suggesting boys were less homogeneous. The variance of the lifestyle and individual factors were also higher for boys.

5. The factors for participation inside/outside school correlated more strongly for boys than girls. The correlations between factors for types of activity did not vary by sex.

6. The correlations were quite high but there remained sizeable scope for additional processes (other than an underlying level of activity) to influence participation by setting and type.

6.5 Cross-sectional analysis of intrinsic motivation and physical self-concept

6.5.1 Preliminary analysis

There are several questions in the BCS70 at age 16 that relate to intrinsic motivation for sport and exercise. Table 6.7 shows the percentage breakdown of responses for these variables by sex. For interest in physical fitness, the sexes were very similar, except that boys were more likely to be very interested (47.8% compared to 38.6%). By far the biggest difference was for agreement with the statement “I am keen on sports”. Boys were around twice as likely to say that this ‘applies very much’ to them (50.2% compared to 25.5%), with girls nearly twice as likely to say that it ‘does not apply’ (31.1% compared to 17.3%). When asked whether they liked outdoor games, girls were somewhat less likely to say they did than boys. Together, the responses suggest that girls were not particularly keen on traditional sports, despite being motivated by fitness considerations. It is common for girls to perceive being ‘sporty’ as unfeminine (Allender et al., 2006; Rees et al., 2001) and traditional sports have been criticised in the academic literature for being dominated by a masculine discourse of competition and elitism (Stevenson, 2002; Kirk, 2004a, 2005). Also, female elite sport typically does not receive a high level of coverage in the media (Godoy-Pressland, 2014).

Comparing these figures with enjoyment of games at age 10 (p.102) shows that enjoyment had deteriorated for a large minority. Almost all of the cohort members

Table 6.7: Percentage breakdown by sex of variables measuring intrinsic motivation at age 16

Variable	Value	Female		Male	
interested in physical fitness	not interested at all	5.1	|	5.7	|
	not sure	12.5	|||	10.1	||
	quite interested	43.8	||||||||||	36.4	|||||||||
	very interested	38.6	|||||||||	47.8	|||||||||||
keen on sports	does not apply	31.1	|||||||	17.3	||||
	applies somewhat	43.4	||||||||||	32.5	||||||||
	applies very much	25.5	||||||	50.2	||||||||||||
likes outdoor games	don't know	12.4	|||	7.8	|
	no	20.8	|||||	14.6	|||
	yes	66.9	||||||||||||||||	77.6	|||||||||||||||||||

Note: for females N∼2,900; for males N∼2,150

enjoyed games at age 10; with 90.9% of girls and 94.3% of boys reporting that they like team games. This compares quite unfavourably with the data from age 16. Only 66.9% of girls and 77.6% of boys reported liking outdoor games, and these proportions were very similar to those reporting they were keen on sports (68.9% of girls and 82.7% of boys). Clearly, many cohort members no longer enjoyed games at age 16. The more competitive style of secondary school sport may have been responsible for this change.

The BCS70 also contains questions designed to measure physical self-perceptions at age 16, where the cohort members were asked to compare themselves to other teenagers of the same age and sex. A percentage breakdown of the responses is shown in Table 6.8. Most of the variables are positively biased (more respondents thought they were above average than below average). This is known as the self-serving bias, and is commonly identified in the psychological literature (Mezulis et al., 2004; Shepperd et al., 2008). However, this bias is much more pronounced for boys than girls, indicating that boys had better physical self-concept than girls. Also, two of the variables are negatively biased for girls: 'body shape' and 'doing sport' – girls tended to think they were too fat or thin, and believed they did less sport than their peers.

The greater positive bias for boys supports the notion that school provision was under-serving adolescent girls at the time, which is a long term criticism of school provision in the academic literature (Kirk, 2004a). The boys' responses exhibited greater variation than the girls', however – i.e. physical self-concept varied more

Table 6.8: Cohort members' physical self-perceptions compared to an average teenager of the same age and sex at age 16, by sex (response options in parentheses implied by survey instrument)

<table>
<tr><th>Variable</th><th>Value</th><th colspan="2">Female (N~2,850)</th><th colspan="2">Male (N~2,150)</th></tr>
<tr><td>fitness</td><td>much less</td><td>2.6</td><td></td><td>2.9</td><td></td></tr>
<tr><td></td><td>(less)</td><td>18.7</td><td>||||||</td><td>11.1</td><td>|||</td></tr>
<tr><td></td><td>(about the same)</td><td>48.2</td><td>||||||||||||||||</td><td>38.5</td><td>||||||||||||</td></tr>
<tr><td></td><td>(more)</td><td>23.6</td><td>|||||||</td><td>33.6</td><td>|||||||||||</td></tr>
<tr><td></td><td>much more</td><td>6.9</td><td>||</td><td>13.9</td><td>||||</td></tr>
<tr><td>physical ability</td><td>much less</td><td>1.4</td><td></td><td>1.8</td><td></td></tr>
<tr><td></td><td>(less)</td><td>9.6</td><td>|||</td><td>7.3</td><td>||</td></tr>
<tr><td></td><td>(about the same)</td><td>55.5</td><td>||||||||||||||||||</td><td>40.8</td><td>|||||||||||||</td></tr>
<tr><td></td><td>(more)</td><td>25.4</td><td>||||||||</td><td>35.0</td><td>|||||||||||</td></tr>
<tr><td></td><td>much more</td><td>8.1</td><td>||</td><td>15.1</td><td>|||||</td></tr>
<tr><td>getting out of breath when exercising</td><td>much more</td><td>5.1</td><td>|</td><td>4.0</td><td>|</td></tr>
<tr><td></td><td>(more)</td><td>20.5</td><td>||||||</td><td>16.2</td><td>|||||</td></tr>
<tr><td></td><td>(about the same)</td><td>46.4</td><td>|||||||||||||||</td><td>37.4</td><td>||||||||||||</td></tr>
<tr><td></td><td>(less)</td><td>20.3</td><td>||||||</td><td>28.8</td><td>|||||||||</td></tr>
<tr><td></td><td>much less</td><td>7.7</td><td>||</td><td>13.6</td><td>||||</td></tr>
<tr><td>take exercise</td><td>much less</td><td>6.5</td><td>||</td><td>5.2</td><td>|</td></tr>
<tr><td></td><td>(less)</td><td>23.7</td><td>|||||||</td><td>16.1</td><td>|||||</td></tr>
<tr><td></td><td>(about the same)</td><td>38.5</td><td>||||||||||||</td><td>32.0</td><td>||||||||||</td></tr>
<tr><td></td><td>(more)</td><td>22.0</td><td>|||||||</td><td>31.5</td><td>||||||||||</td></tr>
<tr><td></td><td>much more</td><td>9.3</td><td>|||</td><td>15.2</td><td>|||||</td></tr>
<tr><td>do sport</td><td>much less</td><td>14.3</td><td>||||</td><td>7.6</td><td>||</td></tr>
<tr><td></td><td>(less)</td><td>24.8</td><td>||||||||</td><td>16.8</td><td>|||||</td></tr>
<tr><td></td><td>(about the same)</td><td>35.3</td><td>|||||||||||</td><td>27.5</td><td>|||||||||</td></tr>
<tr><td></td><td>(more)</td><td>16.4</td><td>|||||</td><td>27.4</td><td>|||||||||</td></tr>
<tr><td></td><td>much more</td><td>9.3</td><td>|||</td><td>20.7</td><td>||||||</td></tr>
<tr><td>physical condition of body</td><td>much worse</td><td>1.8</td><td></td><td>2.4</td><td></td></tr>
<tr><td></td><td>(worse)</td><td>11.7</td><td>|||</td><td>10.4</td><td>|||</td></tr>
<tr><td></td><td>(about the same)</td><td>53.9</td><td>|||||||||||||||||</td><td>39.5</td><td>|||||||||||||</td></tr>
<tr><td></td><td>(better)</td><td>23.8</td><td>|||||||</td><td>31.6</td><td>||||||||||</td></tr>
<tr><td></td><td>much better</td><td>8.8</td><td>||</td><td>16.2</td><td>|||||</td></tr>
<tr><td>look healthy</td><td>much less</td><td>1.1</td><td></td><td>1.0</td><td></td></tr>
<tr><td></td><td>(less)</td><td>7.1</td><td>||</td><td>8.4</td><td>||</td></tr>
<tr><td></td><td>(about the same)</td><td>58.2</td><td>|||||||||||||||||||</td><td>50.1</td><td>||||||||||||||||</td></tr>
<tr><td></td><td>(more)</td><td>26.3</td><td>||||||||</td><td>29.2</td><td>|||||||||</td></tr>
<tr><td></td><td>much more</td><td>7.4</td><td>||</td><td>11.3</td><td>|||</td></tr>
<tr><td>body shape</td><td>too fat/thin</td><td>13.0</td><td>||||</td><td>5.3</td><td>|</td></tr>
<tr><td></td><td>(a bit too fat/thin)</td><td>27.4</td><td>|||||||||</td><td>19.1</td><td>||||||</td></tr>
<tr><td></td><td>(average)</td><td>32.1</td><td>||||||||||</td><td>29.7</td><td>|||||||||</td></tr>
<tr><td></td><td>(near perfect)</td><td>20.8</td><td>||||||</td><td>28.8</td><td>|||||||||</td></tr>
<tr><td></td><td>perfect</td><td>6.7</td><td>||</td><td>17.1</td><td>|||||</td></tr>
</table>

for boys than girls. Interestingly, this mirrored the higher estimated variance of the factors for participation outside school, and participation in individual and lifestyle activities for boys.

These variables were used as indicators of latent measures of intrinsic motivation and physical self-concept:

1. **Fitness motivation** – measured by how interested the cohort member is in physical fitness;
2. **Sport motivation** – measured by whether the cohort member (a) is keen on sports and (b) likes outdoor games;
3. **Perceived fitness** – measured by the cohort member's self-perceptions of (a) fitness, (b) physical ability and (c) getting out of breath when exercising;
4. **Perceived activity** – measured by the cohort member's self-perceptions of (a) frequency of exercising and (b) frequency of doing sport; and
5. **Body image** – measured by the cohort member's self-perceptions of (a) the physical condition of his/her body, (b) whether he/she looks healthy and (c) the shape of his/her body.

Intrinsic motivation was separated into factors for fitness and sport motivation. The intention of this approach was to account for the possibility that cohort members could be motivated to participate in exercise (e.g. for health reasons) without being motivated to participate in sport (as indicated by the girls' responses in Table 6.7). Unfortunately, this did mean there was only one indicator for fitness motivation.

The indicators of physical self-concept were grouped into three constructs similar to those found in the physical self-concept literature (Hagger et al., 2005; Marsh, 1996a). The choice of indicators was influenced by practical considerations and relevance to the research questions. The Physical Self-Perception Profile (PSPP, Fox and Corbin, 1989) contains the sub-domains of sports competence, body attractiveness, physical strength and physical condition. The Physical Self-Description Questionnaire (PSDQ, Marsh, 1996b) contains the sub-domains of strength, body fat, perceived levels of physical activity, endurance/fitness, sport competence, coordination, health, appearance and flexibility. In this research, it was necessary to deviate from these examples somewhat. The factors did not cover all of the sub-domains of the PSDQ or PSPP, and necessarily relied on the use of only a small number of indicators. Nevertheless, they provided good coverage of the most important aspects of physical self-concept required for this research.

A particular problem was the lack of an indicator for perceived sport competence (perceived ability in sport) at age 16. Considering the analysis at age 10 had found perceived ability to be an important influence on enjoyment of games inside school (p.108), it was important to measure it somehow. A proxy measure was available at age 16: whether the cohort member had represented their school in sport. This was used as the sole indicator of 'sport ability'. It was renamed to highlight that it was a proxy and not the same as perceived sport competence in the PSDQ. Table 6.9 shows this variable broken down by sex. Girls (22.4%) were less likely to have represented their school at sports than boys (32.3%). This could have been due to greater provision of inter-school sports competitions for boys, and/or because a greater proportion of boys were keen on sports and wanted to get into school teams, supporting a greater number of teams and perhaps leading to more specialisation.

Table 6.9: Percentage of cohort members representing their school in sports at age 16 by sex

	Female	Male
% represented school in sporting activities	22.4	32.3

Note: for females N=2,716; for males N=2,089

The comparison of this proxy measure with perceived ability in games at age 10 (p.102) is unsurprisingly striking. Whereas most cohort members had high perceptions of ability at age 10 (84.5% of girls and 92.0% boys), only a minority represented their school at age 16. Of course, this proxy is far from perfect – one would expect only the most able children to be selected for school teams – nevertheless, it is of relevance that such a small proportion were selected, considering the levels of perceived ability at age 10. The increase in competitive focus at age 16 would have emphasised differences in ability, and teachers' selection of the most able would have made this explicit to both the cohort members and their peers. Thus, it could be argued that 77.6% of girls and 67.7% of boys at age 16 (those not representing their schools) would regard themselves as not particularly able. As with enjoyment, the competitive sporting environment in secondary school could have had a detrimental impact on perceived ability and physical self-concept more widely.

A pairwise polychoric correlation matrix (shown in Table 6.10) was estimated in order to identify whether the indicators were associated as might be expected by their factor groupings, and whether there were any substantial differences between the sexes[1]. Overall, the associations were similar for each sex, but tended to be slightly weaker for girls. Most associations were moderate or high, compared to the effect size conventions of Cohen (1992), and tended to be higher within the factor groupings. There were some indicators that were strongly associated with those of other factors, however:

- 'do sport' (perceived activity) with 'keen on sports' (sport motivation, 0.74 for girls and 0.75 for boys);
- 'fitness' (perceived fitness) with 'take exercise' (perceived activity, 0.67 for girls and 0.70 for boys) and 'physical condition of body' (body image, 0.65 for girls and 0.73 for boys); and
- 'physical ability' (perceived fitness) with 'physical condition of body' (body image) for boys (0.67).

The strength and grouping of these associations suggests that there may be a conceptual distinction between (a) fitness and (b) sport related motivation and physical self-concept. This provides some support for the distinction between fitness and sport motivation in the factor specifications.

There were also several surprisingly low correlations related to indicators of body image:

- 'look healthy' and 'body shape' with the motivation indicators (ranging from 0.09 to 0.24 for girls and 0.14 to 0.30 for boys);
- 'body shape' with the indicators of perceived activity, 'take exercise' (0.23 for girls and 0.25 for boys) and 'do sport' (0.15 for girls and 0.20 for boys); and
- 'body shape' and 'look healthy' with the indicator of sport ability, 'represented school' (0.10 and 0.18 for girls, and 0.21 and 0.21 for boys).

These estimates suggest that motivation, perceived activity and sport ability were only weakly associated with the more aesthetic aspects of body image. For girls, a

[1]The indicator of sport motivation 'likes outdoor games' was recoded to a binary variable to simplify the modelling and interpretation. The 'no'/'don't know' response options were combined (Table 6.7, p.160)

Table 6.10: Polychoric correlation matrix of variables measuring intrinsic motivation and physical self-concept at age 16, grouped by latent variable – estimates for females are in the upper right triangle, males are in the lower left

	Latent variable →	FM 1	SM 2	SM 3	PF 4	PF 5	PF 6	PA 7	PA 8	BI 9	BI 10	BI 11	SA 12
1	interest in physical fitness		0.54	0.49	0.46	0.37	0.38	0.48	0.44	0.35	0.22	0.12	0.30
2	keen on sports	0.60		0.77	0.51	0.47	0.41	0.51	0.74	0.35	0.24	0.11	0.56
3	likes outdoor games	0.55	0.71		0.38	0.33	0.33	0.37	0.55	0.26	0.15	0.09	0.42
4	fitness	0.51	0.50	0.39		0.75	0.61	0.67	0.52	0.65	0.42	0.34	0.32
5	physical ability	0.45	0.48	0.38	0.80		0.53	0.53	0.47	0.57	0.45	0.27	0.32
6	out of breath exercising	0.40	0.37	0.32	0.59	0.49		0.52	0.43	0.47	0.34	0.26	0.28
7	take exercise	0.57	0.53	0.39	0.70	0.61	0.51		0.55	0.51	0.35	0.23	0.30
8	do sport	0.53	0.75	0.55	0.51	0.48	0.42	0.57		0.36	0.26	0.15	0.49
9	physical condition of body	0.42	0.45	0.36	0.73	0.67	0.50	0.59	0.45		0.54	0.35	0.23
10	look healthy	0.30	0.30	0.22	0.56	0.54	0.35	0.42	0.34	0.66		0.30	0.18
11	body shape	0.24	0.18	0.14	0.38	0.33	0.30	0.25	0.20	0.41	0.38		0.10
12	represented school	0.38	0.52	0.45	0.35	0.37	0.25	0.33	0.49	0.30	0.21	0.21	

Note: Female N=3,320, Male N=2,533; abbreviations for latent variables are FM–fitness motivation, SM–sport motivation, PF–perceived fitness, PA–perceived activity, BI–body image, SA–sport ability commonly stated motivation for exercising is to lose weight (Foster et al., 2005), which could have confounded the associations. However, considering the estimates for boys are very similar, this does not seem plausible.

Indeed, these estimates imply that using sport and exercise to tackle poor body image in adolescents may have limited success. Not only are body shape, physical appearance and obesity risk largely inherited (Farooqi and O'Rahilly, 2007), but adults and children are both increasingly exposed to unattainable images of physical perfection through the media. If these factors are the predominant influences on body image, then experiences of sport and exercise are unlikely to have much effect.

In summary:

1. Girls were less likely than boys to be keen on sports, but their interest in physical fitness was similar.
2. At age 10, almost all cohort members had liked games, whereas a large minority did not at age 16.
3. Most indicators of physical self-concept were positively biased (i.e. self-serving bias). Boys' responses were more positively biased than girls', but also varied more. Girls' perceptions of their 'body shape' and how frequently they 'do sport' were negatively biased.
4. A proxy measure – whether the cohort member had represented their school at sport – was used as an indicator of 'sport ability'. Boys were more likely than girls to have represented their schools, but most cohort members had not.
5. Considering perceived ability in games was very high at age 10, it seems likely this would have reduced by age 16, partly due to selection into school teams.
6. The pairwise correlations were similar between the sexes and tended to reflect the expected groupings. However, there were also some strong associations across sub-domains, suggestive of a separation between (a) sport and (b) fitness related motivation and self-concept.

7. There were some unusually low associations. Two indicators of body image – 'look healthy' and 'body shape' – had relatively low associations with motivation, 'sport ability' and 'perceived activity', i.e. the more aesthetic aspects of body image were not strongly correlated with experiences of sport and exercise.

6.5.2 Constructing latent trait measures of intrinsic motivation and physical self-concept

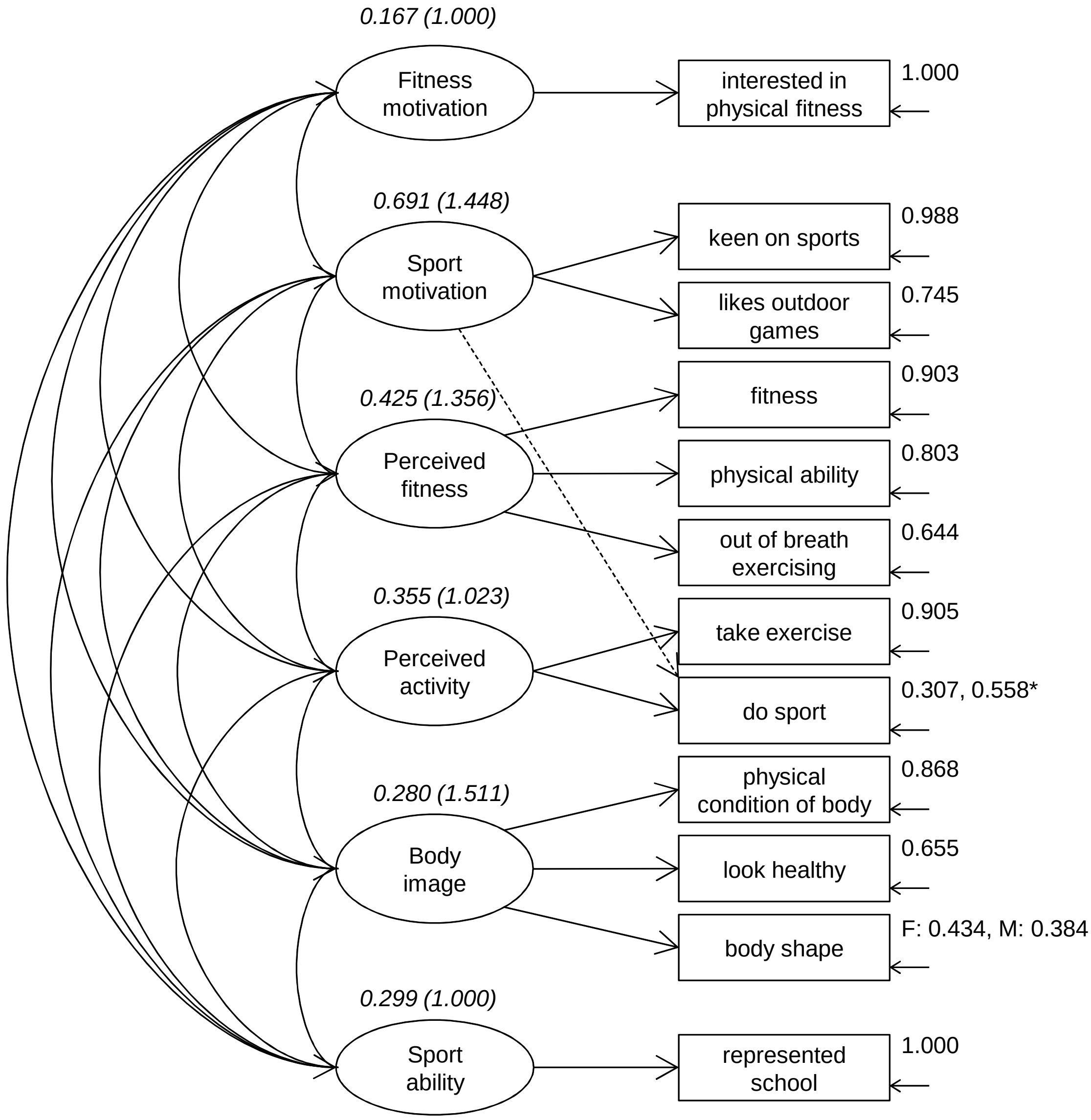
The indicators were used to estimate latent trait measurement models of the sub-domains of intrinsic motivation and physical self-concept, separately by sex[2]. The initial and final model specifications are shown diagrammatically in Figure 6.4. As previously described (pp.162, 163), there were only single indicators available for fitness motivation and sport ability. In order to retain a consistent approach, they were included in the latent measurement models by constraining the factor loadings to one. This is equivalent to creating an underlying variable for each indicator based on the probit function (Long, 1997).

The model fitting and testing are described in detail in Appendix C.3. In order to fit the data well, it was necessary to allow both the perceived activity and sport motivation factors to load onto the indicator 'do sport'. The indicators 'do sport' and 'keen on sports' had previously been found to be strongly associated, and this further supported the notion of a separable sporting identity. Multigroup testing was undertaken to determine whether the models were equivalent by sex. Strict measurement equivalence was not supported, as the loadings onto the 'body shape' indicator varied by sex. This was likely due to the negative bias previously identified in girls' self-perceptions (p.161), which is a finding commonly supported in the academic literature (Croll, 2005). Invariance for this measure was relaxed across groups, resulting in a model which fit the data well and demonstrated good equivalence.

The means of the factors were all significantly higher for boys. The smallest difference was in fitness motivation where boys were 0.167 standard deviations higher

[2]A second-order latent trait model – e.g. where a domain factor is hypothesised to cause the sub-domain factors – was not included, because the specific sub-domains are of primary interest in this research, not overall physical self-concept or intrinsic motivation.

Figure 6.4: Path diagram showing initial measurement model of intrinsic motivation and physical self-concept at age 16 (solid paths) and final model with additional (dashed) path and estimates from multigroup testing for females (F) and males (M)



Note: Female N=3,320, Male N=2,533; estimates in italics are latent means and (variances) for males, these are constrained to 0 and 1 for females, respectively; estimates to the right of indicators are the loadings of the latent variables onto that indicator; the estimate marked with an asterisk relates to the loading of 'Sport motivation' onto 'do sport'; the latent correlations are not included in the diagram, but are discussed in section 6.6; $\chi^2(105)=544.389$ (p=0.0000), RMSEA 0.038 (90% CI: 0.035 to 0.041), CFI 0.993, TLI 0.991

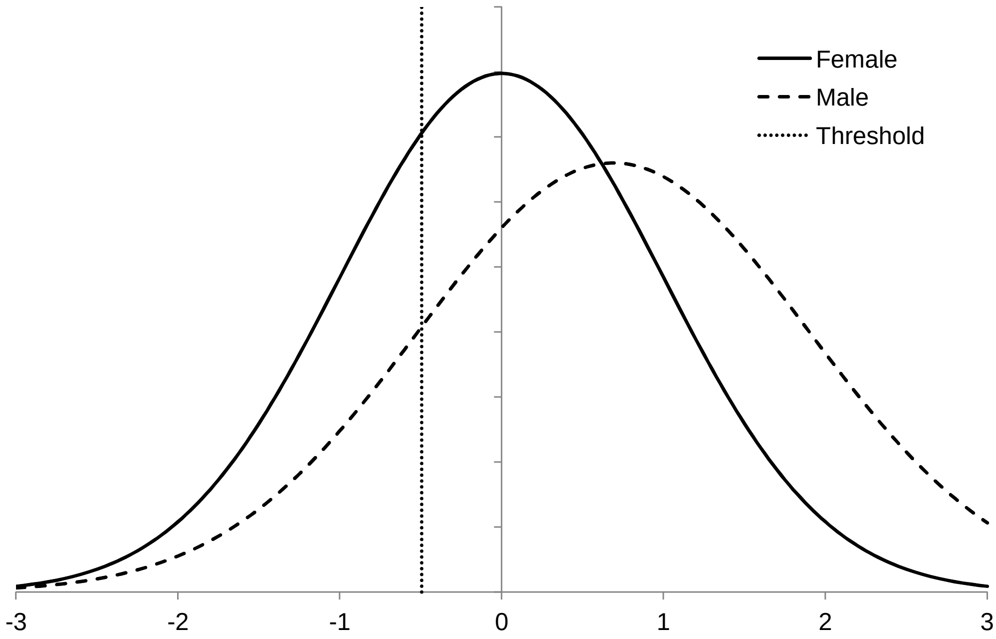
on the latent scale. The largest difference was in sport motivation, where boys were 0.691 standard deviations higher. The remaining mean differences fell between these values, ranging from 0.280 for body image to 0.425 for perceived fitness. Interestingly, the variances of many of the factors were significantly higher for boys. There was greater variation in sport motivation (1.448), perceived fitness (1.356) and body image (1.511) for boys than girls. The variance in perceived activity was not significantly different between the sexes. (The variance in fitness motivation and sport ability was fixed, due to there only being a single indicator for each).

These estimates supported the notion that school provision was not serving girls well, primarily due to the sport focus. To demonstrate the difference in sport motivation, the latent distributions of this factor were plotted (Figure 6.5). The distributions were compared to a threshold based on the proportion of girls who said being keen on sport did not apply to them (p.160). The difference between the sexes is quite striking and the proportions who were not keen on sports quite large.

This provides a distinct contrast to the girls' mean level of fitness motivation, which was very similar to the boys' (a difference of 0.167). Considering that school provision was predominantly comprised of traditional, competitive sport, this interest in physical fitness was most likely not being taken advantage of. Nevertheless, it must have been quite a resilient trait, being maintained despite relatively low levels of sport motivation. Girls' physical self-concept may also have been affected by the sport focus in school. By implicitly defining fitness and exercise as related to performance in competitive sport, girls may have been more likely to have negative self-perceptions.

It is worth noting that the difference in body image between the sexes was affected by measurement invariance. If the parameters for 'body shape' had not been allowed to vary between the sexes, the difference would have been greater (0.439 compared to 0.280). The larger variances of the factors for boys suggests that they were more heterogeneous than the girls. Although many boys may have had positive experiences of school sport and physical education, it seems that a large minority did not.

Figure 6.5: Distributions of the sport motivation factor by sex, compared to a threshold based on the proportion of girls who are not keen on sports at age 16



Note: Female N=3,320, Male N=2,533; female mean and standard deviation are constrained to 0 and 1 for identification purposes, male mean=0.691 and standard deviation=1.448, the threshold in the diagram identifies where girls move from saying that they are not keen on sports to somewhat keen, based on sample statistics

In summary:

1. The indicator 'body shape' was a source of measurement variance between sexes in the latent trait analysis. This was due to the negative bias in girls' self-perceptions of body shape.

2. The means of the motivation and self-concept factors were higher for boys than girls. The smallest difference was in fitness motivation, the largest in sport motivation. The variances of the factors were larger for boys.

3. The latent estimates supported the notion that the sport focus in schools was not serving girls, and a large minority of boys, well. Mean fitness motivation was similar for both sexes, but sport motivation was much lower for girls. The sport focus could have detrimentally affected girls' physical self-concept.

6.6 Cross-sectional correlations of the latent variables at age 16

Pairwise correlations were estimated between all of the factors. Separate models for each sex enabled comparisons to be made. The estimates are shown in Table 6.11. The correlations varied considerably, and tended to be higher for boys. They were particularly strong between perceived fitness, perceived activity and body image, for both boys (0.66 to 0.84) and girls (0.59 to 0.80). This suggests that seeing yourself as fit and active benefits body image, and that body image is closely related to these perceptions. Seeing as the 'body shape' indicator was not strongly associated with the indicators of perceived activity (p.165), associated differences in body image must have been driven by improved perceptions of physical condition and appearance, rather than body shape.

Body image was associated quite weakly with sport ability and the participation factors for both girls (0.20 to 0.30) and boys (0.22 to 0.31), although the associations with participation outside school (0.40) and lifestyle activities (0.41) were slightly higher for boys. This suggests that lifestyle activities were more beneficial for the body image of boys than girls. Seeing as the 'body shape' indicator was a source of measurement invariance between the sexes, perhaps these associations were lower because girls were more concerned with body weight rather than physical conditioning. It is possible that girls who had poor body image participated in lifestyle activities in order to lose weight, confounding the positive effect of participation on body image.

The correlation between participation in team and individual activities was particularly high for girls (0.73) in the combined model, but less so for boys (0.58). Considering that very few girls participated in team sports outside school (p.145), this correlation might be picking up the behaviour of unusually 'sporty' girls. This compares with the association of lifestyle with team activity for girls, which was weaker (0.49). Likewise sport ability was most strongly associated with team, as opposed to individual or lifestyle activity, in both boys (0.59) and girls (0.61).

The separation between sport and fitness was again supported. Fitness motivation and perceived activity were more strongly correlated with lifestyle activities (0.41 and 0.46 for girls, and 0.49 and 0.44 for boys), whereas sport motivation and ability were more strongly correlated with team activities (0.54 and 0.61 for

Table 6.11: Correlation matrix of latent measures of intrinsic motivation, physical self-concept, participation inside/outside school and participation in different types of activity at age 16 – estimates for females are in the upper right triangle, males in lower left

		1	2	3	4	5	6	7	8	9	10	11
1	Fitness motivation		0.57	0.49	0.51	0.35	0.30	0.18	0.43	0.41	0.28	0.31
2	Sport motivation	0.62		0.57	0.58	0.37	0.58	0.29	0.55	0.37	0.54	0.50
3	Perceived fitness	0.54	0.58		0.80	0.79	0.38	0.22	0.39	0.37	0.30	0.33
4	Perceived activity	0.60	0.59	0.82		0.59	0.35	0.19	0.49	0.46	0.32	0.34
5	Body image	0.42	0.46	0.84	0.66		0.25	0.20	0.30	0.28	0.26	0.29
6	Sport ability	0.40	0.59	0.41	0.38	0.31		0.34	0.38	0.21	0.61	0.41
7	Particip. in. school	0.26	0.38	0.27	0.28	0.22	0.41		0.42			
8	Particip. out. school	0.61	0.73	0.46	0.51	0.40	0.45	0.58				
9	Lifestyle activity	0.49	0.33	0.35	0.44	0.41	0.22				0.49	0.61
10	Team activity	0.41	0.75	0.39	0.35	0.26	0.59			0.47		0.73
11	Individual activity	0.38	0.50	0.33	0.34	0.23	0.39			0.59	0.58	

Note: Female N=3,323, Male N=2,540

girls, and 0.75 and 0.59 for boys). Interestingly, sport ability was only weakly associated with participation in lifestyle activities for both boys (0.22) and girls (0.21), suggesting these activities were inclusive of those with low levels of skill and ability in traditional, competitive sports.

The motivation factors were more strongly associated with participation outside (0.43 and 0.55 for girls, and 0.61 and 0.73 for boys) than inside school (0.18 and 0.29 for girls, and 0.26 and 0.38 for boys). Possible explanations are that (a) cohort members generally participated regardless of motivation inside school; and (b) school provision was not particularly effective at fostering motivation for physical activity. Both may be true to some extent. Overall, participation inside school did not seem particularly beneficial to intrinsic motivation and physical self-concept. Except for moderate associations with sport motivation and ability (0.29 and 0.34 for girls, and 0.38 and 0.41 for boys), it was quite weakly associated with all of the other factors (0.18 to 0.22 for girls, and 0.22 to 0.28 for boys). The associations related to participation outside school were much higher. The salience of traditional sports for boys was again supported, with sport motivation being very highly correlated with both team activity (0.75) and participation outside school (0.73). For girls, these associations were lower (0.54 and 0.55, respectively).

The associations demonstrated some similarities with the previous analysis at age 10. The association of liking games (an indicator of sport motivation) with playing sports (outside school) was also lower for girls at age 10 (p.108), and there was evidence of a greater salience of sports in general for boys. Also, the relative importance of traditional sports for experiences inside school were supported in both cases.

In summary:

1. The correlations between the factors were generally slightly stronger for boys than girls.
2. Perceptions of fitness, activity and body image were strongly associated with one another.
3. Participation did not seem to be strongly associated with body image.
4. For girls, participation in team and individual activities were strongly associated with one another. This was may have been due to unusually 'sporty' girls.

5. The separation between sport and fitness was supported. Sport motivation and ability were more strongly correlated with team activity, whereas fitness motivation and perceived activity were more strongly correlated with lifestyle activity.
6. Sport ability was only weakly associated with participation in lifestyle activity, reflecting the non-competitive and inclusive nature of these activities.
7. Participation outside school was strongly correlated with motivation. This was not the case for participation inside school.
8. Participation inside school was quite weakly associated with most of the factors, except for moderate associations with sport ability and motivation.
9. The salience of sport for boys was supported, with strong associations of sport motivation with team activity and participation outside school.
10. Several of these findings were similar to those of the previous analyses, at age 10, despite the use of different methods and measures at a different life stage, suggesting they are enduring phenomena.

6.7 Longitudinal analysis from age 10 to age 16

Although cross-sectional associations are of interest, longitudinal analysis provides stronger evidence of implied causality in observational studies because temporal ordering is incorporated (Bauman et al., 2002). Two stages of modelling were undertaken:

1. a preliminary analysis, where the latent variables at age 16 were jointly regressed on the variables used to measure experiences of sport and exercise at age 10. This modelling process and the resulting estimates are reported in Appendix D; and
2. a more thorough analysis, where variables controlling for the correlates of physical activity were included alongside those measuring experiences of sport and exercise at age 10. As well as the associations with the control variables being of substantive interest, this approach also reduces the possibility of confounding.

The longitudinal models estimated were Multiple Indicators Multiple Causes (MIMIC) models (p.89); the potential causes being the variables measuring experiences of sport and exercise at age 10, and the various correlates of physical activity. Seeing as the inclusion of control variables in the second stage of modelling did not greatly alter the estimates relating to experiences of sport and exercise at age 10, the rest of this chapter solely focuses on the results of this stage, which are more robust.

It was necessary to use multiple imputation to fill in missingness in the dataset (p.91). Because the variables came from two waves and several different survey instruments, each with missing data, overlapping patterns of missingness became a problem. In order to make best use of the available data, multiple imputation was used to create several complete datasets. In order not to depart too greatly from the dataset used in the first stage of modelling (Appendix D), the sample for the imputed datasets was restricted to those cohort members who had answered questions measuring experiences of sport and exercise at age 16.

Variability in the imputed values was taken into account in subsequent analyses using the functionality available in Mplus for analysing multiply-imputed datasets (p.91). Multiple imputation is conducted under the assumption of missing data being conditionally missing at random (i.e. MAR according to Rubin's (1976) terminology). The analysis and process for creating the multiple imputations is described in Appendix E.

6.7.1 The correlates of physical activity

Variables were included in the models to control for physiological factors, parental influences, socioeconomic factors and aspects of the school environment (p.135). Table 6.12 shows descriptive statistics for these variables, broken down by sex. Where there was a chance of control variables being endogenous, they were included from the wave at age 10 rather than age 16 (e.g. weight status at age 10).

There were slightly more girls than boys classified as underweight and overweight, but the same proportion was obese at age 10. Many more girls (26.5%) than boys (4.7%) showed signs of puberty at age 10, and slightly more boys (10.4%) had some form of disability than girls (8.0%). Girls (68.9%) performed better than boys (58.5%) at motor coordination tests at age 10, and slightly more girls (21.6%) than boys (17.8%) smoked at age 16.

Table 6.12: Cross-tabulation of correlates of physical activity by sex

Variable	Value	Female (%)	Male (%)
weight status (10, medic)	underweight	13.3	11.7
	normal	71.6	74.9
	overweight	10.4	8.7
	obese	4.7	4.7
maturation (10, medic)	yes	26.5	4.7
disability (10 or 16, mother)	yes	8.0	10.4
motor coordination (10, medic)	test 1 did not move foot	68.9	58.5
smokes (16, cohort member)	yes	21.6	17.8
mother exercises (16, mother)	yes	43.1	44.5
father exercises (16, mother)	yes	36.2	38.9
family recreation	rarely/never	64.1	54.2
(16, cohort member)	less than once a week	22.1	21.1
	once a week or more	13.8	24.7
teach phys. fitness (16, mother)	yes	77.1	79.8
phys. fitness v.important (16, mother)	yes	13.5	16.9
parental income (16, mother)	<£50	3.0	3.1
	£50-£99	16.8	16.9
	£100-£149	16.5	16.3
	£150-£199	17.8	17.8
	£200-£249	13.8	14.0
	£250-£299	11.0	11.0
	£300-£349	7.0	7.0
	£350-£399	4.2	4.3
	£400-£449	3.8	3.9
	£450-£499	1.9	1.5
	£500+	4.3	4.2
age father left FT education	before age 15	10.1	9.4
(16, mother)	age 15	50.8	50.8
	age 16	18.0	18.0
	between ages 17 and 20	12.8	12.1
	after age 20	8.4	9.7
age mother left FT education	before age 15	5.8	5.3
(16, mother)	age 15	52.1	50.6
	age 16	21.7	21.2
	between ages 17 and 20	14.7	16.3
	after age 20	5.7	6.6
social class (16, mother)	I	7.2	8.0
	II	29.6	29.9
	III non-manual	9.8	10.6
	III manual	41.6	39.8
	IV	9.1	9.4
	V	2.7	2.3
PE compulsory (16, headteacher)	yes	88.1	84.9
games compulsory (16, headteacher)	yes	58.2	62.6
extra-curricular sport (16, headteacher)	yes	63.7	62.2
		Female	Male
school social mix	mean (% of school)	0.42	0.41
(16, headteacher)	std dev (% of school)	0.22	0.22
number of pupils in 5th year	mean (100s)	2.04	2.00
(16, headteacher)	std dev (100s)	0.77	0.74

Note: the respondent/wave at which the data were collected are shown in parentheses in the *Variable* column; available sample sizes vary depending on respondent/wave (see Appendix E)

As might be expected, the proportions of mothers and fathers who exercised were nearly identical for both girls (43.1% and 36.2%) and boys (44.5% and 38.9%). This was not the case for the cohort members' responses relating to family recreation (whether they took part in outdoor recreations with their parents). Although girls (22.1%) and boys (21.1%) were similarly likely to respond that they took part in family recreation less than once a week, boys were much more likely to respond that they did so more frequently than that (24.7% for boys compared to 13.8% for girls). The mothers' opinions on teaching physical fitness in school and whether it was one of the most important topics were broadly equivalent for boys (79.8% and 16.9%) and girls (77.1% and 13.5%).

There were no notable differences between girls and boys in the socioeconomic factors. The proportions of the sample in the various bands of parental income, age groups for when mothers and fathers had left full time education and social class groups were practically identical across the sexes. Variables measuring the school environment were also broadly similar for girls and boys. There were slight differences, with PE being compulsory for slightly more girls (88.1%) than boys (84.9%), and games being compulsory for slightly more boys (62.6%) than girls (58.2%). Availability of extra-curricular sports, the mean school social mix and the mean number of pupils in the 5th year were very similar for boys and girls.

6.7.2 Results of the longitudinal analysis

The model estimates for girls are shown in Table 6.13 and those for boys in Table 6.14. For the sake of brevity, the tables do not include non-significant estimates. As with the analysis at age 10, the estimates relating to the cohort members' experiences of sport and exercise were very robust to the inclusion of controls. Nearly all the estimates were similar to those in the models without controls (for the results of the preliminary models see Appendix D).

Hours of PE at age 10 was not associated with experiences of exercise at age 16 for both sexes. This follows the cross-sectional findings at age 10, which also found school provision to be of little importance to experiences of sport and exercise. Perhaps surprisingly, enjoyment of games at age 10 was also not important. It was only associated with sport motivation at age 16, although the effects were quite large (0.365 for girls and 0.437 for boys). This implies a degree of continuity in the enjoyment of sports between ages 10 and 16, but that this enjoyment did not affect participation or physical self-concept later on.

Table 6.13: Estimates for females of the effect of experiences at age 10 and control variables on latent measures of intrinsic motivation, physical self-concept and participation at age 16

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
Fitness motivation	← perceived ability games age 10	0.151	0.063	0.017	*
	← perceived ability gymnastics age 10	0.172	0.051	0.001	**
	← plays sports outside school age 10	0.147	0.047	0.002	**
	← smokes	-0.370	0.066	0.000	***
	← motor coordination age 10	0.173	0.046	0.000	***
	← maturation at age 10	0.108	0.054	0.046	*
	← underweight age 10	-0.043	0.065	0.509	
	← overweight age 10	-0.089	0.074	0.228	
	← obese age 10	-0.309	0.116	0.008	**
	← family recreation <1/wk	0.197	0.058	0.001	**
	← family recreation 1/wk+	0.598	0.075	0.000	***
	← mother exercises	0.185	0.059	0.002	**
	← teach physical fitness	0.139	0.052	0.007	**
	← physical fitness is v.important	0.163	0.075	0.029	*
Sport motivation	← enjoyment of games age 10	0.365	0.093	0.000	***
	← perceived ability games age 10	0.363	0.061	0.000	***
	← perceived ability gymnastics age 10	0.235	0.060	0.000	***
	← plays sports outside school age 10	0.460	0.047	0.000	***
	← smokes	-0.381	0.058	0.000	***
	← family recreation <1/wk	0.345	0.054	0.000	***
	← family recreation 1/wk+	0.727	0.069	0.000	***
	← mother exercises	0.098	0.049	0.044	*
	← teach physical fitness	0.121	0.055	0.027	*
	← physical fitness is v.important	0.151	0.071	0.034	*
	← social class II	-0.008	0.084	0.928	
	← social class III non-manual	-0.053	0.092	0.562	
	← social class III manual	-0.086	0.078	0.268	
	← social class IV	-0.217	0.097	0.026	*
	← social class V	-0.106	0.165	0.521	
Perceived fitness	← perceived ability games age 10	0.195	0.072	0.007	**
	← perceived ability gymnastics age 10	0.287	0.059	0.000	***
	← plays sports outside school age 10	0.150	0.048	0.002	**
	← smokes	-0.418	0.058	0.000	***

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Table 6.13 – *Continued from previous page*

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
	← disability	-0.235	0.084	0.005	**
	← motor coordination age 10	0.104	0.048	0.029	*
	← underweight age 10	0.009	0.081	0.914	
	← overweight age 10	-0.298	0.077	0.000	***
	← obese age 10	-0.370	0.115	0.001	**
	← family recreation <1/wk	0.220	0.063	0.000	***
	← family recreation 1/wk+	0.602	0.068	0.000	***
	← mother exercises	0.145	0.062	0.019	*
	← teach physical fitness	0.118	0.052	0.022	*
Perceived activity	← perceived ability games age 10	0.164	0.078	0.035	*
	← perceived ability gymnastics age 10	0.194	0.077	0.012	*
	← plays sports outside school age 10	0.135	0.053	0.011	*
	← smokes	-0.362	0.066	0.000	***
	← motor coordination age 10	0.165	0.058	0.004	**
	← family recreation <1/wk	0.313	0.063	0.000	***
	← family recreation 1/wk+	0.673	0.085	0.000	***
	← mother exercises	0.128	0.055	0.021	*
	← games compulsory	0.109	0.051	0.032	*
	← school social mix	0.498	0.170	0.003	**
Body image	← perceived ability games age 10	0.145	0.074	0.048	*
	← perceived ability gymnastics age 10	0.146	0.052	0.005	**
	← plays sports outside school age 10	0.131	0.053	0.013	*
	← smokes	-0.139	0.068	0.040	*
	← motor coordination age 10	0.141	0.054	0.010	*
	← underweight age 10	-0.037	0.080	0.642	
	← overweight age 10	-0.509	0.085	0.000	***
	← obese age 10	-0.606	0.123	0.000	***
	← family recreation <1/wk	0.209	0.063	0.001	**
	← family recreation 1/wk+	0.555	0.076	0.000	***
Sport ability	← perceived ability games age 10	0.300	0.103	0.004	**
	← perceived ability gymnastics age 10	0.211	0.079	0.008	**
	← plays sports outside school age 10	0.363	0.072	0.000	***
	← disability	-0.335	0.116	0.004	**
	← family recreation <1/wk	0.178	0.076	0.019	*

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Table 6.13 – *Continued from previous page*

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
	← family recreation 1/wk+	0.444	0.101	0.000	***
	← social class II	-0.084	0.090	0.354	
	← social class III non-manual	-0.114	0.138	0.411	
	← social class III manual	-0.276	0.110	0.012	*
	← social class IV	-0.272	0.168	0.104	
	← social class V	-0.138	0.199	0.488	
Participation inside school	← perceived ability games age 10	0.238	0.068	0.001	**
	← perceived ability gymnastics age 10	0.130	0.063	0.038	*
	← family recreation <1/wk	0.188	0.070	0.007	**
	← family recreation 1/wk+	0.224	0.071	0.002	**
	← games compulsory	0.146	0.064	0.023	*
Participation outside school	← plays sports outside school age 10	0.131	0.064	0.041	*
	← family recreation <1/wk	0.340	0.087	0.000	***
	← family recreation 1/wk+	0.901	0.089	0.000	***
	← social class II	0.074	0.105	0.484	
	← social class III non-manual	0.100	0.173	0.564	
	← social class III manual	-0.051	0.096	0.597	
	← social class IV	-0.299	0.137	0.030	*
	← social class V	-0.110	0.270	0.683	
	← school social mix	-0.409	0.204	0.045	*
Lifestyle activity	← family recreation <1/wk	0.232	0.099	0.019	*
	← family recreation 1/wk+	0.768	0.106	0.000	***
Team activity	← perceived ability games age 10	0.585	0.138	0.000	***
	← plays sports outside school age 10	0.242	0.077	0.002	**
	← family recreation <1/wk	0.337	0.100	0.001	**
	← family recreation 1/wk+	0.508	0.106	0.000	***
	← games compulsory	0.197	0.100	0.048	*
	← school social mix	-0.828	0.240	0.001	**
	← number of pupils in 5th year	-0.213	0.065	0.001	**
Individual activity	← perceived ability games age 10	0.311	0.116	0.007	**
	← smokes	-0.234	0.093	0.012	*
	← family recreation <1/wk	0.327	0.078	0.000	***
	← family recreation 1/wk+	0.613	0.098	0.000	***
	← physical fitness is v.important	0.231	0.091	0.011	*

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Table 6.13 – *Continued from previous page*

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value

Note: N=3,275; reference categories are: normal weight, family recreation rarely/never, mother left full-time education before age 15, social class I

In contrast, perceived ability at age 10 was associated with many factors at age 16. The effects varied in size, the largest being sport related: perceived ability in games at age 10 was quite strongly associated with sport motivation and team activity at age 16 for both boys (0.430 and 0.486) and girls (0.363 and 0.585). Again, there seemed to be a separation between sport and fitness related experiences. Whereas perceived ability in games was important for sport related factors, experiences in gymnastics seemed to be more relevant to fitness related factors, such as fitness motivation, perceived activity and body image.

It could be argued that the relevance of early perceived ability to later experiences is worrying. In a competitive sport context, perceptions of ability are relative. The more competitive an environment, the more emphasis is placed on relative performance. Thus, a child may be competent in the sense that they are perfectly able to take part in a sport or activity, but they may have poor perceptions of their ability because it is lower than that of their peers' (Chanal et al., 2005; Seaton et al., 2010). It seems that poor self-perceptions developed during primary schooling had long-lasting impacts, affecting motivation, self-concept and participation later on. This supports the analysis at age 10, which found that perceived ability is a crucial mediator of the relationship between participation and enjoyment.

There were some striking differences between the sexes, however. For boys, there was no association between perceived ability in games at age 10 and some of the factors one might expect. Neither participation in individual activity, participation inside school, sport ability, perceived activity or fitness motivation at age 16 were associated with it. In each of these cases, it seemed that the cohort members' experiences of playing sports outside school at age 10 had substituted. Indeed, playing sports outside school at age 10 was a much more important experience for boys than girls.

For girls, the associations of playing sports outside school at age 10 with sport related factors at age 16 were reasonably strong (0.242 to 0.460), suggesting it identified girls who were unusually sporty. For boys, the associations were far stronger, particularly for sport motivation (0.750), sport ability (0.614), and team activity (0.834). It was also associated moderately or strongly with all the other factors, except lifestyle activity. The importance of these early experiences of sport reflects the continuing salience of sport for boys. It suggests that acquired experience in competitive sport could supersede the influence of boys' early perceptions of ability. However, it also means that the experiences of boys who did not play sports outside school at age 10 were far worse at age 16, particularly in terms of sport motivation and participation in team activities. Essentially, they got left behind.

As with the analysis at age 10, these effects suggest school provision built-on and emphasised previous experience in sport and exercise, due to family socialisation and the home environment. By doing so, it exacerbated inequalities in motivation and participation. Seeing as competitive sport was less relevant to girls, particularly outside school, the associations were far less dramatic. Girls tended to participate in lifestyle activities outside school (p.145). The estimates relating to this type of activity are particularly interesting for both sexes, as none of the age 10 variables were found to be associated with it. Indeed, there was only one strong association, with family recreation. This is a very striking finding, as it implies that family socialisation was the only influence on participation in lifestyle activities, which made up the core of participation outside school. Neither primary school experiences, physiological factors, socioeconomic factors or the school environment influenced it. This provides a strong affirmation for the accessibility, inclusivity and flexibility of these types of activity.

Table 6.14: Estimates for males of the effect of experiences at age 10 and control variables on latent measures of intrinsic motivation, physical self-concept and participation at age 16

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
Fitness motivation	← perceived ability gymnastics age 10	0.159	0.053	0.003	**
	← plays sports outside school age 10	0.343	0.056	0.000	***
	← smokes	-0.325	0.079	0.000	***
	← family recreation <1/wk	-0.023	0.073	0.758	
	← family recreation 1/wk+	0.297	0.100	0.003	**
	← father exercises	0.194	0.077	0.012	*
	← extra-curricular sport available	0.249	0.064	0.000	***

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Table 6.14 – *Continued from previous page*

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
Sport motivation	← enjoyment of games age 10	0.437	0.131	0.001	**
	← perceived ability games age 10	0.430	0.102	0.000	***
	← perceived ability gymnastics age 10	0.189	0.056	0.001	**
	← plays sports outside school age 10	0.750	0.075	0.000	***
	← smokes	-0.510	0.079	0.000	***
	← disability	-0.191	0.087	0.029	*
	← maturation at age 10	0.285	0.127	0.024	*
	← family recreation <1/wk	0.160	0.069	0.020	*
	← family recreation 1/wk+	0.416	0.095	0.000	***
	← father exercises	0.171	0.077	0.026	*
	← income	0.020	0.010	0.045	*
	← extra-curricular sport available	0.192	0.081	0.018	*
	← number of pupils in 5th year	0.146	0.040	0.000	***
Perceived fitness	← perceived ability games age 10	0.330	0.127	0.009	**
	← perceived ability gymnastics age 10	0.207	0.053	0.000	***
	← plays sports outside school age 10	0.358	0.057	0.000	***
	← smokes	-0.368	0.073	0.000	***
	← disability	-0.215	0.079	0.007	**
	← underweight age 10	0.063	0.102	0.536	
	← overweight age 10	-0.001	0.083	0.993	
	← obese age 10	-0.426	0.124	0.001	**
	← family recreation <1/wk	0.082	0.078	0.293	
	← family recreation 1/wk+	0.365	0.079	0.000	***
	← PE compulsory	0.175	0.088	0.048	*
	← school social mix	0.529	0.261	0.042	*
Perceived activity	← perceived ability gymnastics age 10	0.236	0.055	0.000	***
	← plays sports outside school age 10	0.349	0.066	0.000	***
	← smokes	-0.379	0.076	0.000	***
	← motor coordination age 10	0.128	0.062	0.039	*
	← family recreation <1/wk	0.100	0.070	0.154	
	← family recreation 1/wk+	0.375	0.088	0.000	***
	← social class II	0.124	0.092	0.178	
	← social class III non-manual	0.131	0.116	0.258	
	← social class III manual	0.066	0.090	0.465	

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Table 6.14 – *Continued from previous page*

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
	← social class IV	-0.064	0.136	0.638	
	← social class V	-0.429	0.196	0.028	*
	← games compulsory	-0.147	0.072	0.041	*
Body	← perceived ability games age 10	0.214	0.106	0.044	*
image	← perceived ability gymnastics age 10	0.291	0.051	0.000	***
	← plays sports outside school age 10	0.225	0.065	0.001	**
	← smokes	-0.167	0.076	0.028	*
	← disability	-0.226	0.087	0.009	**
	← underweight age 10	-0.177	0.094	0.058	
	← overweight age 10	-0.026	0.107	0.806	
	← obese age 10	-0.654	0.140	0.000	***
	← family recreation <1/wk	0.080	0.070	0.249	
	← family recreation 1/wk+	0.279	0.071	0.000	***
	← school social mix	0.553	0.233	0.018	*
Sport	← perceived ability gymnastics age 10	0.157	0.059	0.008	**
ability	← plays sports outside school age 10	0.614	0.086	0.000	***
	← underweight age 10	-0.232	0.112	0.039	*
	← overweight age 10	0.027	0.109	0.803	
	← obese age 10	0.193	0.151	0.201	
	← family recreation <1/wk	0.167	0.085	0.050	
	← family recreation 1/wk+	0.382	0.068	0.000	***
	← extra-curricular sport available	0.215	0.076	0.005	**
	← school social mix	0.558	0.244	0.022	*
	← number of pupils in 5th year	-0.171	0.072	0.017	*
Participation	← plays sports outside school age 10	0.299	0.060	0.000	***
inside	← family recreation <1/wk	0.079	0.078	0.310	
school	← family recreation 1/wk+	0.237	0.074	0.001	**
	← teach physical fitness	0.175	0.081	0.030	*
	← school social mix	0.459	0.149	0.002	**
	← number of pupils in 5th year	-0.235	0.089	0.008	**
Participation	← perceived ability games age 10	0.504	0.157	0.001	**
outside	← plays sports outside school age 10	0.486	0.082	0.000	***
school	← smokes	-0.201	0.093	0.031	*
	← family recreation <1/wk	0.100	0.081	0.218	

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Table 6.14 – *Continued from previous page*

Age 16 outcome	Explanatory variable	Estimate	S.E.	P-Value	
	← family recreation 1/wk+	0.548	0.142	0.000	***
Lifestyle activity	← family recreation <1/wk	0.093	0.082	0.259	
	← family recreation 1/wk+	0.410	0.109	0.000	***
	← mother exercises	0.151	0.068	0.027	*
Team activity	← perceived ability games age 10	0.486	0.175	0.005	**
	← plays sports outside school age 10	0.834	0.086	0.000	***
	← smokes	-0.241	0.097	0.013	*
	← disability	-0.307	0.144	0.033	*
	← family recreation <1/wk	0.087	0.087	0.313	
	← family recreation 1/wk+	0.402	0.132	0.002	**
	← social class II	0.002	0.150	0.991	
	← social class III non-manual	-0.164	0.128	0.199	
	← social class III manual	0.013	0.134	0.920	
	← social class IV	0.422	0.176	0.016	*
	← social class V	0.418	0.257	0.104	
	← number of pupils in 5th year	-0.336	0.089	0.000	***
Individual activity	← plays sports outside school age 10	0.279	0.070	0.000	***
	← family recreation <1/wk	0.081	0.102	0.429	
	← family recreation 1/wk+	0.365	0.093	0.000	***
	← father exercises	0.301	0.090	0.001	**
	← school social mix	0.697	0.221	0.002	**

Note: N=2,509; reference categories are: normal weight, family recreation rarely/never, mother left full-time education before age 15, social class I

Family recreation was the most important correlate for girls overall. It was associated with all of the factors at age 16 and, for those girls whose families took part at least once per week, had particularly large effects on fitness (0.598) and sport (0.727) motivation, perceived fitness (0.602), perceived activity (0.673), body image (0.555), participation outside school (0.901), and participation in lifestyle (0.768) and individual (0.613) activity. The effects also exhibited a strong dose-response pattern, with less frequent family recreation being less beneficial, but nevertheless far better than the reference category of rarely/never taking part in active recreation with the family.

For boys, family recreation was an important correlate, but less so. The popularity of sport amongst boys may have enabled them to increasingly participate with peers, independently of parents or adults. They would have had greater access to sports clubs than girls, but it is important to note that most participation was informal. For example, of the male cohort members that played football or cricket outside school, only 47.7% had represented a sports club in any sport during the year. There were also some positive associations relating to parental exercise and opinion for both boys and girls, but these were much smaller than the associations with family recreation. It seemed that parents being active with their children was much more important than any role-modelling effect.

These effects – family recreation and playing sports outside school at age 10 – provide further evidence of the overwhelming importance of family socialisation into an active lifestyle during childhood. Considering the association of playing sports outside school with perceived ability and enjoyment at age 10 (pp.122, 124), the family undoubtedly played a vital role in determining whether the cohort members had positive experiences of school sport, and exercise in general, at age 16.

There were important effects related to the physiological factors too. Smoking seemed to have a highly detrimental impact on experiences of sport and exercise for both boys and girls. Motivation and physical self-concept were greatly affected, participation less so. The direction of causality is not entirely clear. It is possible that cohort members with poor physical self-concept and low motivation were more likely to take up smoking. Alternatively, the effect of smoking on athletic performance and perceptions of health may have caused the negative effects on self-concept and motivation. Both are plausible. Smoking behaviour in adolescence may have reflected a tendency to "dabble and experiment with a wide range of leisure interests" (Roberts and Brodie 1992, cited in Green, 2010, p.106) that were previously unavailable to them. And so, participation in sport and exercise may have been trimmed in favour of other activities and new ways to socialise.

There were also some impacts of weight status at age 10 on experiences of sport and exercise at age 16. Overweight and obesity was associated with perceived fitness and body image, for both boys and girls, but there were some differences between the sexes. For girls, there was evidence of a dose-response relationship. For boys, only obesity appeared to be detrimental. There were also effects on fitness motivation for girls, and sport ability for boys, where being underweight was detrimental – being heavier may have been an advantage in some competitive sports. Importantly, there were no associations with sport motivation or any of the participation factors, for either sex. These estimates suggest that obesity mainly affected cohort members' self-perceptions, rather than their behaviour. Of course, these cohort members were also less likely to play sport outside school at age 10 (pp.122, 124), and so the effect of weight status may have acted through its impact on participation outside school at age 10.

There were some additional associations with other physiological correlates, but these were less consistent. For girls, disability, motor coordination and maturation at age 10 had small effects on fitness motivation and physical self-concept. For boys, there were associations with sport motivation, physical self-concept and participation in team activity. These estimates suggest that experiences of sport and exercise at age 16 were not strongly influenced by early differences in motor ability or maturation. Likewise, having some form of disability was not particularly detrimental (although the measure is simplistic). It is important to remember, however, that disability had a negative effect on playing sports outside school at age 10. Thus, as with weight status, the effect may have been entirely mediated by earlier experiences of playing sport outside school. Similarly, there were some associations with social class and income, but these were neither strong nor consistent, with no significant estimates relating to parental education. This mirrors the cross-sectional analysis at age 10 (pp. 122, 124, 127), which also found that socioeconomic factors were not particularly important.

The final set of correlates related to aspects of the school environment. For girls, the availability of extra-curricular sport was not associated with any of the factors, whereas for boys, it was associated with motivation and sport ability. This can be explained by the salience of sport for boys, but it may also have been the case that extra-curricular sport opportunities were less widely available for girls. Also, the association with sport ability for boys may have simply reflected the additional capacity of schools with extra-curricular provision to develop sports teams. There was a small positive effect of compulsory games provision on girls' perceived activity, participation inside school and in team activity. For boys, there was also a small effect on perceived activity. Again, this provides further evidence of the salience of competitive sport for boys – i.e. given the choice, girls would be less likely to participate in team games. There were no notable associations of compulsory PE with any of the factors, for either sex, probably because it was compulsory in almost all schools.

The social mix of the school and the number of pupils in the year group were far more important. For girls, there was some evidence to support the 'activitystat' hypothesis (Gomersall et al., 2013) – which states that overall activity levels for an individual tend to remain static over time, and intervention in one setting is compensated for by a behaviour change in another setting; schools with a high social class intake were associated with higher levels of perceived activity, but correspondingly lower participation outside school. Also, there was a very strong negative association with participation in team activities (-0.828). Assuming higher social class schools had a greater variety of activities available, this suggests girls were likely to prefer the alternatives to team activities.

For boys, there were even more associations with the social mix of the school. As with girls, a greater variety of activities seemed to be available in high social class schools – there were strong associations with participation inside school (0.459) and in individual activities (0.697). This variety also seemed to positively impact on physical self-concept, with perceived fitness (0.529), body image (0.553) and sport ability (0.558) all positively associated with the social mix of the school.

In contrast, the number of pupils in the school year seemed to reflect strain on facilities and provision (the largest schools had over 300 pupils in the year). For girls, the number of pupils was negatively associated with team activity (-0.213). For boys, it was negatively associated with both team activity (-0.336) and participation inside school (-0.235). Also, year group size was associated with slightly lower sport ability (-0.171) for boys. This could be due to frame of reference effects, or simply a reduced probability of being picked for school teams.

In summary:

1. The inclusion of controls did not have a great impact on the estimates from the preliminary model.
2. As with the cross-sectional analysis at age 10, the hours of PE provided in primary school did not seem to be important.
3. There was evidence of continuity in the enjoyment of sport, with enjoyment of games at age 10 associated with sport motivation at age 16.
4. Perceived ability in games at age 10 was associated with sport related experiences at age 16. Perceived ability in gymnastics was more relevant to fitness related experiences at age 16.
5. Playing sports outside school at age 10 was widely associated with positive experiences at age 16, and was particularly important for boys.
6. The estimates supported the notion that competitive sport was particularly salient for boys, far less so for girls.
7. Experiences at age 10 had no effect on participation in lifestyle activities at age 16, the only association being with family recreation.
8. Family recreation was one of the most important correlates. For girls, there was a strong dose-response relationship with all of the age 16 factors. For boys, only very frequent family recreation had an effect.
9. There were some small associations with parental exercise and opinion, suggesting that there may be some subtle parental influences in addition to family recreation.
10. Smoking was detrimental to motivation and physical self-concept, but not participation.
11. Weight status was associated with perceived fitness and body image, in a dose-response manner for girls, and their fitness motivation was also affected. For boys, being overweight was not detrimental, but obesity was.
12. Disability did not greatly affect experiences at age 16. As with weight status, the effect on playing sports outside school at age 10 may have been what mattered.

13. As with the analysis at age 10, the socioeconomic factors were not important correlates of experiences at age 16 for either sex.

14. Provision of extra-curricular sport in school was a boon for boys' motivation and sport ability, but had no effect for girls.

15. Compulsory games was associated with girls' participation inside school, in team activities and their perceived activity. This suggests girls chose not to participate when given the choice.

16. For girls, there was some evidence in support of the 'activitystat' hypothesis (Gomersall et al., 2013): the school social mix (a proxy for facility quality) was positively associated with perceived activity but negatively associated with participation outside school and in team activity.

17. Boys in high social mix schools participated more inside school and in individual activities, i.e. high social mix schools provided more opportunity to participate in a wider variety of activities.

18. The number of pupils in the year group put a strain on provision, affecting participation in team activity. For boys, there were also negative effects on participation inside school and sport ability, possibly due to more competition for school teams.

6.8 Conclusions

The analyses presented in this chapter sought to answer the following research questions:

- How does participation in sport and exercise inside school compare to that outside school at age 16?
  - Was school provision focused on traditional, competitive sport?
  - Were schools complicit in gender stereotyping of sport and exercise?
- Were there differences between the sexes in participation, intrinsic motivation and physical self-concept?

- Is the amount of participation associated with positive experiences at this age?
- Are experiences of sport and exercise at age 16 associated with those at age 10?
- Is their further evidence of family socialisation into sport and exercise at age 16?
- Did the correlates of physical activity have an influence on experiences of sport and exercise?

The comparison between participation inside and outside school was striking. School provision was undoubtedly dominated by traditional competitive sports, particularly team games. Most specific activities were reported as optional by headmasters, despite participation being compulsory or obligatory. The amount of provision increased from an average of two hours per week at age 10 to around three or four school periods per week at age 16. There was strong evidence that schools were complicit in reinforcing gender stereotypes in sport and exercise, with particular activities available exclusively to boys or girls. Today, schools tend to actively confront this kind of sexism, and so activities are far more likely to be made available irrespective of sex (Quick et al., 2010). It is important to note, however, that gender stereotypes are a feature of cultural norms. In the BCS70 data, this is reflected in polarised participation outside school in activities like aerobics, dancing and weight training. These stereotypes persist today.

Outside school, participation in traditional, competitive sport was far less common. Apart from a small minority that played racquet sports, virtually none of the girls participated in competitive sports at all – instead, tending to participate in lifestyle activities. Many boys played football and cricket outside school, though it is likely much of this was informal (e.g. in parks with friends). There are several possible explanations for why participation differed so greatly between settings. Firstly, competitive sports often require facilities and organisation, and so are less accessible. Secondly, given that competitive sports were so common inside school, this provision may have satisfied any participation that would have occurred otherwise (i.e. the ‘activitystat’ hypothesis). Thirdly, competitive sport may not have been that popular anyway. This seems to have been the case for girls, less so for boys.

Both the setting and the activity type were important aspects of participation – i.e. the setting mattered and cohort members exercised preferences for activity types. The boys had higher average levels of intrinsic motivation and physical self-concept than the girls, but they were a less homogeneous group. The strong sporting culture amongst boys could have increased inequality by emphasising, and exacerbating, any differences in ability. It was apparent that a large minority of both boys and girls had negative experiences of sport and exercise at age 16.

Boys' average level of sport motivation was much higher than girls', but the difference in fitness motivation was small. Considering sport was not particularly popular with girls, school provision clearly failed to build on this motivation. In comparison, girls' physical self-concept was considerably lower on average. The possibility that school sport was partly to blame for lowering it must be taken seriously. It is generally thought that young women are exposed to unrealistic ideals of physical beauty (Coleman, 2008; López-Guimerà et al., 2010; Grosick et al., 2013) – the negative bias in the girls' self-perceptions of body shape reflects this (p.161). School provision may have added to this pressure by representing ideals of physical fitness primarily through sport performance.

Participation was associated with positive experiences, but the strength of association varied by setting. The correlations were consistently far stronger for activity undertaken outside school. The relative weakness of the associations with activity inside school demonstrates that cohort members participated regardless of motivation, and this was not particularly beneficial for physical self-concept. In order to have positive experiences at age 16, participation outside school seemed to be vital.

These associations were not temporally ordered, and so could have been bidirectional. To get a stronger sense of possible causal processes, the analysis was extended longitudinally from age 10. As with the cross-sectional analysis at this age, the hours of PE provided in school at age 10 seemed to be completely irrelevant to experiences of sport and exercise at age 16. More surprisingly, enjoyment in primary school was also not particularly relevant to experiences at age 16, having no association with either participation or physical self-concept at this age.

In contrast, perceived ability and playing sports outside school at age 10 were both widely associated with later experiences. Playing sports outside school at an early age was particularly important for boys, seeming to supplant some of the impact of early perceptions of ability. The importance of perceived ability highlights the competitive nature of school sport – one would expect these perceptions to be less important if achievement goals in school provision were predominantly task orientated.

There was considerable evidence for the continuing role of family socialisation at age 16. Not only was playing sports outside school at age 10 important, but the amount of family recreation at age 16 also had a very strong and consistent effect on experiences of sport and exercise at this age. It was particularly important for girls, the estimates indicating a strong dose-response effect.

The correlates of physical activity continued to affect experiences of sport and exercise at age 16, controlling for experiences at age 10. Smoking and obesity were negatively associated with motivation and physical self-concept at age 16, but had no additional effect on participation. Disability affected perceived fitness for both boys and girls, and boys' participation in team activities. In the cross-sectional analysis at age 10, both weight status and disability had been negatively associated with playing sports outside school at age 10 (pp.122, 124). Thus, the effect on participation at age 16 was through earlier differences in playing sports outside school. Socioeconomic factors (parental social class, income and education) had little effect at age 16, as was the case at age 10.

The school context continued to be an important influence at age 16. There was evidence that schools with high social class mixes had better provision, more facilities and a wider variety of activities available. This also implies a stronger sporting ethos. Girls' participation outside school and in team activity was negatively associated with their school's social mix. Thus, it seems that greater opportunity in school may have reduced participation outside school to some extent and allowed girls to drop team sports. For boys, there was more participation inside school and in individual activities, but their physical self-concept also benefited. In contrast, larger year groups appeared to strain school facilities, negatively impacting participation in team activity for both sexes. For boys, schools with extra-curricular provision fostered slightly higher levels of motivation for sport and fitness. Compulsory games provision was associated with greater participation by girls. These estimates both reinforce the finding that sport was not particularly popular amongst girls – extra-curricular provision was unimportant and they tended to opt out of team activities where possible.

An additional and unexpected finding from the longitudinal analysis was the lack of effects for lifestyle activity. The only important correlate for both boys and girls was family recreation. Neither experiences at age 10, physiological factors, socioeconomic factors or the school environment had any effect on participation in these activities. This provides a strong affirmation of the accessibility, inclusivity and flexibility of these types of activity.

The analyses presented in this chapter strongly support the findings of the cross-sectional analyses at age 10. Socialisation into an active lifestyle by family and home influences was by far the most important factor affecting cohort members' experiences of sport and exercise at age 16. School provision was dominated by traditional, competitive sport, and was heavily gendered. Many girls and a large minority of boys were poorly served by this narrow approach to sport and exercise. Worryingly, perceptions of ability developed inside school at age 10 made a lasting difference. By age 16, many cohort members no longer enjoyed sport, and the cohort as a whole had become more heterogeneous. This was particularly the case for boys. It seems highly likely that a focus on competition in school sport had a lot to do with this. Considering that performance inside school was predominantly due to factors beyond the school's influence, this emphasis seems perverse – the very children who were already disadvantaged by inactive home environments would tend to have negative experiences inside school.

The next chapter presents a necessary detour from the main content of this thesis. It introduces the main outcome of this research: adult exercise behaviour. In the BCS70, it is measured at ages 29 and 34 using three relatively simplistic questions, which ask whether a cohort member exercises regularly, how often, and how intensively. Because these questions are so simple, it is prudent to validate them somehow. In the following chapter, a latent measure of exercise behaviour is developed, which is then validated against two health outcomes: BMI and malaise.

Chapter 7

Adult exercise behaviour and health outcomes

7.1 Introduction

This empirical chapter introduces the main outcome of the research presented in this thesis: adult exercise behaviour. It uses the data available in the BCS70 to identify exercise behaviours. It then examines two health outcomes, body mass index (BMI) and malaise. It aims to answer the following main research question:

- Is the measure of exercise behaviour at ages 29 and 34 associated with health outcomes?

There are only three questions available in the BCS70 asking the adult cohort members about their exercise behaviour, which are repeated at ages 29 and 34[1]. The questions ask only whether the cohort member exercises regularly, how frequently they exercise, and whether they get out of breath and sweaty when they exercise (i.e. how intensively they exercise). Compared to modern survey instruments used for measuring physical activity, and the increasingly popular objective methods (such as accelerometry), these questions offer only a general estimate of current exercise behaviour. It is therefore prudent to validate them somehow.

[1]There is an additional wave of data containing information on sport and exercise, which was collected in 2012 when the cohort members were aged 42, but this data was only recently made available, and so it has not been possible to include it in the research presented here.

In this chapter, the simplicity of these questions is acknowledged by analysing the responses using latent class analysis. This approach allows a set of relatively homogeneous groups or classes to be identified based on their patterns of response (p.85). The classes are then validated by identifying their time-varying associations with important health outcomes related to physical activity: body mass index (BMI) and mental well-being, measured using the Rutter malaise scale (Rutter, 1967; Rutter et al., 1970; Rodgers et al., 1999). These outcomes have been chosen because they respond to exercise (pp.19, 20), are measured at multiple waves in the BCS70, and are relevant to the health of young adults (<40 years old).

Latent growth curve models (p.81) are estimated for BMI and malaise from childhood to adulthood, so that individual differences in baseline and trajectory can be modelled, and these can be controlled for when estimating the influence of exercise behaviour at specific time points. Additional variables are included in the models to control for potential confounding. The main research question is supplemented by the following additional questions:

- What types of adult exercise behaviour can be identified in the BCS70?
  - Is there a continuum of exercise or are there discrete types (classes) of exercise behaviour?
  - Is exercise behaviour stable between ages 29 and 34?
  - Are men and women similar in their exercise behaviour?
- How does BMI and malaise vary over time from childhood to adulthood in the BCS70?
  - Are there differences between individuals in BMI and malaise over time?
  - Are there differences between the sexes in BMI and malaise over time?
- Is exercise behaviour associated with BMI and malaise controlling for confounding variables?

The following sections are included in this chapter:

Variables – describes the measures used in the analyses;

Analytical strategy – describes the approach used to answer the research questions;

Exercise behaviour at ages 29 and 34 – presents an analysis of the variables measuring exercise behaviour in adulthood, and goes on to develop latent class models of exercise behaviour;

BMI and malaise from childhood to adulthood – presents an analysis of the variables measuring BMI and malaise in the BCS70, and goes on to develop latent growth curve models for these health outcomes;

Investigating the effect of exercise behaviour on BMI and malaise – estimates the time-varying associations of latent classes of adult exercise behaviour with BMI and malaise, and then controls for potential confounding by inclusion of additional correlates of health outcomes;

Conclusions – summarises the findings of this chapter.

7.2 Variables

There were only three questions in the BCS70 related to exercise behaviour at ages 29 and 34 (whilst being asked the questions, the cohort members were given the showcard reproduced in Figure 7.1):

Regular exercise – measured using a binary variable, the cohort members were asked: "Do you regularly take part in any of the activities on this card [see Figure 7.1]. By regularly I mean at least once a month, for most of the year?" – (a) yes, (b) no;

Exercise frequency – measured using an ordinal variable, the cohort members were asked: "[If yes,] how often do you take part in any activity of this type?" – (a) every day, (b) 4/5 days per week, (c) 2/3 days per week, (d) once per week, (e) 2/3 times per month, (f) less often; and

Exercise intensity – measured using an ordinal variable, the cohort members were asked: "And when you take part in any activity of this type, would you say you got out of breath or sweaty..." – (a) most times, (b) sometimes, (c) rarely, (d) never.

It is clear from the show card that the exercise questions are intended to refer to physical activity that can be classified as sport or exercise, rather than informal or domestic physical activity.

Figure 7.1: Showcard used by interviewer during exercise questions (named Card VV at age 29 and Card NN at age 34)

Card VV/NN

1. Take part in competitive sport of any kind
2. Go to "keep fit" or aerobics classes
3. Go running or jogging
4. Go swimming
5. Go cycling
6. Go for walks
7. Take part in water sports
8. Take part in outdoor sports
9. Go dancing
10. Take part in any other sport or leisure activity which involves physical exercise

The health outcomes modelled in this chapter were BMI and malaise:

BMI – measured with a continuous variable, calculated from weight in kilograms and height in metres using Quetelet's formula (BMI=kg/m^2). During childhood (ages 10 and 16), these measurements were taken by a medic; in adulthood (ages 26, 29 and 34) they were self-reported. Pregnant women were asked to report their weight from before they were pregnant;

Malaise – measured with an ordinal variable at ages 16, 26, 29 and 34, derived using nine items of the Rutter Malaise Inventory (Rutter, 1967; Rutter et al., 1970):

1. "Do you feel tired most of the time?"
2. "Do you often feel miserable or depressed?"
3. "Do you often get worried about things?"
4. "Do you often get into a violent rage?"
5. "Do you often suddenly become scared for no good reason?"

6. "Are you easily upset or irritated?"
7. "Are you constantly keyed up and jittery?"
8. "Does every little thing get on your nerves and wear you out?"
9. "Does your heart often race like mad?"

Various versions of the Rutter Malaise Inventory were used in the BCS70 to measure psychological distress at different waves. The full version includes 24 questions. At age 16, 22 questions were used, with three response options (most of the time, some of the time, rarely or never). At ages 26 and 29, the full set of 24 questions were included, with the standard response options (yes, no). At age 34, nine of the questions were asked, again with the standard response options (yes, no).

So that the measures at each wave were comparable, the analysis presented in this chapter restricted the question items to those used at age 34. The response options were coded so "most of the time" and "yes" had a numerical value of one. "Some of the time" was coded as 0.5, and "rarely or never" and "no" were coded as zero. The numerical values of the answers were then summed to create a scale value for the respondent, taking values between zero and nine. A score of four or higher is typically thought to indicate the respondent is suffering symptoms commonly associated with depression (Rodgers et al., 1999; Centre for Longitudinal Studies, 2007). Where there were half values in the age 16 wave, they were rounded up.

Additional variables were included in order to control for the influence of correlates of health (O'Neil et al., 2012; Stranges et al., 2014). Variables measuring family composition, socioeconomic factors, health related factors and vehicle ownership were included. The specific correlates used depended on the health outcome being analysed. Measures used to control for family composition included:

Marital status – measured using a binary variable indicating whether the cohort member is single, cohabiting or married, measured at age 34; and

Children – measured using a binary variable indicating whether there are any children living in the household, measured at age 34.

Measures used to control for socioeconomic factors included:

Employment – measured using a categorical variable indicating whether the cohort member is unemployed, employed part-time or full-time, measured at age 34;

Social class – measured using a categorical variable indicating the highest social class of the cohort member and their partner, measured at age 34 using the Registrar General's classification (Rose and Pevalin, 2001);

Income – measured using a categorical variable indicating the total weekly take-home pay of the cohort member and their partner, measured at age 34; and

Education – measured using a categorical variable indicating the highest academic qualification achieved by the cohort member at age 34.

Measures used to control for health related factors included:

Disability – measured using a binary variable indicating whether the cohort member has a disability or limiting illness which affects their day-to-day life, measured at age 34;

Smoking – measured using a binary variable indicating whether the cohort member is a regular smoker, measured at age 34;

Drinking – measured using a categorical variable indicating the number of days per week the cohort member drinks alcohol, measured at age 34;

Cut drinking – measured using a binary variable indicating whether the cohort member feels they should cut down their drinking, measured at age 34; and

Diet – measured using binary variables indicating whether the cohort member eats certain types of food (fruit, salads, cooked vegetables, fish, chips and red meat) on three or more days per week, measured at age 29.

Lastly, a single measure was used to control for vehicle ownership:

Access to car – measured using a binary variable indicating whether the cohort member usually has access to a motor vehicle, measured at age 29.

7.3 Analytical strategy

The analytical strategy for this chapter comprised three main stages:

1. **Analysis of exercise behaviour at ages 29 and 34**
   (a) a preliminary analysis of the variables measuring exercise behaviour at ages 29 and 34 was undertaken using cross-tabulation. Patterns of behaviour were examined and compared to national statistics from the Health Survey for England;
   (b) the variables were cross-sectionally analysed using latent class analysis in order to identify types/classes of exercise behaviour; and
   (c) the latent class analysis was extended longitudinally to identify whether cohort members changed class between ages 29 and 34.
2. **Analysis of BMI and malaise trajectories**
   (a) a preliminary analysis of BMI trajectories was undertaken by plotting the mean BMI by sex and age. Latent growth curve models were then estimated and the sexes compared; and
   (b) a preliminary analysis of malaise trajectories was undertaken by plotting both the mean malaise score and the proportion of cohort members who could be suffering from depression by sex and age. Latent growth curve models were then estimated and the sexes compared.
3. **Estimating the effect of exercise behaviour on BMI and malaise**
   (a) a preliminary analysis was undertaken to identify the association of exercise behaviour with BMI and malaise at ages 29 and 34, by sex, controlling for the latent baseline and growth factors; and
   (b) the final analyses included additional variables to control for family composition, socioeconomic factors, health related factors and (for BMI) vehicle ownership.

7.4 Analysis of exercise behaviour at ages 29 & 34

7.4.1 Preliminary analysis

The available data for the three variables measuring exercise behaviour at ages 29 and 34 are cross-tabulated by sex as marginal proportions in Table 7.1. The proportions were very similar across waves and sexes, with approximately 79% reporting that they exercised regularly. This estimate corresponds reasonably well with national statistics from the Health Survey for England for 1998 and 2004 (Joint Health Surveys Unit (NatCen) et al., 2010), which classified respondents into three categories:

1. **Meets recommendations** – 30 minutes or more of moderate or vigorous activity on at least five days a week;
2. **Some activity** – 30 minutes or more of moderate or vigorous activity on one to four days a week; and
3. **Low activity** – lower levels of activity than above (Joint Health Surveys Unit (NatCen) et al., 2010).

According to this survey, for the age band 25 to 34, 24% of men and 29% of women were categorised as 'low activity' in 1998 (when the cohort members were 28), and 24% of men and 27% of women were categorised as low activity in 2004 (when the cohort members were 34). Considering that some of the 'regularly exercising' cohort members are likely to have done so very infrequently or at low intensity, the Health Survey estimates appear to be broadly similar.

In order to include all cohort members in Table 7.1, the questions relating to exercise frequency and intensity were recoded to include those who said they did not exercise regularly in the least frequent and intense categories. Almost none of the cohort members who exercised regularly did so less often than 2-3 times per month. However, a large minority of regular exercisers responded that they never got out of breath and sweaty (∼10-15% of the sample). The responses for exercise frequency show that there seemed to be a large group of exercising cohort members who exercise one to three days per week (∼25%), and a large group who exercise every day (∼15-20%).

Table 7.1: Cohort members' self-reported exercise behaviour at ages 29 and 34, by sex

<table>
<tr><th>Variable</th><th>Response</th><th>Age 29 (%)</th><th></th><th>Age 34 (%)</th><th></th></tr>
<tr><td>Female</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Exercises regularly</td><td>yes</td><td>77.9</td><td>|||||||||||||||||||||||||</td><td>79.9</td><td>||||||||||||||||||||||||||</td></tr>
<tr><td></td><td>no</td><td>22.1</td><td>|||||||</td><td>20.1</td><td>||||||</td></tr>
<tr><td>How often exercises</td><td>less often</td><td>24.1</td><td>||||||||</td><td>21.9</td><td>|||||||</td></tr>
<tr><td></td><td>2-3 per month</td><td>5.1</td><td>|</td><td>5.2</td><td>|</td></tr>
<tr><td></td><td>1 day a week</td><td>17.8</td><td>|||||</td><td>15.8</td><td>|||||</td></tr>
<tr><td></td><td>2-3 days a week</td><td>23.5</td><td>|||||||</td><td>25.8</td><td>||||||||</td></tr>
<tr><td></td><td>4-5 days a week</td><td>9.6</td><td>|||</td><td>11.2</td><td>|||</td></tr>
<tr><td></td><td>every day</td><td>19.9</td><td>||||||</td><td>20.2</td><td>||||||</td></tr>
<tr><td>How often gets out of breath and sweaty</td><td>never</td><td>34.6</td><td>|||||||||||</td><td>35.5</td><td>|||||||||||</td></tr>
<tr><td></td><td>rarely</td><td>14.4</td><td>||||</td><td>13.6</td><td>||||</td></tr>
<tr><td></td><td>sometimes</td><td>26.2</td><td>||||||||</td><td>24.9</td><td>||||||||</td></tr>
<tr><td></td><td>most times</td><td>24.8</td><td>||||||||</td><td>26.0</td><td>||||||||</td></tr>
<tr><td>Male</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Exercises regularly</td><td>yes</td><td>79.7</td><td>||||||||||||||||||||||||||</td><td>78.2</td><td>||||||||||||||||||||||||||</td></tr>
<tr><td></td><td>no</td><td>20.3</td><td>||||||</td><td>21.8</td><td>|||||||</td></tr>
<tr><td>How often exercises</td><td>less often</td><td>22.6</td><td>|||||||</td><td>23.6</td><td>|||||||</td></tr>
<tr><td></td><td>2-3 per month</td><td>6.6</td><td>||</td><td>6.6</td><td>||</td></tr>
<tr><td></td><td>1 day a week</td><td>18.6</td><td>||||||</td><td>17.7</td><td>|||||</td></tr>
<tr><td></td><td>2-3 days a week</td><td>26.1</td><td>||||||||</td><td>26.8</td><td>||||||||</td></tr>
<tr><td></td><td>4-5 days a week</td><td>10.9</td><td>|||</td><td>10.5</td><td>|||</td></tr>
<tr><td></td><td>every day</td><td>15.2</td><td>|||||</td><td>14.8</td><td>||||</td></tr>
<tr><td>How often gets out of breath and sweaty</td><td>never</td><td>28.6</td><td>|||||||||</td><td>31.4</td><td>||||||||||</td></tr>
<tr><td></td><td>rarely</td><td>8.8</td><td>||</td><td>10.1</td><td>|||</td></tr>
<tr><td></td><td>sometimes</td><td>21.0</td><td>|||||||</td><td>18.9</td><td>||||||</td></tr>
<tr><td></td><td>most times</td><td>41.6</td><td>|||||||||||||</td><td>39.7</td><td>|||||||||||||</td></tr>
</table>

Note: N=10,338 at age 29 and N=8,904 at age 34; responses 'less often' and 'never' include those cohort members who said they did not exercise regularly; the estimates are marginal proportions

The proportions were very similar across the two waves, but there was a slight difference by sex, with women slightly more likely to respond that they exercise every day. In terms of intensity, there was a large dichotomy, with many cohort members 'never' getting out of breath and sweaty, and many getting out of breath and sweaty 'sometimes' or 'most times'. Men were more likely than women to respond that they got out of breath and sweaty most times (approximately 40% of men and 25% of women). As with exercise frequency, the proportions for each of the intensities were quite consistent across waves.

By including the non-exercisers in the lowest categories of exercise frequency and intensity, it was possible to analyse all of the available cohort members' responses in a two-way cross-tabulation. Table 7.2 shows this cross-tabulation for the wave at age 29 (the corresponding table for age 34 was very similar). The table cells contain a colour gradient so that higher proportions are darker.

Table 7.2: Cross-tabulation of cohort members' self-reported frequency and intensity of exercise at age 29

		How often gets out of breath and sweaty				Total
		never	rarely	some-times	most times	
How often exercises	less often	21.8	0.4	0.6	0.5	23.4
	2-3/mth	0.9	1.0	1.9	2.1	5.8
	1/wk	2.6	2.7	5.5	7.4	18.2
	2-3/wk	1.9	2.7	7.1	13.1	24.8
	4-5/wk	0.8	1.4	2.9	5.2	10.3
	every day	3.8	3.6	5.7	4.6	17.6
Total		31.6	11.7	23.7	33.0	100

Note: N=10,338; responses 'less often' and 'never' include those cohort members who said they did not exercise regularly

It was clear that these patterns of response would be poorly described by a single, continuous latent variable. There seemed to be three general groupings of cohort members:

1. an inactive group who almost all responded that they did not exercise regularly;

2. a group of regular, intensive exercisers who tended to exercise around two to three times per week and got out of breath and sweaty most times; and

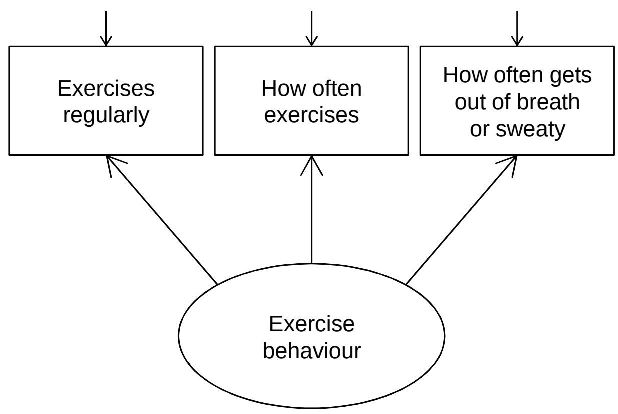
3. a group of very frequent exercisers, who exercised every day, but at a variety of intensities.

This grouping motivated the use of latent class analysis (p.85). By using this method to extract a small number of homogeneous groups from the exercise data, the inherent simplicity of these measures and their ability to provide only a very general indication of exercise behaviour is acknowledged.

7.4.2 Latent class analysis of exercise behaviour

Latent class models were estimated in order to identify how many types of exercise behaviour could be identified in the cohort members' responses. Models with two, three and four classes were estimated. The models were estimated separately by wave and sex. A diagram of the model specification is shown in Figure 7.2.

Figure 7.2: Latent class model for identifying the number of classes needed to describe exercise behaviour at ages 29 and 34



Fit statistics from the models are presented in Table 7.3. In each case, the estimates supported a model with three classes as providing an adequate explanation of the patterns of response. The BIC estimates were all at a minimum for the three class models, and the Vuong-Lo-Mendell-Rubin (VLMR) and parametric bootstrapped likelihood ratio (PBLR) tests both found that a four class model did not provide a significantly better fit. Examination of the standardized residuals from the three class models showed that they provided a very good fit to the data, with no individual residuals above four and the sums of the bivariate residuals being non-significant when compared to the χ^2 distribution.

Table 7.3: Estimates from latent class models used to identify the number of classes needed to describe exercise behaviour, by sex and age

Sex	Age	N	Classes	BIC	VLMR P-Value	PBLR P-Value
Female	29	5,342	2	30,050		
			3	29,857	0.000	0.000
			4	29,937	0.381	0.667
	34	4,664	2	26,570		
			3	26,388	0.000	0.000
			4	26,465	0.223	1.000
Male	29	4,999	2	27,251		
			3	27,141	0.000	0.000
			4	27,222	0.801	1.000
	34	4,240	2	23,109		
			3	23,015	0.000	0.000
			4	23,093	0.829	0.600

Note: p-values for VLMR and PBLR tests compare the current model with c classes against one with $c-1$ classes, a significant result indicates the $c-1$ model is a poorer fit

Multigroup testing was conducted in order to identify whether the classes were equivalent for both sexes at each wave. χ^2 tests of parameter constraints were highly significant (p<0.000) at both ages 29 and 34, demonstrating that the classes were not equivalent for men and women – i.e. male and female exercise behaviours differed. The analysis was extended longitudinally, as shown in Figure 7.3, to identify whether there was within-sex measurement equivalence across time. The latent transition probabilities of moving from one class to another over time were also estimated. It seemed logical that exercise behaviour at age 29 would be predictive of that at age 34, and so a temporally ordered path was specified between the two. There was strong evidence that the within-sex measurement models were equivalent at ages 29 and 34, for both women ($\chi^2(27)=17.5133$, p=0.9177) and men ($\chi^2(27)=14.1952$, p=0.9793). Both models classified cohort members relatively cleanly, with entropy values of 0.71 for both sexes.

Table 7.4 shows the probability estimates describing class composition from the constrained models by class and sex. It was clear from the estimates that despite there being strong measurement variance between the sexes, the classes were substantively equivalent for men and women. Cohort members in class 1 tended to respond that they exercised two to three times per week and got out of breath and sweaty most times, i.e. they were regular exercisers ('Exerciser') who seemed to expend the effort required for fitness gains. Those in class 2 exercised at a variety of frequencies, with many responding that they exercised once per week or every day, but they were far less likely to get out of breath and sweaty most times, i.e. they were active ('Active'), but did not exhibit the behaviour of people who consistently exercise for fitness gains. The final class was composed almost entirely of those who responded that they did not exercise regularly, i.e. they were inactive ('Inactive') in terms of exercise.

Figure 7.3: Longitudinal latent class model used to describe exercise behaviour at ages 29 and 34

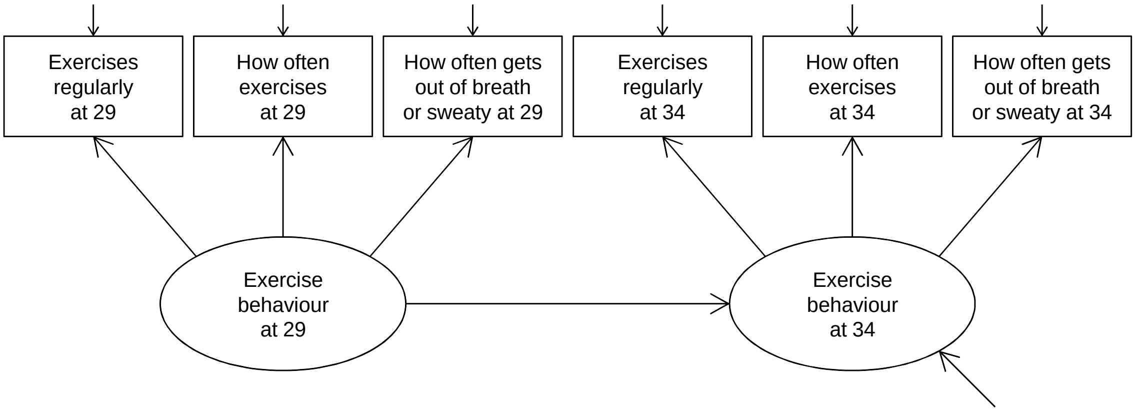


Table 7.4: Estimates from latent class models in the probability scale describing class composition, by class and sex

Variable	Response	Class 1 'Exerciser' Female	Male	Class 2 'Active' Female	Male	Class 3 'Inactive' Female	Male
Exercises regularly	yes	100.0	100.0	100.0	100.0	1.0	0.7
	no	0.0	0.0	0.0	0.0	99.0	99.3
How often exercises	less often	0.9	0.8	3.0	4.1	100.0	100.0
	2-3/mth	4.2	5.2	8.0	11.8	0.0	0.0
	1/wk	18.3	20.3	23.5	26.1	0.0	0.0
	2-3/wk	48.7	43.0	19.6	23.1	0.0	0.0
	4-5/wk	18.7	19.1	9.5	7.7	0.0	0.0
	every day	9.1	11.7	36.4	27.1	0.0	0.0
How often gets out of breath and sweaty	never	0.5	0.0	28.6	23.0	100.0	100.0
	rarely	6.0	2.3	25.8	22.4	0.0	0.0
	sometimes	29.1	16.9	34.9	34.8	0.0	0.0
	most times	64.4	80.8	10.8	19.8	0.0	0.0

Note: Female N=5,598, Male N=5,351

Table 7.5: Percentage of cohort members in each class, by sex and wave

	Female		Male	
	Age 29	Age 34	Age 29	Age 34
Exerciser	30.6	30.9	46.7	43.1
Active	48.2	52.1	32.9	34.8
Inactive	21.2	17.0	20.4	22.0

Note: Female N=5,598, Male N=5,351

Table 7.5 shows the percentage of cohort members classified as being in each class at each wave, by sex. Both sexes were equally likely to be inactive (∼20%), but women were more likely to be active (∼50%) than men (∼34%), and less likely to be exercisers (∼31%) than men (∼45%). There were only small changes between the waves in the proportions of cohort members in each class. Slightly more women were active and fewer inactive at age 34. Slightly fewer men were exercisers at age 34.

Table 7.6: Percentage of cohort members transitioning classes between waves, by sex

		Age 34		
Female		Exerciser	Active	Inactive
Age 29	Exerciser	26.9	1.2	2.5
	Active	1.3	39.0	7.9
	Inactive	2.8	11.9	6.6
Male				
Age 29	Exerciser	41.2	1.6	4.0
	Active	0.0	27.7	5.2
	Inactive	2.0	5.6	12.8

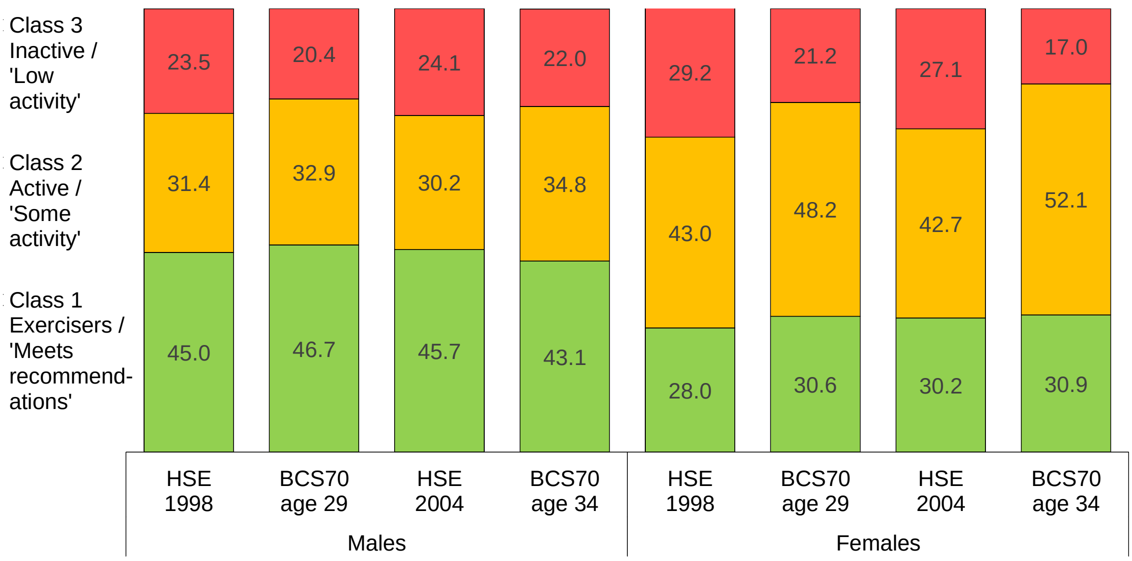
Note: Female N=5,598, Male N=5,351

There seemed to be a reasonably high degree of stability in class assignment between waves (Table 7.6). For women, 72% remained in the same class across the two waves. For men, 82% did. The greatest degree of movement for both sexes was between the inactive and active classes.

Spearman's rank correlation coefficient (Spearman, 1904) was estimated by sex based on the cross-tabulations shown in Table 7.6. This assumes that the classes are ordinal, with the exerciser class being the most active. The correlations were 0.59 for women and 0.74 for men. Clearly, women were more likely to change class than men, and this was mostly between the active and inactive classes. As a consequence of this, men were twice as likely as women to remain inactive across both waves.

The cross-sectional classifications were compared against the national statistics from the Health Survey for England (HSE, Figure 7.4). The proportions were very similar to the estimates from the HSE, despite the survey questions being very different – the HSE contains many more questions and goes into more detail (National Centre for Social Research (NatCen) and University College London, Department of Epidemiology and Public Health, 2008) than the very basic questions available in the BCS70 at ages 29 and 34. Of course, this is a convenient result and it is not possible to identify whether the cohort members would have been classified in the HSE as they have been categorised into latent classes. Nevertheless, the similarity is striking. The only substantial difference was that the BCS70 seemed to estimate more women as active ('some activity') and fewer as inactive ('low activity') than the HSE.

Figure 7.4: Comparison of national statistics from the Health Survey for England (HSE) with the proportion of cohort members in each latent class of exercise behaviour by sex and wave



Note: HSE statistics are for the 25-34 age band; in 1998 the cohort members were 28 years old, in 2004 they were 34 years old

In summary:

1. Most regularly exercising cohort members were active one to three days per week, or every day.
2. A large minority rarely or never got out of breath or sweaty. Men were more likely than women to get out of breath and sweaty 'most times' they exercised.
3. Cross-tabulation of the frequency and intensity questions suggested there were distinct types of exercise behaviour, rather than a continuum of activity.
4. Latent class analysis identified three classes of exercise behaviour at both waves: exerciser, active and inactive classes.
5. The 'exerciser' class exercised one to five times per week at high intensity, the 'active' class exercised at a variety of frequencies but mostly not at high intensity, and the 'inactive' class did not exercise at all.
6. The models were equivalent over time within-sex, and substantively similar (thought not equivalent) between-sex.
7. More men were 'exercisers' than women. More women were 'active' than men. Similar proportions were 'inactive'.
8. Cohort members tended to stay in the same class across both waves, but there was some movement between 'inactive' and 'active' classes, particularly amongst women.
9. The proportions of cohort members in the three classes were very similar to the proportions classified as 'low activity', 'some activity', and 'meets recommendations' in the Health Survey for England.

7.5 Analysis of BMI and malaise trajectories

The main motivation for being interested in adult exercise behaviour is the wide-ranging health benefits associated with leading a physically active life. Ever since the famous London Bus and Whitehall studies by Jeremy Morris (Morris et al., 1953, 1973, 1980), it has been known that being physically active can confer a range of health benefits and increase lifespan. High BMI is known to be associated with increased cardiovascular disease and diabetes risk (Press et al., 2003; Sigal et al., 2004). Generally, it is now thought that people who get heavier subsequently decrease their level of physical activity (Golubic et al., 2013). But conversely, it is also known that being physically active can help maintain a healthy weight status, and maximise dietary weight loss efforts (Fogelholm and Kukkonen-Harjula, 2000; Parsons et al., 2006).

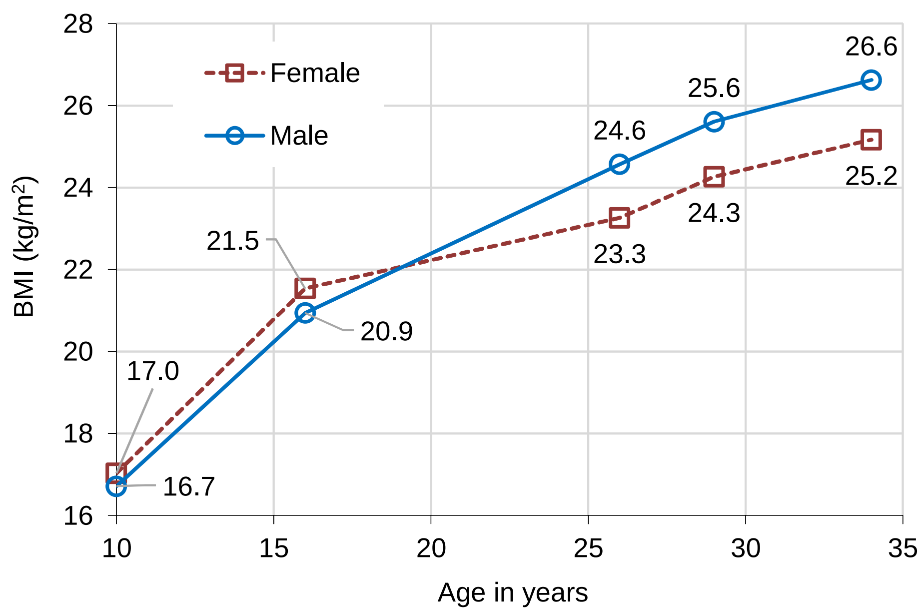
By modelling the latent trajectories of BMI over time for the cohort members, it is possible to get closer to the causal effect of exercise behaviour on BMI. This is because the models inherently control not only for the baseline BMI of the individual, but also the growth process (p.81). Thus, any association of exercise behaviour with BMI at a specific time point indicates that portion of the growth that is correlated with exercise behaviour. This does not in and of itself secure the desired causal direction, as those with greater BMI growth might reduce their exercise levels. However, the previous analysis suggested that exercise behaviour was relatively stable between ages 29 and 34, undermining this causal direction. Instead, we assume here that the level of exercise is predictive of growth in BMI.

Research into the effects of exercise on mental well-being is less developed, but it is generally accepted that exercise can have a small beneficial effect, reducing the incidence of mild anxiety and depressive symptoms (Steptoe and Butler, 1996; Fox, 1999; Strauss et al., 2001; Sacker and Cable, 2006; Johnson and Krueger, 2007). Cross-cohort analyses have found that both BMI and malaise are growing in the UK adult population (Sullivan, 2013), and so investigating any benefit of exercise on these health indicators not only provides validation for the latent class exercise measure, but is worthwhile in its own right.

7.5.1 Latent growth curve models of BMI

In order to identify the general shape of the BMI trajectories, mean BMI was plotted by age and sex (Figure 7.5). The plot was non-linear, with BMI increasing steeply from childhood to adulthood, and then more slowly over time. BMI was slightly higher for girls than boys until adulthood, when men overtook women. Worryingly, the average male cohort member was already overweight (BMI $\geq$25kg/m^2) at age 29, and the average female cohort member reached this ominous milestone at age 34, based on self-reported weight and height. The shape of the trajectories suggested that a model with a linear slope factor (as in Figure 4.4, p.82) would probably not be a good fit to the data. Therefore, latent growth curve models were fit for each sex with only the first and last slope factor loadings constrained, to zero and one, respectively. The loadings at ages 16, 26 and 29 were freely estimated.

Figure 7.5: Cohort members' mean BMI trajectories by sex



The initial model did not fit the female data well, with a $\chi^2(7)$=217.857 (p= 0.0000), an RMSEA of 0.067 (90% CI: 0.059 to 0.075), a CFI of 0.909 and a TLI of 0.870. The most likely explanation for this lack of fit was the difference in data collection between the waves in childhood and those in adulthood. During childhood, measurements were objectively made by a medic, whereas they were self-reported in adulthood. Self-reporting allows an idiosyncratic error or bias to affect the measurement. Seeing as height does not change in adulthood, it is likely this error was attributable to self-assessments of weight. In order to account for it, the residuals were allowed to correlate between all three adult measures of BMI. This improved fit considerably ($\chi^2(3)=153.911$ (p=0.0000)) and resulted in a model that fit the data well, with a $\chi^2(4)=13.554$ (p=0.0089), an RMSEA of 0.019 (90% CI: 0.008 to 0.030), a CFI of 0.996 and a TLI of 0.990.

For males, the initial model fit the data quite well, with a $\chi^2(7)=50.153$ (p= 0.0000), an RMSEA of 0.030 (90% CI: 0.022 to 0.038), a CFI of 0.968 and a TLI of 0.954. This indicates that the error in the men's reports was less problematic than the women's. Nevertheless, correlated residuals were added to the adult measures of BMI in the male model to see whether this adjustment improved the fit significantly, as in the female model. It did ($\chi^2(3)=27.854$, p=0.0000) and resulted in a model that fit the data very well, with a $\chi^2(4)=12.090$ (p=0.0167), an RMSEA of 0.017 (90% CI: 0.006 to 0.028), a CFI of 0.994 and a TLI of 0.985.

Multigroup testing was undertaken to determine whether the male and female measurement parameters were equivalent. The difference between the model with slope factor loadings constrained to be equal between the sexes and that with no constraints was highly significant ($\chi^2(3)=190.778$, p=0.0000), i.e. the shapes of the male and female growth curves were not equivalent. The constrained model also demonstrated poor fit on two of the fit indices (CFI of 0.948 and TLI of 0.905). Therefore, the estimates from the separate models for females and males are shown in Tables 7.7 and 7.8, respectively.

The shapes of the growth curves were very similar, despite the difference in the parameters being significant. The factor means showed that the male cohort members (16.730) had a lower BMI than the females (17.042) in childhood, but in adulthood males (9.841) gained weight faster than females (8.210) on average. The variances of the intercept factors were not significantly different to one another (∼3), but the variance of the slope factor was greater for males (7.509) than females (5.342). These variances were large compared to the mean of the slope factor, indicating that there was a considerable amount of heterogeneity in the weight that cohort members put on between ages 10 and 34.

The correlation between the intercept and slope factors was quite high for females (0.511) but not significant for males, indicating that BMI at age 10 was reasonably predictive of BMI at age 34 for women, but not for men. The residual correlation terms were all higher for women, suggesting that their self-reports suffered a greater degree of idiosyncratic bias.

Table 7.7: Estimates for females for the latent growth curve measurement model of BMI

Description	Factors/outcome measures	Estimate	S.E.	P-Value
Factor loadings	Intercept → BMI at all ages	1.000		
	Slope → BMI at age 10	0.000		
	Slope → BMI at age 16	0.556	0.007	0.000
	Slope → BMI at age 26	0.773	0.005	0.000
	Slope → BMI at age 29	0.886	0.005	0.000
	Slope → BMI at age 34	1.000		
Factor means	Intercept	17.042	0.030	0.000
	Slope	8.210	0.066	0.000
Factor variances	Intercept	3.103	0.351	0.000
	Slope	5.342	0.909	0.000
Correlation	Intercept ↔ Slope	0.511	0.172	0.003
Residual correlations	BMI at age 26 ↔ BMI at age 29	0.732	0.019	0.000
	BMI at age 29 ↔ BMI at age 34	0.733	0.030	0.000
	BMI at age 26 ↔ BMI at age 34	0.633	0.033	0.000

Note: N=6,719; $\chi^2(4)=13.554$ (p=0.0089), RMSEA=0.019 (90% CI: 0.008 to 0.030), CFI=0.996, TLI=0.990; the intercept factor loadings were fixed to 1, and the first and last slope factor loadings were fixed to 0 and 1, respectively

Table 7.8: Estimates for males for the latent growth curve measurement model of BMI

Description	Factors/outcome measures	Estimate	S.E.	P-Value
Factor loadings	Intercept → BMI at all ages	1.000		
	Slope → BMI at age 10	0.000		
	Slope → BMI at age 16	0.427	0.005	0.000
	Slope → BMI at age 26	0.794	0.004	0.000
	Slope → BMI at age 29	0.905	0.004	0.000
	Slope → BMI at age 34	1.000		
Factor means	Intercept	16.730	0.025	0.000
	Slope	9.841	0.058	0.000
Factor variances	Intercept	2.929	0.238	0.000
	Slope	7.509	1.032	0.000
Correlation	Intercept ↔ Slope	0.105	0.071	0.136
Residual correlations	BMI at age 26 ↔ BMI at age 29	0.621	0.060	0.000
	BMI at age 29 ↔ BMI at age 34	0.586	0.059	0.000
	BMI at age 26 ↔ BMI at age 34	0.451	0.074	0.000

Note: N=7,022; $\chi^2(4)=12.090$ (p=0.0167), RMSEA=0.017 (90% CI: 0.006 to 0.028), CFI=0.994, TLI=0.985; the intercept factor loadings were fixed to 1, and the first and last slope factor loadings were fixed to 0 and 1, respectively

7.5.2 Latent growth curve models of malaise

A similar process was undertaken using the measures of malaise available in the BCS70 (Centre for Longitudinal Studies, 2007). The general shapes of the malaise trajectories were identified by plotting the mean malaise score (based on the reduced nine-item scale) by age and sex (Figure 7.6). As with BMI, the plot was non-linear. No questions from the Rutter malaise inventory were included at age 10, and so the earliest estimate is at age 16. For both males (1.84) and females (2.31), this was the highest point in the trajectories across all waves. This may indicate that the teenage years were a time of particular psychological stress for the cohort members, but these estimates may also have been affected by the different measurement approach that was used in this wave (p.197). The trajectories reached a minimum at age 29 for both males (1.31) and females (1.78), and then rose again slightly at age 34. Throughout the trajectory, female scores on the scale were between 0.5 and 0.7 points higher on average than for males – equivalent to 26% to 49% higher.

Figure 7.6: Cohort members' mean Rutter malaise scale (reduced) trajectories by sex

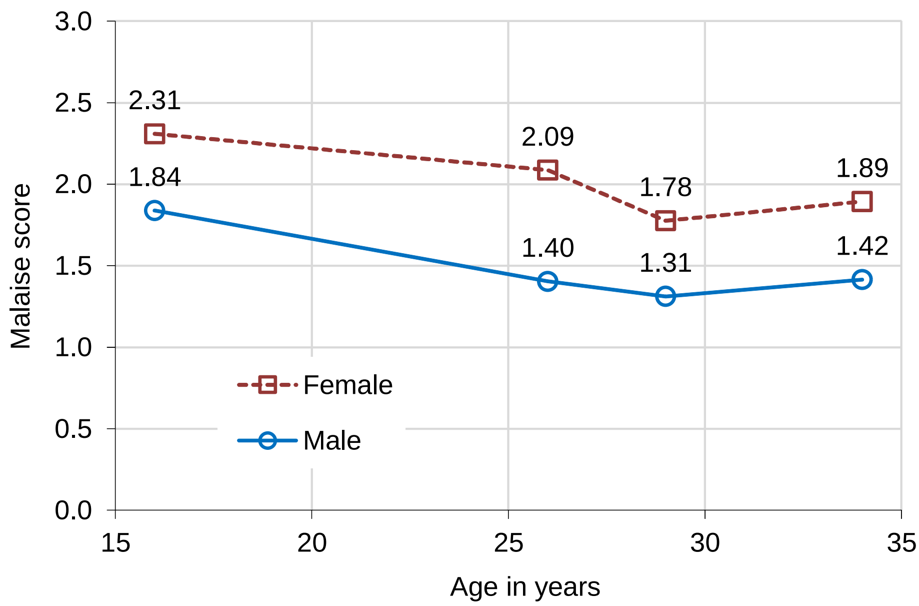
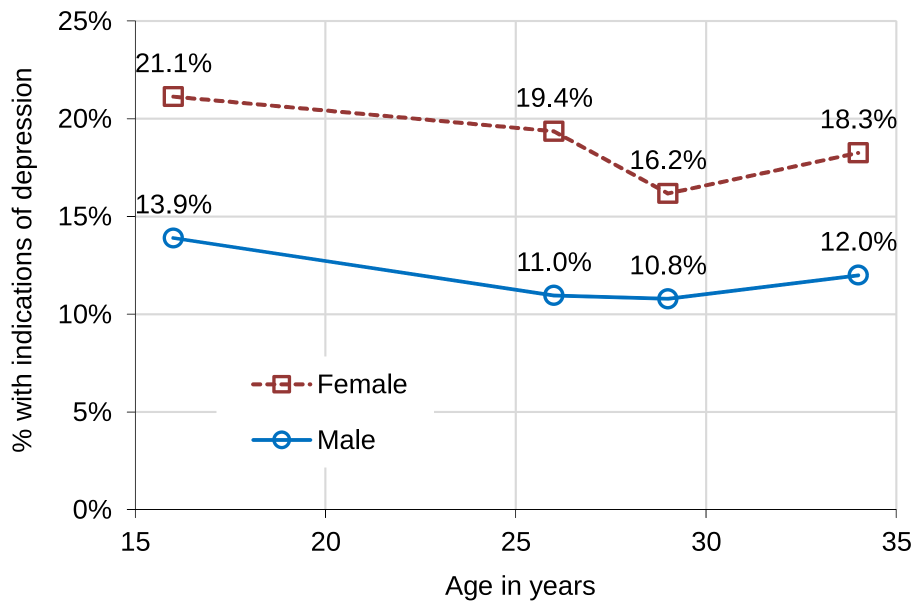


Figure 7.7 shows the proportions of cohort members at each wave with indications they may have been suffering from depression (a score of four or higher) by sex. The shape of the trajectories was very similar to those for the mean score, with maxima at age 16 and a vertex at age 29. Female cohort members were far more likely than male cohort members to be identified as suffering from symp-

toms indicative of depression. At age 16, these proportions were at their highest, with 13.9% of boys and 21.1% of girls with malaise scores of four and above. The minima were 10.8% of men and 16.2% of women at age 29. As a percentage difference, female cohort members were between 50% and 77% more likely to suffer symptoms associated with depression than male cohort members.

Figure 7.7: Percentage of cohort members for whom their Rutter malaise scale (reduced) score indicated they could be suffering from depression, by age and sex



As with BMI, the shape of the trajectories suggested that a latent growth curve model allowing all but the first and last loadings to be freely estimated would be preferable to a model with linear growth. As the scales were not continuous measures, and were highly skewed with many more low scores than high scores, they were recoded into ordinal measures with four categories: scores of zero, one to two, three to four, and five to nine. Where half values were possible at age 16, these were rounded up, so 0.5 was recoded into the ordinal category one to two, etc. Tabulations of the distributions of these variables and the recoded versions can be found in Appendix F. The derived variables were used to estimate latent trait (probit) growth curve models.

The initial model fit the female data well, with a $\chi^2(6)=38.419$ (p=0.0000), an RMSEA of 0.029 (90% CI: 0.021 to 0.039), a CFI of 0.995 and a TLI of 0.995. This model also fit the male data well, with a $\chi^2(6)=15.566$ (p=0.0163), an RMSEA of 0.016 (90% CI: 0.006 to 0.026), a CFI of 0.998 and a TLI of 0.998. Multigroup testing was undertaken to determine whether the male and female measurement parameters were equivalent. Constraining the slope factor loadings, slope and intercept factor variances, slope factor means, and slope and intercept factor covariances to equivalence did not substantially affect the fit of the model. The difference in CFI between the constrained and unconstrained models was 0.008 (0.996-0.988), and although the χ^2 difference was significant, it was not large ($\chi^2(6)=81.733$, p=0.0000). The only parameter that clearly varied between the sexes was the intercept factor mean which, when constrained, severely affected the fit of the model ($\chi^2(1)=454.358$). The estimates from the multigroup model, where the intercept factor means were allowed to vary between groups, are shown in Table 7.9.

Table 7.9: Estimates from the multigroup latent growth curve measurement model of the categorised Rutter malaise scale (reduced)

Description	Factors/outcome measures	Estimate	S.E.	P-Value
Factor loadings	Intercept → malaise at all ages	1.000		
	Slope → malaise at age 16	0.000		
	Slope → malaise at age 26	0.769	0.019	0.000
	Slope → malaise at age 29	1.089	0.023	0.000
	Slope → malaise at age 34	1.000		
Factor means	Intercept (Female)	0.000		
	Intercept (Male)	-0.543	0.027	0.000
	Slope	-0.927	0.030	0.000
Factor variances	Intercept	0.581	0.094	0.000
	Slope	1.280	0.126	0.000
Factor correlation	Intercept ↔ Slope	0.019	0.117	0.870

Note: female: N=6,226, male: N=6,034; $\chi^2(19)=161.199$ (p=0.0000), RMSEA=0.035 (90% CI: 0.030 to 0.040), CFI=0.988, TLI=0.993; the intercept factor loadings were fixed to 1, and the first and last slope factor loadings were fixed to 0 and 1, respectively; the intercept factor mean for females was fixed to 0 for probit identification purposes

The difference in intercept factor means confirms that male cohort members tended to score lower on the malaise scale than females, on average, despite the mean change over time being equivalent. There was significant variation (0.581) in the baseline scores of the cohort members, at age 16, but the variation in the amount of growth experienced over time was much larger (1.280). This suggests that individual differences in growth dominated the malaise trajectories after age 16. Additionally, the correlation between the factors was not significant, implying that teenage malaise was not predictive of malaise in adulthood.

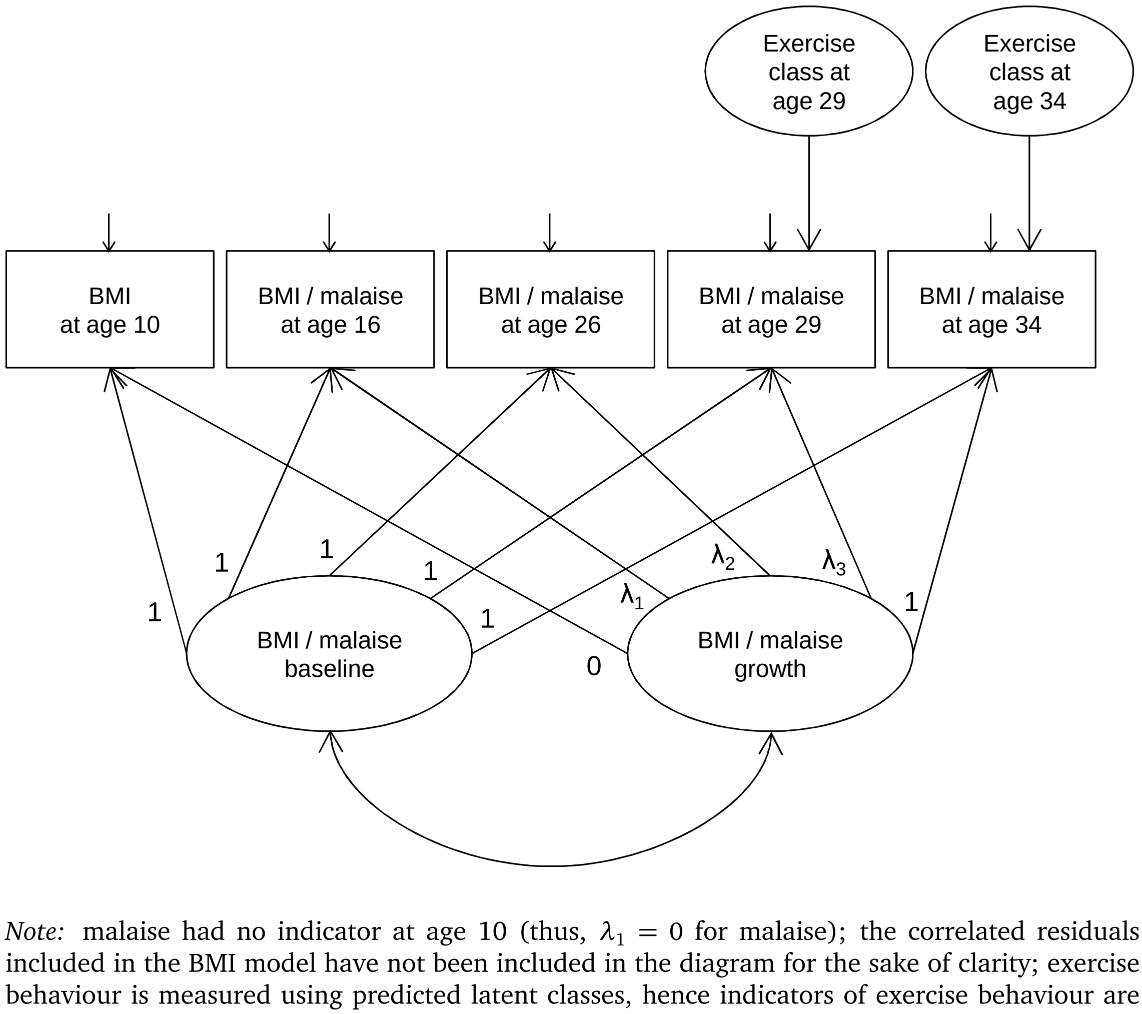
In summary:

1. Girls had slightly higher BMI than boys, but in adulthood, men overtook women. By age 29, the average man was overweight, and at age 34, the average woman was also overweight.
2. In adulthood, there was evidence of bias in the self-reporting of weight, particularly for women.
3. The shapes of the BMI growth curves were not equivalent for men and women, despite being very similar.
4. Men were more heterogeneous in terms of weight gain than women, but for both sexes, the variation in growth was high compared to the average growth.
5. The intercept and slope factors correlated for women, indicating that BMI at age 10 was predictive of weight gain in adulthood. This was not the case for men.
6. The highest malaise scores were at age 16. The teenage years may have been particularly distressing, but the measure at this time point is affected by the use of a different scoring method.
7. Average malaise gradually reduced to a low at age 29 and started to rise again at age 34.
8. Female cohort members had a 26-49% higher mean malaise score than male cohort members, and were 50-77% more likely to suffer symptoms associated with depression.
9. Apart from this higher baseline for women, the malaise growth curves were equivalent between the sexes.
10. The variation in growth of malaise and the lack of correlation between the growth and intercept factors suggested malaise trajectories were highly variable in adulthood.

7.6 Investigating the effect of exercise behaviour on BMI and malaise

In order to identify whether exercise behaviour was associated with health benefits in adulthood, the predicted latent classes of exercise behaviour were allowed to load onto the measures of BMI and malaise at ages 29 and 34, as shown in Figure 7.8. The resulting estimates represent the association of exercise behaviour with BMI and malaise at ages 29 and 34, controlling for the baseline and growth factors. The estimates for BMI are shown in Table 7.10, those for malaise are shown in Table 7.11.

Figure 7.8: Path diagram showing inclusion of the time-varying effect of exercise behaviour on BMI and malaise trajectories



Note: malaise had no indicator at age 10 (thus, $\lambda_1 = 0$ for malaise); the correlated residuals included in the BMI model have not been included in the diagram for the sake of clarity; exercise behaviour is measured using predicted latent classes, hence indicators of exercise behaviour are not included in the diagram

Table 7.10: Time-varying effect of exercise behaviour on BMI at ages 29 and 34, by sex

	Class	Estimate	S.E.	P-Value	
Female					
Age 29	Exercisers	0.034	0.091	0.709	
	Active	-0.110	0.079	0.164	
Age 34	Exercisers	-0.560	0.114	0.000	***
	Active	-0.558	0.103	0.000	***
Male					
Age 29	Exercisers	-0.042	0.083	0.615	
	Active	-0.031	0.082	0.709	
Age 34	Exercisers	-0.405	0.105	0.000	***
	Active	-0.214	0.107	0.044	*

Note: reference class for exercise behaviour is 'inactive'; female: N=5,588, male: N=5,343

There was no significant association of exercise behaviour with BMI at age 29 for either sex. By age 34, this was no longer the case. For women, being 'active' or an 'exerciser' provided similar benefit, both being associated with a reduction in BMI of 0.56 compared to the reference class of 'inactive' cohort members. For men, the benefit of being an exerciser (-0.405) was greater than that of being active (-0.214), suggesting a dose-response effect. These differences in BMI are not large – a difference of 0.5kg/m^2 equates to $\sim$1.5kg difference in weight for a person of 1.75m height – and are far smaller than the mean growth in BMI over time ($\sim$2kg/m^2 between ages 26 and 34). The change from zero association at age 29 to a highly significant effect on weight gain at age 34 suggests that exercise behaviour might have an increasing role to play in the maintenance of weight as people age.

For malaise (Table 7.11), there seemed to be a benefit associated with being classed as active or an exerciser at both ages. The benefit was similar for men and women at age 29, either class being associated with a reduction in malaise of between 0.23 and 0.32 standard deviations. At age 34, the reduction associated with being an exerciser had grown to $\sim$0.5. There was some evidence of a dose-response pattern, the exercisers tending to benefit more.

At age 34, being active was no longer sufficient to confer a benefit for men. In the BMI model, there was also evidence to this effect – being active was of borderline significance for men at age 34. These effects suggests that sex related disparities

Table 7.11: Time-varying effect of exercise behaviour on malaise at ages 29 and 34, by sex

	Class	Estimate	S.E.	P-Value	
Female					
Age 29	Exerciser	-0.231	0.107	0.030	*
	Active	-0.310	0.071	0.000	***
Age 34	Exerciser	-0.482	0.109	0.000	***
	Active	-0.356	0.077	0.000	***
Male					
Age 29	Exerciser	-0.322	0.111	0.004	**
	Active	-0.230	0.093	0.013	*
Age 34	Exerciser	-0.468	0.109	0.000	***
	Active	-0.137	0.092	0.137	

Note: reference class for exercise behaviour is 'inactive'; female: N=5,590, male: N=5,341; estimates are in probits

continue into adulthood. Men were more likely to be exercisers, and needed to be in order for their health to benefit. These differences in malaise are subtle, but important. The mean score (out of nine) at age 34 was only 1.89 for women and 1.42 for men, and the vast majority of cohort members experienced less than four of the listed indications (p.197). It is generally accepted that leading an active lifestyle can have a beneficial effect on mild to moderate depressive symptoms (Fox, 1999), and these results support that conclusion.

7.6.1 Controlling for the correlates of health outcomes

In order to test whether the associations of exercise behaviour with BMI and malaise were robust to confounding, control variables were added to the models at age 34. The variables were specified to load directly onto BMI and malaise at this age, as with the latent classes of exercise behaviour (shown in Figure 7.8). There were several reasons for focusing on the age 34 data. Firstly, the effect of exercise behaviour appeared to be largest at this wave and seemed to increase with age. Secondly, beneficial effects on health become increasingly relevant with age. Finally, restricting the analysis to this wave reduced the impact of missing data on the sample size. Non-significant terms were removed from the model using backward selection in order to augment the available sample and arrive at a parsimonious model.

The control variables added to the model for BMI included measures of family composition, socioeconomic factors, health related factors and vehicle ownership (p.199). For malaise, the control variables for 'smoking', 'drinking', 'cut drinking' and 'access to car' were excluded. 'Smoking', 'drinking' and 'cut drinking' were excluded as they could be viewed as behaviours that result from malaise, rather than being a cause of malaise. 'Access to car' was only relevant to BMI, as vehicle ownership could reduce cohort members' tendency to use active modes of travel. The control variables are cross-tabulated by sex in Table 7.12.

At age 34, slightly more of the women were married (56.7%) than men (51.6%), and they were much more likely to live in households with children (69.8%) compared to the men (53.3%). Almost all the men were employed full-time (93.0%), whereas a large minority of women were employed part-time (32.2%). In both cases, only a small minority were unemployed (∼5%). The proportions of cohort members and their partners in each social class were broadly similar, as were the proportions in each income band. They were also similar in terms of level of education attained, but women were slightly more likely to have a degree (35.0%) than men (31.2%), and men were slightly more likely to have no qualifications (10.4%) than women (8.0%). The proportions having a disability or limiting illness were the same (∼28%), but men were slightly more likely to smoke (26.0%) than women (23.2%).

Some of the largest differences between the sexes were in drinking behaviour and diet. Men were heavier drinkers than women on average, with far fewer 'rarely/never' drinking (12.0%) than women (25.4%), and the proportion drinking most days was much larger for men (22.2%) than women (11.8%). This difference was also reflected in the proportion responding that they felt they should cut down on their drinking, with many more men saying they should cut down (40.3%) than women (26.8%).

The male cohort members' diets also seemed to be less healthy on average than the women's. They were less likely to report frequently eating the healthy foods – fruit (53.2% of men, 67.2% of women), salads (33.1% of men, 45.8% of women), cooked vegetables (67.9% of men, 72.3% of women), and fish (7.7% of men, 8.7% of women) – and were much more likely to report frequently eating the unhealthy foods – chips (17.7% of men, 7.5% of women) and red meat (31.4% of men, 18.6% of women). Men were also slightly more likely to have access to a car (86.2%) than women (80.0%).

Table 7.12: Cross-tabulation of control variables at age 34 by sex

Variable	Value	Female	Male
Marital status	single	24.1	26.3
	cohabiting	19.2	22.1
	married	56.7	51.6
Children	yes	69.8	53.3
Employment	unemployed	4.1	5.2
	part-time	32.2	1.8
	full-time	63.7	93.0
Social class	I	7.8	9.0
	II	42.5	42.9
	III non-manual	20.6	15.7
	III manual	12.4	18.1
	IV	6.4	6.2
	V	1.0	1.6
	not applicable	9.4	6.5
Income	less than £150 per week	17.7	18.5
	£150 to £299 per week	17.5	18.8
	£300 to £449 per week	20.2	20.7
	£450 to £599 per week	19.7	18.8
	£600 to £749 per week	10.8	9.5
	£750+ per week	14.2	13.7
Education	degree	35.0	31.2
	A-level	9.4	9.0
	GCSE	32.7	34.0
	CSE	14.9	15.5
	none	8.0	10.4
Disability	yes	28.3	28.4
Smoking	yes	23.2	26.0
Drinking	rarely/never	25.4	12.0
	2 to 3 days per month	13.9	10.3
	once per week	19.8	18.8
	2 to 3 days per week	29.0	36.7
	most days	11.8	22.2
Cut drinking	yes	26.8	40.3
Diet*	fruit	67.2	53.2
	salads	45.8	33.1
	cooked veg	72.3	67.8
	fish	8.7	7.7
	chips	7.5	17.7
	red meat	18.6	31.4
Access to car*	yes	80.0	86.2

Note: *the dietary variables and 'access to car' were measured at age 29

The final results of the BMI models are shown in Table 7.13. In the female model, backward selection of the controls resulted in the ‘children’, ‘employment’, ‘income’ and ‘diet’ variables being dropped (χ^2(14)=18.369, p=0.1905). In the male model, all of the control variables were dropped, except for ‘education’ and ‘smoking’ (χ^2(29)=18.742, p=0.9277).

Importantly, the effects of exercise behaviour on BMI were not greatly affected by the inclusion of controls. For women, the point estimates reduced from approximately -0.56 to -0.50, a non-significant difference. For men, the estimates were nearly identical, with a slight reduction in the point estimate for the exercisers (-0.370, compared to -0.405 in the model without controls). These results provide strong evidence that even a simple measure of exercise behaviour can identify the impact of an active lifestyle on weight gain.

There were striking differences between men and women in terms of the control variables. The female model retained many significant effects, whereas only education and smoking were retained in the male model. For women, those who were single had a lower BMI than those who were cohabiting (0.624) or married (0.468). Both social class and education were associated with BMI. Those with a disability tended to have a slightly higher BMI (0.322) and those who smoked a slightly lower BMI (-0.301). Curiously, women’s drinking was associated with a lower BMI ($\sim$-0.5), but those who thought they should cut down their drinking had a slightly higher BMI (0.265). Surprisingly, access to a car was associated with a slightly lower BMI (-0.205), though this effect was of borderline significance (p=0.049). For men, education was strongly associated with BMI, and smokers were lighter than non-smokers (-0.342), but none of the other controls were significant.

The final results of the malaise models are shown in Table 7.14. In the female model, backward selection of the control variables resulted in ‘children’, ‘social class’, ‘income’ and most of the ‘diet’ control variables being dropped, except for fruit and chips consumption (χ^2(16)=16.908, p=0.3916). In the male model, ‘social class’ and all of the ‘diet’ control variables were dropped, except for fruit consumption (χ^2(11)=10.974, p=0.4454).

The effect of exercise behaviour was moderated by the inclusion of controls for women. The point estimate for the exerciser class reduced from -0.482 to -0.320 standard deviations. The estimate for the active class reduced from -0.356 to -0.213. The difference in both cases was significant at the 5% level, but only just

Table 7.13: Models estimating the effect of exercise behaviour on BMI at age 34, controlling for the correlates of health outcomes, by sex

Variable	Value	Estimate	S.E.	P-Value	
Female					
Exercise class	Exerciser	-0.486	0.113	0.000	***
	Active	-0.518	0.101	0.000	***
Marital status	cohabiting	0.624	0.120	0.000	***
	married	0.468	0.099	0.000	***
Social class	II	0.174	0.133	0.192	
	III non-manual	0.293	0.159	0.066	
	III manual	0.270	0.172	0.115	
	IV	0.493	0.231	0.033	*
	V	0.963	0.437	0.028	*
	not applicable	0.637	0.203	0.002	**
Education	A-levels	-0.032	0.137	0.817	
	GCSEs	0.163	0.121	0.179	
	CSEs	0.328	0.154	0.033	*
	none	0.462	0.200	0.021	*
Disability	yes	0.322	0.094	0.001	***
Smoking	yes	-0.301	0.100	0.003	**
Drinking	low	-0.415	0.142	0.004	**
	medium	-0.472	0.128	0.000	***
	high	-0.460	0.120	0.000	***
	very high	-0.571	0.139	0.000	***
Cut drinking	yes	0.265	0.093	0.004	**
Access to car	yes	-0.205	0.104	0.049	*
Male					
Exercise class	Exerciser	-0.370	0.105	0.000	***
	Active	-0.219	0.103	0.033	*
Education	A-levels	0.235	0.132	0.075	
	GCSEs	0.264	0.099	0.008	**
	CSEs	0.497	0.125	0.000	***
	none	0.558	0.158	0.000	***
Smoking	yes	-0.342	0.091	0.000	***

Note: reference class for exercise behaviour is 'inactive'; reference classes for control variables are single, social class I, degree, and rarely/never drinking; female: N=4,380, male: N=4,232

Table 7.14: Models estimating the effect of exercise behaviour on malaise at age 34, controlling for the correlates of health outcomes, by sex

Variable	Value	Estimate	S.E.	P-Value	
Female					
Exercise class	Exerciser	-0.320	0.075	0.000	***
	Active	-0.213	0.067	0.001	***
Marital status	cohabiting	-0.078	0.078	0.314	
	married	-0.253	0.064	0.000	***
Employment	full-time	-0.894	0.130	0.000	***
	part-time	-0.897	0.124	0.000	***
Education	A-levels	0.062	0.092	0.499	
	GCSEs	0.066	0.065	0.307	
	CSEs	0.237	0.084	0.005	**
	none	0.546	0.110	0.000	***
Disability	yes	0.607	0.065	0.000	***
Diet	fruit	-0.368	0.058	0.000	***
	chips	0.254	0.100	0.011	*
Male					
Exercise class	Exerciser	-0.369	0.091	0.000	***
	Active	-0.122	0.088	0.164	
Marital status	cohabiting	-0.302	0.109	0.005	**
	married	-0.412	0.111	0.000	***
Children	yes	0.180	0.087	0.039	*
Employment	full-time	-1.160	0.274	0.000	***
	part-time	-0.914	0.160	0.000	***
Income	£150-£299/wk	-0.137	0.117	0.241	
	£300-£449/wk	-0.211	0.117	0.071	
	£450-£599/wk	-0.197	0.122	0.107	
	£600-£749/wk	-0.237	0.146	0.105	
	£750+/wk	-0.358	0.141	0.011	*
Education	A-levels	-0.036	0.124	0.770	
	GCSEs	0.010	0.087	0.911	
	CSEs	0.168	0.107	0.117	
	none	0.320	0.121	0.008	**
Disability	yes	0.559	0.074	0.000	***
Diet	fruit	-0.171	0.067	0.011	*

Note: reference class for exercise behaviour is ‘inactive’; reference classes for control variables are single, unemployed, degree, and <£150/wk; female: N=4,330, male: N=3,549; estimates are in probits (exerciser class: $\chi^2(1)=4.373$, p=0.0365; active class: $\chi^2(1)=4.376$, p=0.0364). Clearly, inclusion of the correlates was effective at controlling for a degree of confounding in the female model. For men, the point estimate for the exerciser class also reduced slightly, from -0.468 to -0.369, but this difference was not significant ($\chi^2(1)=2.133$, p=0.1441). These results support the premise that exercise behaviour has a subtle but important impact on malaise, and that this can be captured using very simple measures of exercise behaviour.

Compared with the models for BMI, there were far fewer differences between the sexes for the control variables. Unemployment had by far the largest impact. Women who were working either full-time (-0.894) or part-time (-0.897) had much lower levels of malaise. Married women had lower levels of malaise (-0.253) than those who were single or cohabiting. Low levels of education were also detrimental. Cohort members whose highest qualification was a CSE (0.237) or had no qualifications (0.546) fared worse than the rest. Disability was also associated with higher malaise (0.607). Finally, there were indications that diet might be important. High consumption of fruit was associated with a lower level of malaise (-0.368), and high consumption of chips with a higher level (0.254).

For men, as with women, being unemployed was highly detrimental. Men who were employed both full-time (-1.160) and part-time (-0.914) had much lower levels of malaise. Being married (-0.412) and cohabiting (-0.302) were associated with lower malaise, compared to being single. Having children in the household was associated, although weakly, with higher levels of malaise (0.180). This variable had been dropped from the female model. There were moderate associations with both income and education. Disability was again associated with higher levels of malaise (0.559), and diet may have had an influence, with fruit consumption having a small beneficial effect (-0.171).

This analysis has shown that a latent class variable of exercise behaviour – based on just three simple questions in the BCS70 – is associated with changes in both BMI and malaise in adulthood. This association was robust to the inclusion of a variety of control variables, and provides some reassurance that the latent class measure of adult exercise behaviour represents a valid main outcome for this research.

In summary:

1. The latent class of exercise behaviour was not associated with BMI at age 29, but was at age 34, suggesting an increasing role for exercise in weight maintenance as people age.

2. Exercise behaviour was associated with reductions in malaise at both ages. For those that were classed as exercisers, this effect grew at age 34.

3. Descriptive analysis of the control variables identified some important differences between men and women. Women were more likely to live in households with children, and more likely to be employed part-time. Men were heavier drinkers, and their diets were less healthy.

4. Addition of controls to the models of BMI at age 34 did not affect the association with latent class of exercise behaviour.

5. Addition of controls to the models of malaise moderated the association with latent class of exercise behaviour somewhat.

6. Overall, these models provided good validation for using the latent classes of exercise behaviour as an outcome. Despite being based on three simple variables in the BCS70, they were associated with change in BMI and malaise when controlling for a range of confounding variables.

7.7 Conclusions

The analyses presented in this chapter sought to answer the following research questions:

- What types of adult exercise behaviour can be identified in the BCS70?
  - Is there a continuum of exercise or are there discrete types (classes) of exercise behaviour?
  - Is exercise behaviour stable between ages 29 and 34?
  - Are men and women similar in their exercise behaviour?

- How does BMI and malaise vary over time from childhood to adulthood in the BCS70?
  - Are there differences between individuals in BMI and malaise over time?
  - Are there differences between the sexes in BMI and malaise over time?
- Is the measure of exercise behaviour at ages 29 and 34 associated with health outcomes?
  - Is exercise behaviour associated with BMI and malaise controlling for confounding variables?

There was strong evidence for discrete types of exercise behaviour in the BCS70. Along with a large minority who did not exercise (the 'inactive' class), there were many who exercised intensively several times a week (the 'exerciser' class), and many who were active at a variety of frequencies, but tended not to exercise intensively (the 'active' class). Cohort members' type tended to remain stable between the ages of 29 and 34. The cohort members that did switch type, tended to move between the active and inactive classes. Men and women were similar in exercise behaviour, although men were more likely to be exercisers and women more likely to be active. Conveniently, the proportions of cohort members in each class were very similar to the proportions classified as 'low activity', 'some activity', and 'meets recommendations' in the Health Survey for England.

BMI rose greatly from childhood to adulthood. On average, the girls were heavier in childhood. By the early twenties, the male cohort members were heavier, and at age 29 the average male was overweight. At age 34, this was also the case for the female cohort members. With age, weight continued to increase. There was evidence that self-reports were biased, more so for women. Although the variation amongst individuals was equivalent at baseline, there was greater variation in the growth process amongst men. Compared to the average increase in weight, the variation was large, indicating that individuals varied greatly in the amount of weight they put on between childhood and adulthood. One of the most striking differences between the sexes was that childhood BMI was predictive of weight change for women, but not for men.

Malaise was at a high at age 16 for the cohort members. This may have been because the teenage years were particularly distressing, but could also have been due to the different measurement method used in this wave. The growth trajectories were equivalent for both sexes, except that female cohort members consistently experienced much higher levels of malaise at all time points. Teenage reports were not predictive of malaise in adulthood for either sex and the variation in growth over time was very large. This suggests that individuals varied considerably in whether or not they developed symptoms associated with depression, or experienced a reduction in symptoms as they grew older.

There was no difference in BMI between the different classes of exercise behaviour at age 29. By age 34, those who were inactive had gained more weight. For men, being active was not as beneficial as being an exerciser. In terms of malaise, being inactive was consistently associated with poorer psychological health. For men, it again seemed that being active was not as beneficial as being an exerciser, and by age 34, being in the active class had no effect on malaise for men. Controlling for a wide variety of additional variables made little difference to the effects of exercise behaviour on BMI at age 34, for both sexes. The association of exercise behaviour with malaise was slightly moderated by inclusion of the controls. For women, this difference was statistically significant.

The main purpose of this chapter was to provide validation of the simple exercise questions asked at ages 29 and 34 in the BCS70. By using latent class analysis to identify the types of exercise behaviour that are identifiable in these questions, their simplicity is reflected and over-interpretation avoided. Nevertheless, the impact of being a member of each class on both BMI and malaise was clearly demonstrated. This analysis confirms these classes are valid measures of exercise behaviour, and motivates their use as outcomes. The next (and final) empirical chapter addresses the over-arching research question of this thesis – it identifies how childhood experiences of sport and exercise are associated with adult exercise behaviour in the BCS70.

Chapter 8

Childhood experiences and adult exercise behaviour

The analysis presented in the previous three chapters has laid the groundwork for this final empirical chapter: the cross-sectional analysis at age 10 (p.96) showed that family socialisation and self-determination theory provided good explanations for experiences of sport and exercise in primary school; latent measures of experiences at age 16 were developed (p.133), and further evidence of family socialisation identified; and latent class measures of adult exercise behaviour were developed (p.195) and found to be associated with change in BMI and malaise, validating their use as a final outcome.

Each of these chapters can be regarded as preparatory work for the analyses presented in this final empirical chapter, which presents findings aimed at addressing the over-arching research question of this thesis:

- In what way are childhood experiences of sport and exercise associated with adult exercise behaviour?

In the second chapter of this thesis (p.27), recurring themes were identified in government policy relating to school sport and physical education. One of these themes is typified by the title of the most recent policy document, *Creating a sporting habit for life* (Department for Culture Media and Sport, 2012b) – i.e. that getting children to take part in lots of competitive sport in school will cause them to take up and maintain participation in sport and exercise throughout their lives.

The research presented in this chapter tests this premise by identifying which aspects of the cohort members' childhood experiences of sport and exercise influenced their exercise behaviour in adulthood.

Latent class models of adult exercise behaviour were estimated in a similar fashion to those found in the previous chapter (p.205), except with the addition of explanatory variables (measuring the cohort members' experiences of sport and exercise in childhood) and control variables (measuring the correlates of physical activity in adulthood). The resulting model is a latent class analogue of a MIMIC model (p.90 Yang, 2005; Clark and Muthén, 2009). The analysis focused on explaining exercise behaviour at age 34, as this was the most distal measure of adult exercise behaviour available in this research, and the most relevant to health outcomes. A two stage modelling process was undertaken. In the first stage, models were estimated in order to identify which childhood measures of intrinsic motivation, physical self-concept and participation were most strongly associated with adult exercise behaviour. In the second stage, the modelling aimed to identify which childhood experiences provided the strongest evidence for causal effects on adult exercise behaviour, controlling for the correlates of physical activity.

The main research question was supplemented by the following additional questions:

- Does school provision influence adult exercise behaviour?
- Does family socialisation in childhood affect adult exercise behaviour?
- Are there differences between the sexes?
- How do the correlates of physical activity in adulthood influence adult exercise behaviour?

The following sections are included in this chapter:

Variables – describes the measures used in the analyses;

Analytical strategy – describes the approach used to answer the research questions;

Preliminary models – presents an analysis identifying which of the childhood measures of intrinsic motivation, physical self-concept and participation were most strongly associated with adult exercise behaviour;

Final models – identifies which experiences of sport and exercise in childhood were most likely to have a causal effect on adult exercise behaviour, controlling for the correlates of physical activity in adulthood;

Conclusions – restates the research questions for this chapter and summarises the answers provided by the research findings.

8.1 Variables

The measures used in this chapter have largely been described previously, and so are summarised briefly here. The variables used to measure latent class of adult exercise behaviour included (a) whether the cohort member exercised regularly, (b) how often, and (c) at what intensity (p.197). The variables used to measure experiences of sport and exercise at age 10 included (a) enjoyment of games, perceived ability in (b) games and (c) gymnastics, (d) whether the cohort member played sports 'often' outside school, and (e) the hours of PE/movement/games the cohort member experienced in school (p.98).

The variables used to measure experiences of sport and exercise at age 16 included factor scores for (a) fitness motivation, (b) sport motivation, (c) perceived fitness, (d) perceived activity, (e) body image, (f) sport ability, participation (g) inside and (h) outside school, participation in (i) lifestyle, (j) team and (k) individual activities, and the categorical measure for (l) family recreation (p.135). The measure of family recreation at age 16 was included, despite being previously used as a control variable (p.137). This was because it was strongly associated with many experiences of sport and exercise at age 16, particularly for girls (pp.178, 182), and is a direct measure of family socialisation into physical activity.

Predicted factor scores were used in place of the measurement models for the latent traits. This approach was taken for two reasons. Firstly, incorporating the latent trait measurement models into latent class models requires the use of numerical integration during estimation, which takes an inordinate amount of time and processing power (Muthén and Muthén, 2012). Secondly, it was important to retain the latent class approach. It is possible to predict the most likely latent class of a respondent – as in the previous chapter (p.219) – using a model with no explanatory or control variables, and use this as a variable in subsequent analyses. However, this is not the preferred approach, as it can introduce bias to estimates and produce incorrect standard errors (Clark and Muthén, 2009). In effect, it removes the probabilistic nature of class allocation in the latent class model, by assuming respondents are classified with 100% probability.

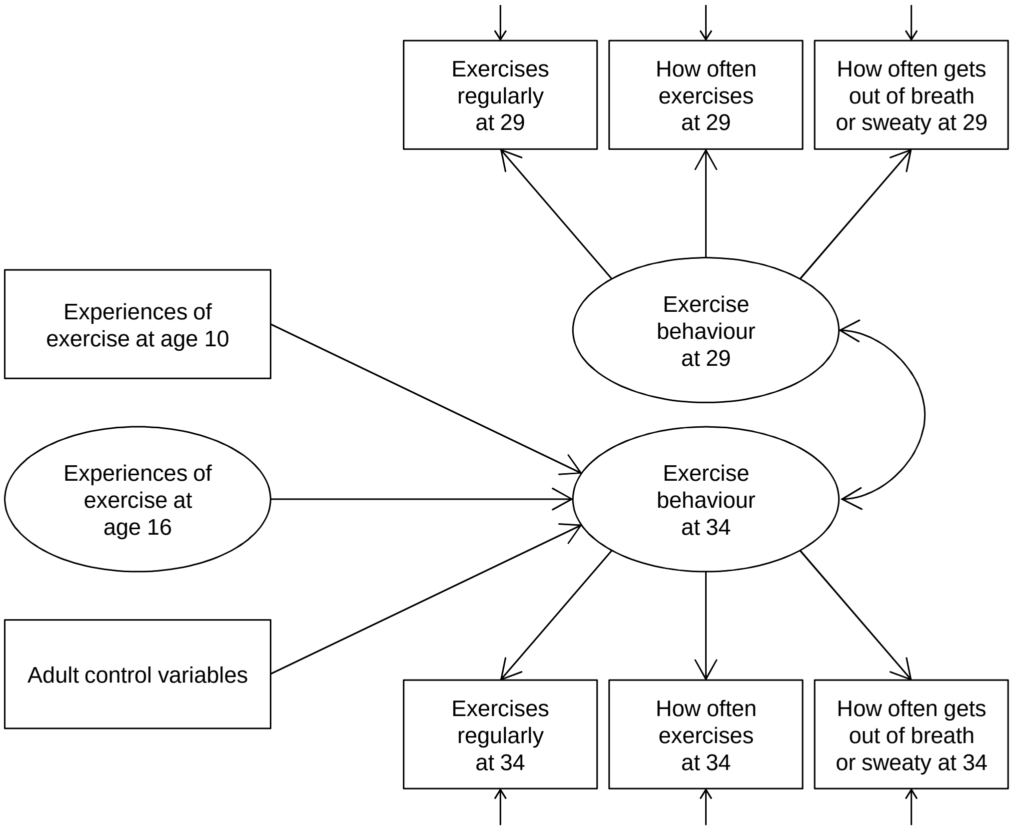
Additional variables were included in the final models to control for the influence of the correlates of physical activity in adulthood. Variables measuring physiological factors included (a) weight status, (b) disability and (c) smoking behaviour. Variables measuring family composition included (a) marital status and (b) whether there were children in the household. Variables measuring socioeconomic factors included (a) employment status, (b) social class, (c) income and (d) education. A variable measuring access to a car was also included (p.199).

8.2 Analytical strategy

As previously described, the approach to modelling in this chapter involved estimating latent class models (p.85) with the addition of explanatory and control variables. Figure 8.1 shows a path diagram representing the models estimated. The diagram represents a latent class analysis with multiple causes, and so can be viewed as a latent class analogue to a traditional Multiple Indicators Multiple Causes (MIMIC) model (p.89 Yang, 2005; Clark and Muthén, 2009).

The models included latent classes of exercise behaviour at both ages 29 and 34. These were allowed to covary. The reason for specifying the model in this way is that it exploits information on exercise behaviour at age 29 to inform classification of cohort members into latent classes at age 34. In effect, the age 29 measures are used as auxiliary variables. By using a covariance, rather than a direct path (as in the longitudinal latent class model in the previous chapter (p.207)), exercise behaviour at age 29 was prevented from accounting for variance in exercise behaviour at age 34, allowing the effect of the explanatory/control variables to be estimated. The covariance was implemented using a log-linear parameterization (Espeland, 1986) because the latent class of exercise behaviour is a nominal variable. The effects of the explanatory/control variables on the latent class at age 34 were specified as multinomial logistic regression models (p.90), and so the resulting estimates are shown as odds ratios (exponentiated coefficients).

Figure 8.1: Latent class model for identifying the association of childhood experiences of sport and exercise with adult exercise behaviour



Two stages of modelling were undertaken:

1. **Preliminary models** several models were estimated, each including subsets of the measures of childhood experiences of sport and exercise. The first model included the measures from age 10; the second, measures of intrinsic motivation at age 16; the third, measures of physical self-concept at age 16; the fourth, measures of participation by setting at age 16; the fifth, measures of participation by type of activity at age 16.

2. **Final models** in order to arrive at the final models, a process of backward selection was undertaken on an initial model which contained all significant measures of childhood experiences from the preliminary models. This resulted in a parsimonious model which contained only significant associations of childhood experiences of sport and exercise with adult exercise behaviour. These models controlled for the correlates of physical activity in adulthood.

The preliminary models were used to identify experiences at age 10 and in each domain (participation, intrinsic motivation and physical self-concept) at age 16 which were associated with adult exercise behaviour. This careful approach was adopted for two reasons. Firstly, the relative effects within each subset were of substantive interest, and secondly, the measures of childhood experiences of sport and exercise (particularly at age 16) were highly correlated. Including all the childhood variables in a single model ran the risk of producing unstable estimates due to multicollinearity (Gunst and Webster, 1975; Midi et al., 2010). Likewise, in the final stage of modelling, only those childhood variables which were significantly associated with adult exercise behaviour were retained. This resulted in efficient, parsimonious final models, which provided strong evidence for the causal effect of childhood experiences on adult exercise behaviour.

It was necessary to use multiple imputation (p.91) to fill in missingness in the dataset. Because the variables came from four waves and several different survey instruments (including the problematic age 16 wave (p.70)), overlapping patterns of missingness had the potential to greatly reduce sample size. In order to make best use of the available data, twenty complete datasets were imputed. Variability in the imputed values was taken into account in subsequent analyses using the functionality available in Mplus for analysing multiply-imputed datasets (Muthén and Muthén, 2012). The analysis and process for creating the multiple imputations is described in detail in Appendix G.

8.3 Preliminary models

The results of the first stage of modelling are shown in Tables 8.1 and 8.2. For female cohort members (Table 8.1), the only significant effects at age 10 were for enjoyment and playing sports outside school. These effects were not small. Enjoying games in school at age 10 was associated with a 40-50% increase in the odds of being both an exerciser (1.490) and active (1.438) in adulthood. Playing sports outside school was associated with a 37% increase in the odds of being an exerciser (1.368), but its effect on being active was of borderline significance (1.202, $p=0.053$).

Neither the females' perceived ability nor the hours of PE experienced at age 10 were associated with adult exercise behaviour. As with the longitudinal analysis at age 16 (p.178), there was no evidence that primary school provision had any effect on experiences of sport and exercise. The lack of an effect for perceived ability could be interpreted as a positive finding, however, as poor perceived ability at age 10 was not detrimental in the long term.

At age 16, females' fitness motivation was associated with a 62% increase in the odds of being an exerciser (1.623) and a 43% increase for being active (1.426) in adulthood. There was no significant association with sport motivation, providing further evidence that competitive sport was of little relevance to female cohort members.

Table 8.1: Estimates from preliminary models for females of the association of childhood experiences of sport and exercise on adult exercise behaviour at age 34

Females	Exerciser			Active		
Variable	Exp(Est.)	P-Value		Exp(Est.)	P-Value	
Age 10						
enjoyment (games)	1.490	0.026	*	1.438	0.029	*
perceived ability (games)	0.870	0.392		0.920	0.560	
perceived ability (gymnastics)	1.095	0.375		0.946	0.587	
plays sports outside school	1.368	0.002	**	1.202	0.053	
hours of PE	0.975	0.728		1.026	0.710	
Age 16						
Fitness motivation	1.623	0.005	**	1.426	0.027	*
Sport motivation	1.223	0.130		0.968	0.781	
Age 16						
Perceived fitness	1.011	0.961		0.984	0.948	
Perceived activity	1.565	0.007	**	0.958	0.781	
Body image	0.826	0.230		1.235	0.186	
Sport ability	1.330	0.079		1.200	0.247	
Age 16						
Participation inside school	0.936	0.523		1.017	0.872	
Participation outside school	1.516	0.000	***	1.306	0.019	*
family recreation <1/wk	1.795	0.000	***	1.318	0.060	
family recreation 1/wk+	1.346	0.155		1.490	0.031	*
Age 16						
Lifestyle activity	1.290	0.076		1.195	0.091	
Team activity	0.968	0.874		1.020	0.910	
Individual activity	1.250	0.325		1.201	0.291	

Note: reference class for exercise behaviour outcome is 'inactive'; N=4,680

The only significant effect related to females' physical self-concept was for perceived activity at age 16 (1.565), which was associated with an increase in odds of being an exerciser of 57%. Considering this is likely to reflect actual levels of activity, physical self-concept in childhood did not seem to have much (if any) impact on adult exercise behaviour.

Female participation inside school at age 16 was not associated with either of the exercise classes in adulthood. In contrast, participation outside school was associated with a 30-50% increase in the odds of being an exerciser (1.516) and being active (1.306) in adulthood. The lack of an effect for participation inside school strongly indicates that it did not have a causal effect on the females' adult exercise behaviour.

The largest effects in the female models were for family recreation at age 16. Unexpectedly, the most frequent category of family recreation (1/wk+) was not associated with being an exerciser in adulthood (1.346, p=0.155), but less frequent family recreation (<1/wk) was (1.795, p=0.000). One explanation for this could be related to the development of independent, active lifestyles; girls from very active families may have moved on to self-determined, independent forms of participation by their teenage years.

None of the activity types were associated with female adult exercise behaviour. This suggests that the characteristics of activities participated in during childhood were not important – i.e. extensive experience of lifestyle activities in childhood did not promote adult exercise behaviour, and extensive experience of competitive activities did not have a negative impact either.

For male cohort members (Table 8.2), none of the childhood measures were significantly associated with being in the active class at age 34. Together with the models of BMI and malaise in the previous chapter (pp.225, 226), this provides further evidence that being in the active class at age 34 was indiscernible from being inactive for the male cohort members.

At age 10, the only significant effect for males related to playing sports outside school. It was associated with a 116% increase in the odds of being in the exerciser class at age 34 (2.164). As with the female model, perceived ability and hours of PE were not associated with adult exercise behaviour, but neither was enjoyment. Perhaps, as with the longitudinal analysis at age 16 (p.182), this was evidence that early sports experiences were much more important for males, influencing both enjoyment and perceived ability in primary school, experiences at age 16, and adult exercise behaviour.

Table 8.2: Estimates from preliminary models for males of the association of childhood experiences of sport and exercise on adult exercise behaviour at age 34

Males	Exerciser			Active	
Variable	Exp(Est.)	P-Value		Exp(Est.)	P-Value
Age 10					
enjoyment (games)	1.252	0.351		1.105	0.630
perceived ability (games)	0.856	0.456		0.919	0.672
perceived ability (gym)	1.113	0.298		1.052	0.606
plays sports outside school	2.164	0.000	***	1.184	0.122
hours of PE	1.076	0.296		0.955	0.486
Age 16					
Fitness motivation	1.815	0.014	*	0.892	0.591
Sport motivation	1.600	0.006	**	1.171	0.338
Age 16					
Perceived fitness	0.893	0.766		1.204	0.628
Perceived activity	1.483	0.104		0.666	0.072
Body image	0.913	0.702		1.157	0.564
Sport ability	2.965	0.000	***	1.285	0.284
Age 16					
Participation inside school	1.038	0.786		1.096	0.503
Participation outside school	2.102	0.000	***	1.053	0.718
family recreation <1/wk	1.093	0.578		1.083	0.664
family recreation 1/wk+	1.143	0.470		1.143	0.451
Age 16					
Lifestyle activity	1.018	0.904		0.972	0.845
Team activity	1.804	0.000	***	1.175	0.310
Individual activity	1.368	0.139		1.040	0.860

Note: reference class for exercise behaviour outcome is 'inactive'; N=4,115

For males, both fitness (1.815) and sport motivation (1.600) at age 16 were strongly associated with being an exerciser at age 34. Clearly, as with the analyses at ages 10 and 16, sport was highly salient to male experiences. This was further supported by a very strong association of sport ability at age 16 with being an exerciser in adulthood (2.965) – implying a three-fold increase in odds. Of course, this result should be treated with caution, as the sport ability measure was a simple proxy based on whether the cohort member had represented their school at sport (p.135). Additionally, the results from age 16 had shown that variables relating to early family socialisation were strongly associated with sport ability (p.182), and so sport ability was itself an outcome of family socialisation. None of the other physical self-concept factors were associated with male adult exercise behaviour.

Participation outside school (2.102) and in team activity (1.804) were both associated with (approximately) a doubling in the odds of being an exerciser in adulthood. Team activity had been very popular amongst boys outside school at age 16 (p.146), and so these effects may reflect the same underlying association. In contrast to the female model, family recreation was not associated with adult exercise behaviour. Previous findings had suggested that boys developed their sporting identities earlier than girls (p.186), and so this can be explained by active boys moving on to self-determined, independent forms of participation by their teenage years. As with the female models, the association with participation inside school was not significant, and none of the other types of activity were significantly associated with adult exercise behaviour.

These findings provide additional support for those of previous chapters in this research. Measures related to family socialisation (playing sports outside school at age 10, family recreation and participation outside school at age 16) and intrinsic motivation (enjoyment at age 10, fitness and sport motivation at age 16) were strongly associated with adult exercise behaviour. Competitive sport seemed to be much more relevant to the experiences of males than females, and male cohort members' experiences of sport and exercise in childhood seemed to have no influence on them being in the active class at age 34.

In summary:

1. For females, enjoyment at age 10 was associated with adult exercise behaviour.
2. Playing sports often outside school at age 10 was an important correlate of adult exercise behaviour for both sexes, but particularly for males.
3. For males, there were no significant associations of childhood experiences with being in the active class of exercise behaviour in adulthood.
4. Fitness motivation was associated with adult exercise behaviour for both sexes but, for females, sport motivation was not.

5. Experiences of sport seemed to be much more salient to males. Both sport motivation and ability were associated with male exercise behaviour in adulthood.
6. Family recreation was the strongest correlate of adult exercise behaviour for females, but was not associated with male adult exercise behaviour.
7. Participation outside school was associated with adult exercise behaviour for both sexes.
8. Participation inside school at both ages 10 (hours of PE) and 16 was not associated with adult exercise behaviour for either sex.
9. Physical self-concept did not seem to be an important influence on cohort members' exercise behaviour in adulthood for either sex.
10. The types of activity participated in at age 16 did not seem to have important effects on adult exercise behaviour for either sex.
11. The results provided support for the importance of family socialisation and intrinsic motivation (i.e. self-determination) to long term participation in sport and exercise.

8.4 Final models

The significant effects from the preliminary models were included in a final model for each sex, which controlled for the correlates of physical activity in adulthood. In the multiple imputation datasets, the summary statistics did not vary greatly from the estimates presented in the analysis of health outcomes (Table 7.12, p.223), and so are not discussed here. As described previously (p.236), backward selection was undertaken to drop non-significant measures related to childhood experiences of sport and exercise.

In the female model, this resulted in the age 10 measures (enjoyment and playing sports outside school), and the age 16 measures of participation outside school and perceived activity being dropped ($\chi^2(8)$=8.892, p=0.3514). Family recreation and fitness motivation at age 16 were retained in the model. Estimates (odds ratios) from the final model are shown in Table 8.3. This model classified female cohort members cleanly into latent classes of exercise behaviour, with an entropy value of 0.794.

Table 8.3: Estimates for females from final model of adult exercise behaviour

Females		Exerciser			Active		
Variable	Value	Exp(Est.)	P-Value		Exp(Est.)	P-Value	
Age 16	Fitness motivation	1.674	0.000	***	1.241	0.069	
	family rec. <1/wk	1.608	0.003	**	1.278	0.108	
	family rec. 1/wk+	1.196	0.427		1.550	0.018	*
Weight status	overweight age 29	0.930	0.572		0.862	0.186	
	obese age 29	0.965	0.838		0.763	0.063	
Disability	yes	1.023	0.851		0.934	0.529	
Smokes	yes	0.428	0.000	***	0.775	0.024	*
Marital status	cohabiting	0.469	0.000	***	1.101	0.548	
	married	0.640	0.017	*	1.306	0.058	
Children	yes	0.553	0.000	***	1.106	0.415	
Employment	part-time	0.880	0.717		2.006	0.003	**
	full-time	0.948	0.872		1.527	0.056	
Social class	II	0.848	0.404		1.318	0.240	
	III non-manual	0.714	0.143		1.220	0.416	
	III manual	0.696	0.174		1.714	0.033	*
	IV	0.318	0.007	**	1.208	0.488	
	V	0.380	0.632		1.682	0.217	
Income	£150-£299/wk	1.007	0.978		0.961	0.800	
	£300-£449/wk	1.608	0.051		0.783	0.134	
	£450-£599/wk	1.848	0.018	*	0.713	0.063	
	£600-£749/wk	1.931	0.024	*	0.561	0.012	*
	£750+/wk	2.425	0.003	**	0.678	0.083	
Education	A-levels	0.808	0.298		1.411	0.053	
	GCSEs	0.676	0.005	**	1.009	0.944	
	CSEs	0.529	0.002	**	1.182	0.286	
	none	0.292	0.000	***	0.953	0.796	
Access to car	yes	1.665	0.007	**	0.809	0.110	

Note: reference class for exercise behaviour outcome is ‘inactive’; N=4,680

The effects of both fitness motivation (1.674) and family recreation (1.608) on being an exerciser were robust to the inclusion of controls, both associated with an increase in odds of 61-67%. However, there remained no significant association of the most frequent category of family recreation (1/wk+) with being an exerciser. The effect of family recreation on being in the active class (1.550) was also unaffected by the inclusion of controls. However, the effect of fitness motivation on the active class was no longer significant.

In terms of control variables, weight status and disability were not associated with adult exercise behaviour. The lack of an effect for weight status is surprising. In their review of correlates, Trost et al. (2002) found weight status to be strongly associated with physical activity. Heavier cohort members may have come from less active families, and so this effect may be captured by the family recreation and fitness motivation variables. For example, the age 10 analysis had found that heavier cohort members were less likely to play sports outside school often (pp.122, 127). Alternatively, their general exercise behaviour in adulthood may not have been affected (as captured by the latent class measure used in this research), even though they were less active in terms of objective measures of physical activity (i.e. accelerometry, calorie count, etc.)

There was a strong negative effect of smoking on the odds of being both an exerciser (0.428), and active (0.775) – a decrease in odds of 57% and 22%, respectively. There was also evidence that single women were more likely to be exercisers, with both cohabitation (0.469) and being married (0.640) associated with a decrease in odds. Having children in the household (0.553) also reduced the odds of them being exercisers. There were no effects of family composition on the odds of women being in the active class.

Part-time employment (2.006) was associated with twice the odds of being in the active class compared to those who were unemployed or employed full-time, but there were no employment associations with being an exerciser. There seemed to be a social class gradient to women being exercisers, with lower classes less likely to be in this class. There were strong income and education gradients to the odds of women being exercisers. The richest category (£750+ per week) was associated with an increase in odds of 142% (2.425) compared to those earning less than £300 per week. Having no qualifications (0.292) was associated with a reduction in the odds of being an exerciser of 71% compared to those with a degree. Women with access to a car were more likely to be exercisers (1.665), an increase in odds of 67%. There were far fewer significant effects related to being in the active class. Apart from part-time employment, none of the socioeconomic factors demonstrated clear effects, and the family composition variables also had no effect.

The results for males are shown in Table 8.4. Backward selection resulted in the age 16 measures of participation outside school, sport motivation, sport ability and participation in team activity being dropped ($\chi^2(8)=13.441$, p=0.0976). Playing sports outside school at age 10 and fitness motivation at age 16 were retained in the model. It is particularly surprising that the measure of sport ability at age 16 was dropped. In the preliminary model (Table 8.2), it was very strongly associated with being an exerciser (2.965).

This result supports the conclusion that male cohort members' sport ability was an outcome of family socialisation. The measure of participation (playing sports often) outside school at age 10, and the measure of fitness motivation at age 16, provided a more proximal, accurate measure of the important effects of family socialisation and self-determination on adult exercise behaviour. As previously described, sport ability was a proxy measure which would be affected by school provision, sporting ethos and size (p.163). This model classified male cohort members cleanly into latent classes of exercise behaviour, with an entropy value of 0.807.

The inclusion of controls had little effect on the estimate for playing sports outside school at age 10 (2.052). In contrast, the association with fitness motivation increased greatly, from 1.815 in the preliminary model to 2.748 in the final model. This was due to sport motivation being dropped, which was strongly correlated with fitness motivation[1] (p.171). As in the preliminary models, the active class of adult exercise behaviour seemed to lack relevance for men. The only measure which provided explanatory power in discriminating between men in the active and inactive classes was smoking (0.731), associated with a 27% decrease in the odds of being active and a 74% decrease in the odds of being an exerciser (0.258).

As with the female model, weight status and disability were not associated with adult exercise behaviour, but family composition was. Single men were more likely to be exercisers, with both cohabitation (0.537) and being married (0.524) associated with a decrease in odds. Likewise, having children in the household (0.711) also reduced the odds of men being exercisers in adulthood, but less than for women (0.553).

Although there were no associations related to employment status for men, there were effects related to other socioeconomic factors. The ordering of the estimates for income suggested it had a strong effect, but they were not highly significant. The estimate for the income category of £600-£749 per week (1.948) suggested

[1]A preliminary model with only fitness motivation included (i.e. without sport motivation) resulted in an odds ratio of 2.841.

Table 8.4: Estimates for males from final model of adult exercise behaviour

Males		Exerciser			Active		
Variable	Value	Exp(Est.)	P-Value		Exp(Est.)	P-Value	
Age 10	plays sport out. sch.	2.052	0.000	***	1.175	0.148	
Age 16	Fitness motivation	2.748	0.000	***	1.041	0.755	
Weight status	overweight age 29	1.039	0.761		0.865	0.184	
	obese age 29	0.882	0.530		0.922	0.602	
Disability	yes	0.776	0.059		0.933	0.511	
Smokes	yes	0.258	0.000	***	0.731	0.004	**
Marital status	cohabiting	0.537	0.002	**	0.924	0.629	
	married	0.524	0.001	***	1.025	0.889	
Children	yes	0.711	0.027	*	0.931	0.610	
Employment	part-time	0.533	0.260		0.781	0.522	
	full-time	1.127	0.742		1.067	0.806	
Social class	II	0.700	0.104		0.670	0.077	
	III non-manual	0.751	0.283		0.650	0.089	
	III manual	0.390	0.001	***	0.629	0.076	
	IV	0.416	0.022	*	0.776	0.400	
	V	0.190	0.014	*	0.640	0.269	
Income	£150-£299/wk	0.904	0.681		1.076	0.659	
	£300-£449/wk	1.165	0.483		1.183	0.337	
	£450-£599/wk	1.302	0.252		1.048	0.810	
	£600-£749/wk	1.948	0.016	*	0.937	0.794	
	£750+/wk	1.689	0.057		0.999	0.997	
Education	A-levels	0.710	0.111		1.108	0.619	
	GCSEs	0.452	0.000	***	1.106	0.493	
	CSEs	0.329	0.000	***	1.044	0.804	
	none	0.279	0.000	***	0.862	0.439	
Access to car	yes	1.476	0.086		0.863	0.348	

Note: reference class for exercise behaviour outcome is 'inactive'; N=4,115 a doubling of the odds of being an exerciser compared with those earning under £300 per week. In contrast, the effects of social class and education were both strong and highly significant. The odds of being an exerciser for those in social class III manual (0.390) were 61% lower than those in social class I. In terms of education, having no qualifications (0.279) was associated with a reduction in odds of 72% compared to having a degree. This is very similar to the effect identified in the female model (0.292). For men, having access to a car did not have an effect.

The strong socioeconomic effects in both models contrasts strongly with the lack of associations of these factors with childhood experiences of sport and exercise at ages 10 and 16 (pp.122, 124, 178, 182). It seems that socioeconomic influences on exercise behaviour did not emerge until after secondary school. These findings suggest that adult exercise behaviour is strongly influenced by economic, social and cognitive differences. These effects are consistently supported in reviews of the adult correlates of physical activity (Dishman et al., 1985; Bauman et al., 2002; Trost et al., 2002).

In summary:

1. Measures of family socialisation remained important correlates of adult exercise behaviour, controlling for the correlates of physical activity in adulthood.

2. For female cohort members, family recreation at age 16 was associated with an increase in odds of 50-60% of being active or an exerciser in adulthood.

3. For male cohort members, playing sports outside school at age 10 was associated with a doubling in the odds of being an exerciser in adulthood.

4. For both sexes, fitness motivation at age 16 was also associated with being an exerciser in adulthood – a 67% increase in odds for women, and a 175% increase for men.

5. Except for smoking, there were no associations with being in the active class for men. This class was practically indiscernible from inactivity in terms of the explanatory and control variables.

6. Smoking was detrimental to adult exercise behaviour for both sexes.

7. Weight status and disability had no effect on exercise behaviour in adulthood for either sex.
8. There were strong associations of the measures of family composition with exercise behaviour. Single men and women were more likely to be exercisers, and having children in the household reduced the odds of being an exerciser.
9. Access to a car increased the odds of female cohort members being exercisers, but had no effect on male exercise behaviour.
10. Employment status was only associated with being in the active class for female cohort members, with part-time employment doubling the odds of being active.
11. There were strong effects related to the other socioeconomic factors for both sexes. Social class, income and education all had strong effects on the likelihood of being an exerciser. For women, they also influenced the odds of being in the active class. This contrasted strongly with the lack of socioeconomic effects in childhood.

8.5 Conclusions

The analyses presented in this final empirical chapter sought to answer the following research questions:

- In what way are childhood experiences of sport and exercise associated with adult exercise behaviour?
  - Does school provision influence adult exercise behaviour?
  - Does family socialisation in childhood affect adult exercise behaviour?
  - Are there differences between the sexes?
- How do the correlates of physical activity in adulthood influence adult exercise behaviour?

There was strong evidence that childhood experiences of sport and exercise had an important effect on adult exercise behaviour in the BCS70. The similarity between the models for male and female cohort members is striking. Childhood experiences related to family socialisation and intrinsic motivation had an enduring effect. Family socialisation was represented by family recreation at age 16 for females, and playing sports outside school at age 10 for males. It seems plausible that this difference is due to gendered opportunities and preferences in participation. By age 16, the majority of active boys are likely to have moved on to independent participation in sport, which was very popular. For girls, traditional sports were not popular outside school, and so the age 10 measure of playing sports may not have captured this socialisation process.

There were also some striking differences between the sexes. For males, the active class of adult exercise behaviour was not associated with any of the explanatory or control variables, except for smoking. This suggests that being in the active class was practically indistinguishable from being in the inactive class for men. It is possible that low intensity exercise is simply not salient to male physical identities – i.e. when men consciously decide to be physically active, they only choose intense exercise. The other important difference was the size of the effects related to childhood experiences. For male cohort members, the associations were much larger – odds ratios of 2.052 to 2.748, compared with 1.550 to 1.674 for female cohort members. This may reflect the strong and persistent gender disparities in experiences of sport and exercise identified in childhood, and demonstrates that they continue to affect behaviour in adulthood.

The lack of a significant effect for the most frequent category of family recreation (1/wk+) in the female model is difficult to explain. At age 16, there was a strong dose-response association of family recreation with girls' participation outside school (p.178). However, as with the boys, it may have been the case that those female cohort members who went on to lead active lifestyles in adulthood had already been socialised into an independent active lifestyle by age 16, and so did not participate very frequently with their families. Thus, the strange effect of family recreation in adulthood may reflect the lack of appropriate measures in the BCS70 to capture the experiences of these girls in childhood.

Fitness motivation was also associated with adult exercise behaviour for both sexes. Essentially, those cohort members with high intrinsic motivation at age 16 were more likely to be active in adulthood. The best explanation for fitness motivation superseding sport motivation is the difference in participation between childhood and adulthood. Lifestyle activities are by far the most popular in adulthood. This is mostly because they are cheap, convenient and flexible, but they are also fitness orientated (Coalter, 1999; Green, 2002a). Thus, developing an interest in physical fitness during childhood may help to ease this transition to non-sport participation in adulthood. It also seems plausible to suggest that the cohort members will become more interested in health and fitness as they age. This association could also be viewed as an indirect effect of family socialisation. At age 16, fitness motivation was strongly influenced by various measures intended to capture the influence of the family and parents in childhood (pp.178, 182), including: family recreation, parental exercise and attitudes to physical fitness at age 16, and playing sports outside school at age 10.

There was very little evidence that school provision of physical education and sport had any effect on adult exercise behaviour. Both the hours of PE at age 10 and participation inside school at age 16 had no effect on either class of exercise behaviour in adulthood. Similarly, perceived ability at age 10 and physical self-concept at age 16 did not seem to have any impact on adult exercise behaviour. This can be viewed as a positive finding; it suggests that negative physical self-perceptions in school are not themselves responsible for differences in adult exercise behaviour. Rather, they are largely an outcome of physical disadvantage (weight, maturity, size, etc.) and a lack of family socialisation into a physically active lifestyle. There was also no evidence to support the hypothesis that particular types of activity at age 16 had different impacts on adult exercise behaviour. It has been suggested in the academic literature (Green, 2002a, 2004) that experience of lifestyle activities in childhood could promote adult exercise behaviour, but the findings from this research do not provide evidence of any associated difference based on participation at age 16. Of course, one caveat to this is that family recreation is likely to have been largely based on lifestyle activities.

Smoking, family composition and socioeconomic factors were also strongly associated with exercise behaviour in adulthood for both sexes. Smoking may have represented a health behaviour that co-occurs with inactivity, but it seems plausible that it might also cause a reduction in activity. Smoking was detrimental to experiences of sport and exercise at age 16 (pp.178, 182) and undoubtedly affects fitness (Conway and Cronan, 1992; Sandvik et al., 1995). For both sexes, cohabitation, marriage and children in the household reduced the odds of being an exerciser. It seems likely these effects reflect reductions in solitary leisure time associated with pair bonding and childcare. Social class, income and education were also strongly associated with the odds of being an exerciser for both sexes. This is striking because of the contrast with the findings from childhood. The analyses at ages 10 and 16 had both found little influence of socioeconomic factors on childhood experiences of sport and exercise (pp.122, 124, 178, 182). This difference suggests that economic, social and cognitive influences in adulthood have a strong impact on whether exercise behaviour is maintained.

Overall, the research presented in this chapter provided strong support for family socialisation and self-determination theory. Estimates for the correlates of physical activity in adulthood generally agreed well with those found in the research literature (except in the case of weight status, Dishman et al., 1985; Bauman et al., 2002; Trost et al., 2002). In contrast, there was no evidence that school sport and physical education encourages adult participation in sport and exercise. It would appear that the assertions commonly made in government policy documents (Department of National Heritage, 1995; Department for Culture Media and Sport, 2000; Department for Culture Media and Sport and Strategy Unit, 2002; Department for Culture Media and Sport, 2012b) are baseless.

The next chapter comprises a discussion of the research findings presented in this thesis. It briefly summarises the policy context and academic literature which has been used to frame the research, before discussing the findings of the empirical chapters in childhood, and then in adulthood. It then discusses the implications of this research for policy, highlights the limitations with it and suggests future research to extend the analyses presented here.

Chapter 9

Discussion

9.1 Introduction

This chapter provides a brief summary of the policy context and academic literature which was used to frame the research presented in this thesis. It then goes on to discuss the findings, focusing first on those in childhood, and then on those in adulthood. The implications of the findings for policy are discussed, and the limitations of the research are highlighted. Suggestions are made as to how future efforts might extend the research presented in this thesis.

Research into physical activity should be regarded as vital, now more than ever. The impact it could have on the health of the population is unequivocal. Leading a physically active lifestyle has repeatedly been found to provide a range of health benefits: increased longevity, more years lived in good health, lower risk of cardiovascular diseases, lower incidence of particular cancers, improved mental health, etc. (p.20). We are living in a time where the opportunity to be almost completely sedentary is greater than ever. Many occupations are desk based (Office for National Statistics, 2011a), few people choose active modes of travel (Shephard, 2008; Office for National Statistics, 2011b), audio-visual entertainment is increasingly popular (Meeker, 2014), and many adults and children choose to spend their leisure time engaged in activities which involve no physical exertion at all (Scholes and Mindell, 2013). As a result, rates of overweight and obesity continue to rise (National Obesity Observatory, 2010), and the trend in diabetes prevalence is particularly alarming (Diabetes UK, 2012). It seems prudent to invest in understanding what truly works in encouraging people to become, and remain, active for life.

Consecutive governments have viewed physical education and school sport as the most promising way in which to mould a more active population (Department of National Heritage, 1995; Department for Culture Media and Sport, 2000; Sport England et al., 2009; Department for Culture Media and Sport, 2012b). By including it as part of compulsory education, policy makers aim to make children more active and help them grow into active adults. However, encouraging physical activity is not the only aim of school sport policy; there is also a strong focus on nurturing youth sporting talent and building 'character'. As a result, competitive participation in traditional sports is typically promoted above other forms of physical activity. This focus has been criticised in the academic literature (Penney and Evans, 1997; Green, 2004) because many children do not enjoy competitive sport.

In school, children experience a context in which explicit (by the school) and implicit (social) peer comparisons are made. As a result, children form self-perceptions of their abilities, fitness and appearance. The theory of physical self-concept (Marsh, 1996b; Fox and Corbin, 1989) provides a framework for these judgements and how they can affect enjoyment, participation and performance. In competitive sport, comparisons tend to be relative to other participants. Thus, even perfectly able children can develop negative self-concept if their peers happen to be more able, and this can result in amotivation and desistance (Chanal et al., 2005). Direct competition between individuals is fundamental to many traditional sports. This creates an 'ego orientation' to achievement goals, where success is defined by relative performance against others. In contrast, 'task orientated' goals involve self-referential performance, individual achievement against one's own previous attempts (Nicholls, 1984; Treasure and Roberts, 1995; Senko et al., 2011).

Several theories have been put forward in the academic literature which aim to explain why people lead active lifestyles, how they come to do so, and how participation might therefore be encouraged in those that are not active. The parents, family and home environment children are brought up in are thought to have a central role in the development of active lifestyles (Roberts et al., 1991; Fredricks and Eccles, 2003; Birchwood et al., 2008; Trost and Loprinzi, 2011; Haycock and Smith, 2012). Children who grow up in active families are supported, encouraged, and habituated into active lifestyles. These children regularly enjoy fun, recreational, leisure time participation with their family and rapidly become more physically able than children from inactive families. Unsurprisingly, people tend to seek out opportunities to engage in leisure activities that they enjoy, are interested in, feel good at, and/or feel some kind of personal connection with. These kinds of motivations are elucidated on in self-determination theory (Ryan and Deci, 2000a,b), which posits that intrinsic motivation is driven by the desire to fulfil basic psychological needs for feelings of autonomy, competence and connectedness. It has also been suggested that childhood experience of lifestyle activities might be beneficial, as these are the most common activities adults participate in (Coalter, 1999; Green, 2002a; Kirk, 2005).

Previous research in this area has tended to be either qualitative, short term and/or retrospective (p.59). The qualitative literature provides rich descriptions of experiences, but only for small numbers of individuals. Tracking studies tend to look at how participation varies over time, but are limited to relatively brief time spans (e.g. three to five years). Retrospective studies ask adults to remember their experiences in childhood, and are susceptible to recall bias (Matt et al., 1999). The research presented in this thesis has overcome all of these limitations by using data from an ongoing, large sample cohort study, which has surveyed the same individuals from their births in 1970 to today. By using modern statistical methods (p.72), it provides the best answer yet to the question of how childhood experiences of sport and exercise influence adult exercise behaviour.

9.2 Childhood experiences of sport and exercise

This research examined childhood experiences of sport and exercise, both inside and outside school, when the cohort members of the BCS70 were in primary school (at age 10) and secondary school (at age 16). It found little evidence that provision of physical education and school sport was related to positive experiences of sport and exercise in childhood. In primary school, provision had a small impact on swimming outside school (p.111). In secondary school, there was no identifiable longitudinal effect (pp.178, 182).

In contrast, there was very strong evidence that children's participation outside school was crucial to positive experiences of physical education and school sport (pp.122, 124, 127, 178, 182). This should probably not come as a surprise. Children who were socialised into an active lifestyle at home would tend to bring a skill and fitness advantage into the school environment. This difference in ability would be highlighted by school provision, with able children tending to experience competitive success to the detriment of their inexperienced peers. Early perceptions of ability had a lasting effect on experiences. It was a crucial mediator of enjoyment in primary school (p.119) and continued to influence experiences in secondary school (pp.178, 182). It seems unlikely that a few hours of lessons per week would bridge this gap, even if PE teachers focused solely on children with low ability. In secondary school, selection into coached, school teams would further emphasise this inequality (p.163).

Interestingly, those children that played sports from an early age outside school had a much greater advantage in school than children who took part in lifestyle activities such as cycling and swimming (p.114). This suggests that having well-developed sports skills conferred a greater advantage than simple aerobic fitness. This explains many of the differences seen between boys and girls in the BCS70. Competitive sports were not popular with girls outside school (pp.145, 160), and so they were less likely to bring a skill advantage into school. Boys were generally more keen on sport (p.160), thus sports skills mattered more, resulting in a more heterogeneous group (e.g. p.170). The importance of sports skills in school contrasted greatly with the general picture of activity outside of school, where lifestyle activities formed the bulk of participation in physical activity (pp.145, 146). Participation in lifestyle activities was far less gendered and was not influenced by experiences in primary school, physiological factors, socioeconomic factors or the school environment (pp.178, 182). They were activities for anyone and everyone.

Gendered experiences were in evidence both inside and outside school. In the primary school years, there were large differences in sports participation outside school between boys and girls (pp.104, 105). Unisex provision inside school acted to minimise this difference, but it was nevertheless evident that gymnastics was more salient for girls and games for boys (e.g. p.116). In contrast, secondary schools seemed to provide highly gendered activities (pp.145, 146). One would hope that schools take an active role in challenging this kind of sexism today. National statistics suggest this is the case (Quick et al., 2010), although there is still a long way to go in both schools and the wider society to break down perceptions of particular activities as male or female. Considering the lack of popularity of competitive sport with girls (pp.145, 160), it seems that they were far less well served in general than boys by school provision. Their levels of sport motivation in secondary school were far lower than the boys', despite similar levels of fitness motivation (p.168). It seems likely that non-competitive, fitness oriented activities would have served girls' preferences far more effectively.

Ultimately, this research provided extensive support for the crucial role of family socialisation for positive experiences of sport and exercise in childhood, both inside and outside school. There was little in the way of evidence to suggest that school provision was responsible for encouraging children to be more active. The focus on competitive performance is unlikely to have helped those children who were less experienced at competitive sport. The accumulated evidence supported the processes outlined in self-determination, physical self-concept and achievement goal theory. In contrast, the broad, sweeping claims for the benefits of physical education and school sport typically asserted in government policy were not. Of course, this does not mean that school sport was entirely counter-productive – a majority of the cohort members enjoyed school sport to some extent. However, it does mean that school provision was building on, and possibly exacerbating, pre-existing differences in activity. Thus, the less active cohort members were outside school, the less likely they were to benefit from school provision.

9.3 Adult exercise behaviour

One of the main challenges to this research was related to the simplicity of the measures of exercise behaviour available in adulthood (p.203). It was possible to identify three discrete types (latent classes) of exercise behaviour: 'exerciser', 'active' and 'inactive' (p.207). Interestingly, the proportions of men and women in each class were similar to estimates from the Health Survey for England of 'low activity', 'some activity' and 'meets recommendations' (National Centre for Social Research (NatCen) and Department of Epidemiology and Public Health (UCL Medical School), 2012). Most cohort members stayed within the same class between the ages of 29 and 34. Those that did not tended to move between the active and inactive classes (p.208). There was evidence that the exercise behaviour of men was different to that of women. Women were more likely to be in the active class and less likely to be in the exerciser class (p.208). They were also less likely to get out of breath and sweaty 'most times'. This difference may be related to the preferred activities of men and women. Some activities which are popular amongst women are not aerobically intensive (such as yoga, Fox and Rickards, 2004). In contrast, men may be more likely to identify being fit with competitive sport, intensive aerobic exercise, and muscle development. These differences reflect the pervasive gendered stereotypes relating to sport and exercise in our culture.

In order to validate the classes of exercise behaviour, models were estimated to identify how they were associated with changes in BMI and malaise in adulthood (pp.220, 221). Exercise behaviour had no discernible effect on BMI at age 29. By age 34, the association was highly significant, suggesting that exercise might have an increasing role to play in weight control as people age. In terms of malaise, exercise was consistently beneficial, the effect seeming to increase slightly with age. For women, being in the active class was as beneficial to BMI as being an exerciser. For men, it was not, and also failed to confer a benefit on the level of malaise they experienced at age 34. It seems men might need to exercise intensively to experience these health benefits. Despite the estimated effects on BMI and malaise being relatively small, they were highly significant (both statistically and substantively). Considering that the cohort members were still relatively young at age 34, it seems fair to expect these effects to be maintained or even increase at later waves. The estimates at this age were robust to the inclusion of a variety of control variables (pp.225, 226), providing reasonable validation for the latent class measure of exercise behaviour.

The main findings of this research related to whether childhood experiences of sport and exercise were associated with adult exercise behaviour. The most striking finding was the lack of any association of participation inside school (both primary and secondary) with adult exercise behaviour (pp.242, 245). In contrast, measures of participation outside school were strongly associated with adult exercise behaviour. For women, family recreation at age 16 was associated with being both an exerciser and active at age 34. For men, playing sports often outside school at age 10 was strongly associated with being an exerciser at age 34 (again, simply being active did not seem particularly relevant for men, only being distinguishable from inactivity through the measure of smoking). Clearly, family socialisation into an active lifestyle was not only crucial to experiences within school, but continued to affect exercise behaviour into adulthood. The only other childhood measure associated with adult exercise behaviour was fitness motivation at age 16 – cohort members who had developed an interest in fitness by their teenage years were more likely to exercise in adulthood. Fitness motivation at age 16 was itself associated with measures of family socialisation – playing sports outside school at age 10, family recreation, parental attitudes to physical fitness and parental exercise behaviour (pp.178, 182). These findings provide emphatic support for the roles of family socialisation and intrinsic motivation in encouraging the development and maintenance of an active lifestyle.

Sport motivation at age 16 was not independently associated with adult exercise behaviour in the final models. This makes sense considering competitive sport is not particularly popular with active adults (Fox and Rickards, 2004; Kirk, 2005). Participation tends to become much more fitness orientated in adulthood, dominated by flexible, convenient, lifestyle activities. It has been suggested in the literature that experience in lifestyle activities in childhood could help young people transition into an adult mode of participation (Green, 2002a). Little evidence was found to support this hypothesis, as participation in particular activity types (lifestyle or otherwise) at age 16 was not found to be associated with adult exercise behaviour. None of the physical self-concept factors at age 16 were associated with adult exercise behaviour either. This can be viewed as a positive finding, as it implies that poor physical self-concept experienced in the teenage years (as frequently described in qualitative studies) had no independent, long term effect on adult exercise behaviour.

Additional findings related to the correlates of physical activity. During childhood, there seemed to be little influence of socioeconomic factors on experiences of sport and exercise (pp.122, 124, 127, 178, 182). This was no longer the case in adulthood, with strong effects of social class, income and education emerging. Clearly, social, economic and cognitive influences start to have a strong effect on the maintenance of an active lifestyle in adulthood. Perhaps surprisingly, weight status and disability were not associated with exercise behaviour at age 34. This contrasts with the effect of smoking, which was highly detrimental to exercise behaviour in adulthood, as it was to experiences of sport and exercise in childhood. Those cohort members who were cohabiting, married or had children, also seemed to be less likely to exercise. This probably reflected reduced leisure time and substitution of exercise for other activities.

9.4 Implications for policy

There are several important implications of these findings for government policy. Simply put, the current approach to physical education and school sport is unlikely to increase physical activity in the general population. Instead, it mainly serves to highlight the inequalities in physical skill and fitness that children have developed through their experiences of sport and exercise outside school, which are primarily caused by family socialisation.

The main problem with this is that it exacerbates negative childhood experiences of sport. Firstly, direct competition between peers explicitly defines ability as relative and ego orientated, rather than absolute or task orientated. Thus, even physically active children may develop self-perceptions of inability if relatively inexperienced in traditional sports. Secondly, the most able are likely to benefit more from school provision. They will not only be more likely to enjoy competitive success in the first place, but their abilities are more likely to be developed through preferential coaching by PE teachers and selection into school teams.

There is a common perception that sports competition fairly rewards effort, encouraging perseverance and determination. This narrative is inherently appealing, and is encouraged by government, the media and elite sports bodies, who are invested in promoting competitive sport. It is the basis for assertions in government policy that competitive sport 'builds character'. This seems highly unlikely in the school environment. Children who do not benefit from an active, sporting upbringing will be disadvantaged, as will those who are short, gangly, overweight, underweight and uncoordinated. Similarly, maturation will have a dramatic effect on aptitude, and it is well-established that month of birth effects are pervasive in school sport (Wattie, 2013). Recent research has highlighted that bullying and cheating are commonplace in school sport too (Chance to Shine, 2012, 2013). This is emphatically not what the government means when they say that school sport 'builds character'.

These considerations lead to a fundamental question: what is school sport for? The focus on traditional, competitive sport seems to be sustained by the popularity of elite sport. Both young people and adults enjoy watching elite sport and like to see international success for national sports teams and athletes. Politicians are keen to be associated with elite sport success and the narrative of hard work and determination associated with it. Thus, competitive sport is promoted above other forms of physical activity in school, and developing talented young athletes into the "stars of the future" (Department for Education, 2013) becomes a central goal of government policy. But is this sensible? The proportion of children that go on to participate in elite sport is negligible; most elite athletes retire by the age of 35; and very few adults participate in competitive sport at all. Do we want school sport to service elite sport goals, or do we want it to promote physical activity to the general population?

If this exclusive focus on competitive sport is perverse, what should schools focus on? The academic theories exploited in this research together with its findings provide possible answers. By focusing on fulfilling the basic psychological needs of autonomy, competence and connectedness, school provision could maximise the possibility for children developing intrinsic motivation to participate in physical activity, both inside and outside school. Narrow definitions of sport and exercise should be consigned to the dustbin. Schools should focus on enabling children to discover physical activities they enjoy, whether that means dance, martial arts, fitness exercise, skate boarding, team games, swimming, circus skills, yoga, climbing, whatever!

Also, schools have a leading role to play in challenging gender stereotypes. All activities must be promoted irrespective of sex, and children should be encouraged to try activities which are stereotypically gender opposite. Variety is the name of the game, both in the activities available and in the way in which one can participate. Recreational participation should be the norm, with competitive opportunities available for those who want to compete. Ironically, children who enjoy and become self-motivated to participate in particular activities are more likely to move on to competitive participation anyway (Côté, 1999; Côté et al., 2007).

Achievement goal theory is also useful here. Children naturally make peer comparisons and the school system explicitly formalises these through assessment. In order to maximise reward and motivation, self-referential achievement should be consistently emphasised. This means different things for different activities – personal fitness goals can be developed from comparison with previous performance; a new dance style can be learned; gradings can be taken in martial arts. This approach will help to minimise the exclusion of children who are relatively unskilled, unfit, overweight or otherwise disadvantaged. It is interesting to note that traditional school provision tends to be predominantly focused on externally referenced achievement – competitive athletics, team games, and racquet sports all tend to emphasise ego orientations to achievement goals.

This approach to school provision may seem ambitious. Many schools have limited funding, equipment, facilities, and appropriately trained staff. However, there are reasons for optimism. Many activities that could be provided in schools require far less in the way of equipment and facilities than traditional sports. Indeed, many activities simply need a teacher with the appropriate experience to manage the provision and guide participation. Before Michael Gove removed funding for it (Gove, 2010), the 'School Sport Partnerships' programme served to link schools with local sports clubs in order to provide expertise and facilities to support provision. This programme was generally regarded as successful at increasing variety and encouraging participation, as well as forming a bridge between school and external participation (House of Commons Education Committee, 2013). There is no reason why this model could not be expanded to encompass a far wider range of activities, where they are available locally. The potential to increase membership could encourage clubs/instructors to become involved in providing a service to schools.

The effect fitness motivation had on adult exercise behaviour (pp.242, 245) provides an additional avenue schools might exploit. Traditionally, physical education has been centred around movement skills and participation in competitive sport. Instead, an educational component could be included by teaching children about human physiology, the health benefits of physical activity, how to avoid injury, nutrition, etc. This could be coupled with participation in self-referential exercise in order to foster an interest in physical fitness and enhance self-efficacy (Hagger et al., 2001).

These suggestions have the potential to make physical education and school sport a more positive and valuable experience for many children, particularly the girls and minority of boys who are currently under-served by traditional provision. However, this does not necessarily mean that this approach will result in a more active adult population. Preferably, more needs to be done to make it easier for adults to maintain physically active lifestyles too. Although this research has not focused on adult correlates of physical activity, it is striking that those identified in the final model – smoking, family composition and (most importantly) socioeconomic factors – had very strong effects on exercise behaviour. Considering the potential physical activity holds for improving public health, perhaps a variety of solutions should be considered and piloted long term:

- encourage tobacco users to give up and switch to tar-free nicotine replacement products;
- do more to make cycle/walk commuting convenient, safe and pleasant;

- develop incentives to encourage employers to provide standing office environments, showering facilities, cycle storage, gym membership, etc.;
- fully subsidise local authority leisure centres so that access is entirely free at the point of use;
- link school facilities, sports clubs and leisure centres in order to create a large resource for access by schools and the wider community; and
- encourage family participation in physical activity by promoting opportunities for parents and children to participate together in sports and active recreation.

Ultimately, however, it is quite possible that these kinds of efforts would have limited success. The large socioeconomic gradients identified in this research (pp.242, 245) suggest that inequalities in adult exercise behaviour are largely driven by fundamental inequalities in society; small scale public policy interventions may not have the scope or funding to counteract these.

9.5 Limitations and future research

The research presented in this thesis is inherently limited by its design. As described in the chapter on methods (p.69), the wider validity of cohort based studies can always be called into question. The men and women that make up the respondents of the BCS70 are now 44. Children going through primary and secondary schooling today are living through a very different time. There are different cultural norms, different educational and social policies, a different economic background, more cars on the road, more stranger danger, and (probably most relevant to this research) very different technologies readily available (the internet, social media, smart phones, computer gaming, Aggio et al., 2012).

If anything, this means that the challenges to encouraging physical activity are increasing. Nevertheless, recent qualitative (Haycock and Smith, 2014) and quantitative (Downward et al., 2014) research on sports participation in children and young adults supports the view that the processes influencing the transition from childhood to adult participation, such as family socialisation, have not changed. Similarly, school sport policy today looks much the same as it did in John Major's time: strongly reminiscent of a traditional, competitive sport model. If anything, the London Olympics in 2012 has given fresh impetus to the desire to promote competitive sport in schools.

Another limitation of this research is also related to the use of cohort data. Some of the measures used were not designed as one might have hoped. There was no measure of enjoyment of gymnastics at age 10 (p.102); no measures of perceived ability in particular activities at age 16 – thus, a proxy was used based on school team representation (p.163). Also, considering the results of the final chapter, it would have been preferable to have more questions explicitly designed to capture intrinsic motivation and family socialisation. This would allow these processes to be investigated in more detail and with more precision.

Additionally, there was limited information available in the adult waves related to exercise behaviour. Only a very general categorisation of exercise behaviour could be identified: whether the cohort member was an 'exerciser', 'active' or 'inactive' (p.207). Fortunately, a new wave of data in the BCS70 has recently been released (TNS BMRB, 2013). This data was collected when the cohort members were aged 42, and captures detail on both general exercise behaviour and participation in specific sports and exercise activities. Also, it repeats the collection of weight and height data (for the calculation of BMI), and repeats the reduced (nine item) Rutter malaise scale. Thus, there is a great potential to extend the research presented in this thesis to identify how experiences of sport and exercise in childhood affect those at age 42, and whether this has an increasing impact on the health of the cohort members as they age.

Appendix A

Estimates from model of swimming at age 10

Table A.1: Estimates for female path model of swimming outside school regressed on participation inside school, controlling for socioeconomic factors

Explanatory variable	Value	Estimate	S.E.	P-Value	
participation inside school	hours PE/movement/games	0.119	0.031	0.000	***
parental income	£50 to £99 per week	0.097	0.126	0.440	
	£100 to £149 per week	0.219	0.126	0.081	
	£150 to £199 per week	0.329	0.132	0.013	*
	£200 to £249 per week	0.276	0.148	0.063	
	£250+ per week	0.221	0.154	0.151	
social class	II	-0.057	0.101	0.572	
	III non-manual	-0.101	0.118	0.390	
	III manual	-0.042	0.104	0.686	
	IV	-0.195	0.116	0.092	
	V	-0.173	0.147	0.239	
mother's education	trade apprentice	0.052	0.061	0.393	
	O-levels	-0.006	0.057	0.910	
	A-levels	-0.054	0.097	0.578	
	degree	-0.122	0.138	0.374	
school social mix	% social class I & II	-0.010	0.093	0.914	

Note: estimates are in probits; reference categories are under £50 per week for parental income, social class I, no qualifications for mother's education

Table A.2: Estimates for male path model of swimming outside school regressed on participation inside school, controlling for socioeconomic factors

Explanatory variable	Value	Estimate	S.E.	P-Value	
participation inside school	hours PE/movement/games	0.142	0.027	0.000	***
parental income	£50 to £99 per week	-0.024	0.116	0.837	
	£100 to £149 per week	0.130	0.115	0.256	
	£150 to £199 per week	0.223	0.121	0.066	
	£200 to £249 per week	0.029	0.140	0.837	
	£250+ per week	0.332	0.146	0.023	*
social class	II	0.148	0.101	0.142	
	III non-manual	0.208	0.121	0.086	
	III manual	0.204	0.112	0.069	
	IV	0.257	0.124	0.038	*
	V	0.018	0.150	0.904	
father's education	trade apprentice	0.056	0.055	0.303	
	O-levels	0.005	0.062	0.932	
	A-levels	-0.011	0.075	0.888	
	degree	-0.046	0.091	0.616	
school social mix	% social class I & II	-0.018	0.090	0.842	

Note: estimates are in probits; reference categories are under £50 per week for parental income, social class I, no qualifications for father's education

Appendix B

Latent motor coordination at age 10

B.1 Introduction

A single binary indicator of motor coordination was used in the main analysis as a proxy for innate physical ability. The findings from a latent trait analysis supported its use in this way. In the BCS70, four binary variables measured the ability of the cohort member to balance on one leg during the medical examination at age 10. The child was asked to stand on the right leg with the left foot against the knee of the right leg and hands on hips. The child was then told to try to hold the position for 30 seconds (test 1). The medic recorded whether the hands or feet moved out of position within the 30 seconds. The test was then repeated with the child standing on the left leg (test 2). This appendix describes the modelling that was undertaken to estimate a single latent trait for motor coordination, the tests undertaken to determine measurement equivalence across the sexes, and the rationale for resorting to a single indicator once this analysis had been completed.

B.2 Descriptive analysis

A tabulation of the four binary indicators by sex demonstrated that girls performed better on the tests than boys (Table B.1), with the percentage of them using their hands and feet to balance during the test being consistently lower by 8% to 10%. A tetrachoric correlation matrix was then estimated to determine to what extent the indicators were correlated (Table B.2). All correlations were high, varying between 0.46 and 0.82, suggesting that the indicators may be measures of an underlying motor coordination trait. The highest correlations (0.76 to 0.82) were between the indicators for moving the foot and hands in a single test, as might be expected due to losing balance on a test occasion. The next highest correlations were between indicators for moving the hands on both occasions (0.65 and 0.65) and moving the foot on both occasions (0.60 and 0.61), suggesting a preference for using the hands or feet to aid balance.

Table B.1: Descriptive statistics for binary motor coordination indicators at age 10

Variable	Value	Female (%)	Male (%)
motor coordination (medic report)	test 1 moved foot	31.08	41.50
	test 1 moved hands	22.46	30.45
	test 2 moved foot	33.88	42.30
	test 2 moved hands	23.97	32.55

Table B.2: Tetrachoric correlation matrix of binary motor coordination indicators at age 10 – correlations for females are in the upper right triangle, for males the lower left triangle

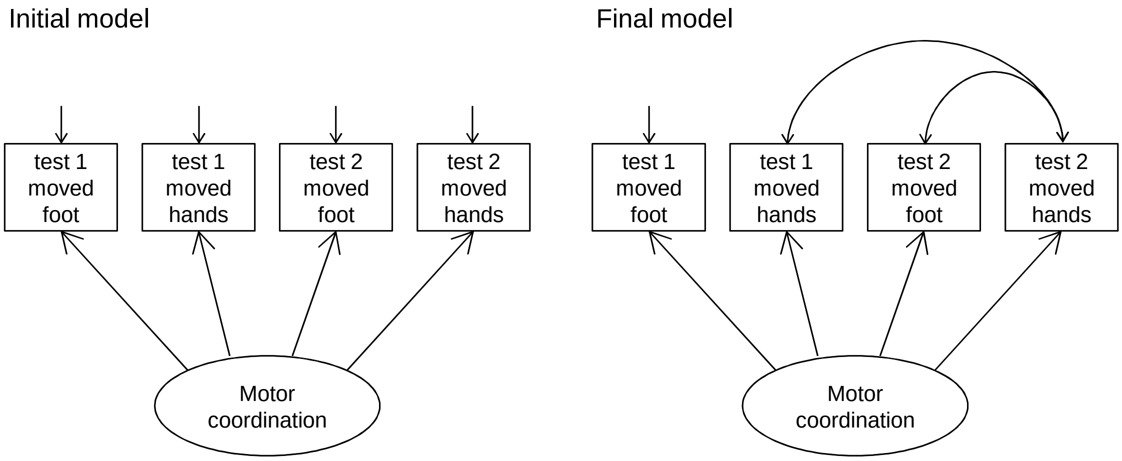
	t1mf	t1mh	t2mf	t2mh
test 1 moved foot	1	0.79	0.60	0.47
test 1 moved hands	0.76	1	0.50	0.65
test 2 moved foot	0.61	0.46	1	0.82
test 2 moved hands	0.47	0.65	0.81	1

B.3 Specifying the model

A model was specified that attempted to account for the correlations amongst the indicators using a single latent trait. Figure B.1 shows a diagram of the initial model and the final model. Model selection was undertaken separately for each sex in order to determine whether the same configuration arose from separate model selection processes. The models were identified by constraining the variance of the latent trait to 1, allowing all loadings onto the indicators to be freely estimated.

Parameters were added to the initial model based on a combination of substantive rationale and evidence from modification indices in order to achieve a good fit

Figure B.1: Path diagrams of initial and final latent trait measurement models of the coordination indicators at age 10



to the data. In both cases, the initial model did not fit the data well. For girls, the model demonstrated poor fit with a $\chi^2(2)=482.75$ (p=0.0000), RMSEA of 0.202 (90% CI: 0.187 to 0.218), a CFI of 0.958 and a TLI of 0.875. The modification indices suggested that allowing the residuals for the items related to test 2 to be correlated would improve the model fit considerably (MI=414.683, StdYX EPC=1.928). This modification index suggested that variation in ability to balance on the left leg was not explained adequately by the latent trait. Laterality provides a reasonable explanation for this correlation. Children are likely to have more ability on one leg than on another, irrespective of their overall motor coordination ability. The degree to which they are laterally biased would vary, with children generally being strongly left or right biased and some being ambidextrous.

The model with this correlation added was a significantly better fit to the data $\chi^2(1)=303.78$ (p=0.0000), with overall fit statistics of $\chi^2(1)=185.41$ (p=0.0000), RMSEA of 0.177 (90% CI: 0.156 to 0.199), a CFI of 0.984 and a TLI of 0.904. Although this was a much improved fit, the fit was still quite poor. Modification indices for this model suggested that allowing the residuals to correlate between the indicators for moving the hands on both test occasions would improve the fit considerably (MI=185.408, StdYX EPC=1.020). The descriptive statistics showed that moving the hands was less frequent than moving the foot in order to stay balanced. It seems plausible that children would vary in their tendency to use their hands to balance when in the set position, again irrespective of their overall motor coordination ability.

Adding this correlation to the model resulted in a just-identified model, with no remaining degrees of freedom to test model fit. However, a difference test of nested models demonstrated that this correlation significantly improved model fit $\chi^2(1)$=185.41 (p=0.0000). In order to test the overall model fit, a constraint was added to the model. The loading of the indicator for moving the foot on the first test was not significantly different from 1 ($\chi^2(1)$=2.12 (p=0.1454)), and so it was constrained to this value. The overall fit of the resulting model was very good, with a $\chi^2(1)$=2.120 (p=0.1454), RMSEA of 0.014 (90% CI: 0.000 to 0.040), a CFI of 1.000 and a TLI of 0.999.

An identical approach was taken for boys, resulting in a model with an identical configuration. As with the model for girls, the loading of the indicator for moving the foot on the first test was constrained to 1 to allow testing of model fit. The resulting model was a very good fit to the data, with a $\chi^2(1)$=0.043 (p=0.8352), RMSEA of 0.000 (90% CI: 0.000 to 0.020), a CFI of 1.000 and a TLI of 1.000.

The next stage of testing involved identifying whether the model was equivalent across the sexes. The model was estimated with increasing constraints placed on the parameters. The resulting model demonstrated very strong measurement equivalence, with only one indicator threshold (for moving the hands in the second test) varying between groups. The results for the models are shown in Table B.3. The chi-square difference between this highly constrained model and the model with no constraints across the sexes was not significant $\chi^2(7)$=8.173 (p=0.3176), and the fit of the constrained model was very good, with a $\chi^2(8)$=8.505 (p=0.3857), RMSEA of 0.003 (90% CI: 0.000 to 0.016), a CFI of 1.000 and a TLI of 1.000.

A comparison of the latent trait means for the male and female models demonstrated that boys had poorer motor coordination than girls, the mean being 0.308 standard deviations less than that of the females on the latent scale, reflecting the poorer performance on each indicator that was previously identified in Table B.1. The loading for moving the foot in test 1 was very high (0.984), and estimates of the proportion of variance explained (R-square) for this indicator showed that it was almost perfectly explained by the latent trait. This suggested that using this single indicator in subsequent analyses would be an acceptable simpler alternative to using the latent trait as a measure of motor coordination. Accordingly, this indicator was included in the path analyses to control for motor coordination, as a proxy for innate ability.

Table B.3: Estimates from the model testing for measurement equivalence of the motor coordination latent trait at age 10

Parameters	Estimate	S.E.	P-Value
Loadings			
test 1 moved foot	0.984	0.012	0.000
test 1 moved hands	0.786	0.011	0.000
test 2 moved foot	0.611	0.011	0.000
test 2 moved hands	0.468	0.014	0.000
Residual correlations			
test 2 indicators	0.529	0.012	0.000
moved hands indicators	0.285	0.012	0.000
Trait means			
female	0.000		
male	-0.308	0.023	0.000

Note: estimates are in probits; $\chi^2(8)=8.505$ (p=0.3857), RMSEA=0.003 (90% CI: 0.000 to 0.016), CFI=1.000, TLI=1.000; the female trait mean was constrained for identification purposes

Appendix C

Additional cross-sectional analysis at age 16

C.1 Participation inside and outside school

The count of activities participated in infrequently (<1/week) at age 16 could be seen as a proxy for the cohort members' 'sampling' of activities, as described in Côté's *Developmental Model of Sport Participation* (1999; 2007). Accordingly, these data were reduced in the same way as those for frequent participation (p.149). Table C.1 shows the categorised versions of these count variables.

Overall, the sampling mode of participation seemed to be less common than the specialisation mode, with a greater proportion of boys and girls not participating at lower frequencies. Sampling was more common inside than outside school for team and individual activities. This was possibly due to a much greater variety of these activities being available inside school. Lifestyle activities were more common outside school. Inside school, girls were more likely to sample lifestyle activities (30.2%) than boys (22.2%), whereas boys were slightly more likely to sample team activities than girls, with 58.6% of girls not participating at this frequency, compared to 53.0% of boys. The proportions of boys and girls sampling individual activities inside school were practically identical.

Outside school, boys were less likely than girls to sample lifestyle activities, with 59.8% not participating at this frequency, compared to 47.5% of girls. As with frequent participation (indicative of 'specialisation'), girls were much less likely to participate in team activities than boys, with only 13.9% doing so, compared to 29.1% of boys. Slightly more boys (29.8%) participated in individual activities outside school than girls (25.4%) at this frequency. Overall, the participation rates reflected the gendered nature of participation in these activities, with a persistent bias toward team activities for boys and lifestyle activities for girls.

Table C.1: Categorised activity counts for participation ≥1/month but <1/week at age 16 inside and outside school, by activity type and sex

<table>
<tr><th></th><th>Activity type</th><th>Count</th><th>Female</th><th></th><th>Male</th><th></th></tr>
<tr><td>Inside school</td><td>Lifestyle activities</td><td>none</td><td>69.8</td><td>|||||||||||||||||</td><td>77.8</td><td>|||||||||||||||||||</td></tr>
<tr><td></td><td></td><td>1+</td><td>30.2</td><td>|||||||</td><td>22.2</td><td>|||||</td></tr>
<tr><td></td><td>Team activities</td><td>none</td><td>58.6</td><td>||||||||||||||</td><td>53.0</td><td>|||||||||||||</td></tr>
<tr><td></td><td></td><td>1 or 2</td><td>25.6</td><td>||||||</td><td>30.2</td><td>|||||||</td></tr>
<tr><td></td><td></td><td>3+</td><td>15.8</td><td>|||</td><td>16.8</td><td>||||</td></tr>
<tr><td></td><td>Non-team activities</td><td>none</td><td>61.9</td><td>|||||||||||||||</td><td>62.1</td><td>|||||||||||||||</td></tr>
<tr><td></td><td></td><td>1+</td><td>38.1</td><td>|||||||||</td><td>37.9</td><td>|||||||||</td></tr>
<tr><td>Outside school</td><td>Lifestyle activities</td><td>none</td><td>47.5</td><td>|||||||||||</td><td>59.8</td><td>||||||||||||||</td></tr>
<tr><td></td><td></td><td>1</td><td>26.6</td><td>||||||</td><td>25.2</td><td>||||||</td></tr>
<tr><td></td><td></td><td>2+</td><td>26.0</td><td>||||||</td><td>15.0</td><td>|||</td></tr>
<tr><td></td><td>Team activities</td><td>none</td><td>86.1</td><td>|||||||||||||||||||||</td><td>70.9</td><td>|||||||||||||||||</td></tr>
<tr><td></td><td></td><td>1+</td><td>13.9</td><td>|||</td><td>29.1</td><td>|||||||</td></tr>
<tr><td></td><td>Individual activities</td><td>none</td><td>74.6</td><td>||||||||||||||||||</td><td>70.2</td><td>|||||||||||||||||</td></tr>
<tr><td></td><td></td><td>1+</td><td>25.4</td><td>||||||</td><td>29.8</td><td>|||||||</td></tr>
</table>

Note: for females N=2,539; for males N=1,965

In order to investigate the overall variety of activities participated in at age 16, counts of the number of different activities participated in, irrespective of frequency, were derived (Tables C.2 and C.3). The counts inside and outside school (Table C.2) demonstrated broad similarity between the sexes, and both varied greatly. Inside school, there was a large minority who experienced very few activities. Around 25% experienced between one and three activities, and 11.3% experienced none at all. A similar sized minority experienced more than eight activities (∼23%). Outside school, the mean number and variation in activities experienced was smaller. Again, a minority experienced no activities at all (∼10%). There seemed to be more variation in the number of activities boys experienced outside school compared to girls.

The count of total activities experienced (Table C.3), irrespective of whether inside or outside school, showed a high degree of similarity between the sexes. The number of cohort members who experienced none of the selected activities was near zero (<1%). The boys again seemed to vary slightly more than the girls in the number of activities experienced.

Table C.2: Counts of number of activities experienced at age 16 inside and outside school, by sex

<table>
<tr><th></th><th colspan="4">Inside school</th><th colspan="4">Outside school</th></tr>
<tr><th>Count</th><th colspan="2">Female</th><th colspan="2">Male</th><th colspan="2">Female</th><th colspan="2">Male</th></tr>
<tr><td>0</td><td>11.3</td><td>|||||||||||</td><td>11.3</td><td>|||||||||||</td><td>10.4</td><td>||||||||||</td><td>9.2</td><td>|||||||||</td></tr>
<tr><td>1</td><td>6.0</td><td>||||||</td><td>8.1</td><td>||||||||</td><td>13.0</td><td>|||||||||||||</td><td>11.9</td><td>|||||||||||</td></tr>
<tr><td>2</td><td>7.5</td><td>|||||||</td><td>8.5</td><td>||||||||</td><td>15.1</td><td>|||||||||||||||</td><td>12.6</td><td>||||||||||||</td></tr>
<tr><td>3</td><td>9.1</td><td>|||||||||</td><td>10.5</td><td>||||||||||</td><td>14.2</td><td>||||||||||||||</td><td>11.7</td><td>|||||||||||</td></tr>
<tr><td>4</td><td>9.2</td><td>|||||||||</td><td>9.2</td><td>|||||||||</td><td>13.3</td><td>|||||||||||||</td><td>12.4</td><td>||||||||||||</td></tr>
<tr><td>5</td><td>9.9</td><td>|||||||||</td><td>8.6</td><td>||||||||</td><td>10.0</td><td>||||||||||</td><td>10.5</td><td>||||||||||</td></tr>
<tr><td>6</td><td>8.8</td><td>||||||||</td><td>7.5</td><td>|||||||</td><td>7.0</td><td>|||||||</td><td>8.2</td><td>||||||||</td></tr>
<tr><td>7</td><td>7.3</td><td>|||||||</td><td>6.8</td><td>||||||</td><td>4.6</td><td>||||</td><td>6.6</td><td>||||||</td></tr>
<tr><td>8</td><td>7.6</td><td>|||||||</td><td>6.2</td><td>||||||</td><td>4.6</td><td>||||</td><td>4.1</td><td>||||</td></tr>
<tr><td>9</td><td>5.1</td><td>|||||</td><td>5.8</td><td>|||||</td><td>2.4</td><td>||</td><td>4.0</td><td>||||</td></tr>
<tr><td>10</td><td>4.4</td><td>||||</td><td>4.5</td><td>||||</td><td>2.1</td><td>||</td><td>2.4</td><td>||</td></tr>
<tr><td>11</td><td>3.7</td><td>|||</td><td>3.5</td><td>|||</td><td>0.9</td><td></td><td>1.7</td><td>|</td></tr>
<tr><td>12</td><td>2.9</td><td>||</td><td>2.9</td><td>||</td><td>0.5</td><td></td><td>1.2</td><td>|</td></tr>
<tr><td>13</td><td>2.4</td><td>||</td><td>1.7</td><td>|</td><td>0.5</td><td></td><td>0.9</td><td></td></tr>
<tr><td>14</td><td>1.7</td><td>|</td><td>1.2</td><td>|</td><td>0.4</td><td></td><td>0.8</td><td></td></tr>
<tr><td>15</td><td>1.2</td><td>|</td><td>1.4</td><td>|</td><td>0.2</td><td></td><td>0.6</td><td></td></tr>
<tr><td>16 to 34</td><td>1.8</td><td>|</td><td>2.4</td><td>||</td><td>1.0</td><td>|</td><td>1.4</td><td>|</td></tr>
</table>

Note: for females N=2,539; for males N=1,965

The contrast between Table C.2 and Table C.3 was particularly striking. A large proportion of cohort members participated in very few (0 to 3) activities inside or outside school, but Table C.3 showed that almost all cohort members were participating in three or more activities overall (∼90%), with almost none (∼1%) participating in no activities at all. Therefore, the cohort members who were not participating inside school must have been active outside school, and vice versa. This finding is suggestive of the 'activitystat' hypothesis (Gomersall et al., 2013), which states that activity levels for an individual tend to remain static over time regardless of environmental intervention. Thus, if a cohort member was more active inside school, this would suppress activity outside school. However, there has been a great deal of debate about this hypothesis in the literature, with evidence both supporting (Wilkin et al., 2006; Wilkin, 2011) and refuting it (Baggett, 2008; Reilly, 2011; Frémeaux et al., 2011). It seems plausible that there are genetic influences on general level of activity, but that these are modifiable to some extent.

Table C.3: Counts of number of activities experienced in total at age 16, by sex

<table>
<tr><th>Count</th><th>Female</th><th></th><th>Male</th><th></th></tr>
<tr><td>0</td><td>0.5</td><td></td><td>1.0</td><td>|</td></tr>
<tr><td>1</td><td>2.8</td><td>||</td><td>4.0</td><td>||||</td></tr>
<tr><td>2</td><td>5.3</td><td>|||||</td><td>6.6</td><td>||||||</td></tr>
<tr><td>3</td><td>6.7</td><td>||||||</td><td>7.5</td><td>|||||||</td></tr>
<tr><td>4</td><td>7.5</td><td>|||||||</td><td>8.1</td><td>||||||||</td></tr>
<tr><td>5</td><td>8.6</td><td>||||||||</td><td>8.5</td><td>||||||||</td></tr>
<tr><td>6</td><td>8.2</td><td>||||||||</td><td>8.3</td><td>||||||||</td></tr>
<tr><td>7</td><td>8.3</td><td>||||||||</td><td>8.4</td><td>||||||||</td></tr>
<tr><td>8</td><td>7.9</td><td>|||||||</td><td>6.4</td><td>||||||</td></tr>
<tr><td>9</td><td>7.9</td><td>|||||||</td><td>7.2</td><td>|||||||</td></tr>
<tr><td>10</td><td>6.4</td><td>||||||</td><td>5.4</td><td>|||||</td></tr>
<tr><td>11</td><td>6.2</td><td>||||||</td><td>5.8</td><td>|||||</td></tr>
<tr><td>12</td><td>5.8</td><td>|||||</td><td>5.2</td><td>|||||</td></tr>
<tr><td>13</td><td>4.5</td><td>||||</td><td>4.0</td><td>||||</td></tr>
<tr><td>14</td><td>3.9</td><td>|||</td><td>3.5</td><td>|||</td></tr>
<tr><td>15</td><td>2.6</td><td>||</td><td>3.0</td><td>|||</td></tr>
<tr><td>16</td><td>2.1</td><td>||</td><td>1.7</td><td>|</td></tr>
<tr><td>17</td><td>1.5</td><td>|</td><td>1.6</td><td>|</td></tr>
<tr><td>18 to 34</td><td>3.4</td><td>|||</td><td>4.0</td><td>||||</td></tr>
</table>

Note: for females N=2,539; for males N=1,965

Using both the derived variables shown in Table C.1 and the equivalent variables based on more frequent participation (≥1/week, p.150), a pairwise polychoric correlation matrix (shown in Table C.4) was estimated in order to identify:

- whether frequent participation (≥1/week, suggestive of specialisation or investment) was independent of infrequent participation (≥1/month, suggestive of sampling or recreational participation);
- whether participation in the different types of activity either inside or outside school were associated with one another, suggesting that cohort members who were active in a particular location tended to participate largely irrespective of activity type;
- whether participation in a particular type of activity inside school was associated with participation in that type of activity outside school, suggesting

preference for participation in a particular type of activity; and

- whether the associations were different across the sexes, providing evidence for gender disparities at age 16.

The correlations between frequent (≥1/week) and infrequent (≥1/month) participation were generally near zero, supporting the notion that they are largely independent behaviours. The only notable correlations between these behaviours for girls were for participation in team activities inside school (-0.26), suggesting that those who participated in more of these activities frequently were slightly less likely to participate in them infrequently inside school and vice versa. Also, girls' infrequent participation in team activities outside school was correlated with frequent participation in all activity types outside school (0.15 to 0.26), suggesting that those girls who were more active outside school were also slightly more likely to participate in more team activities infrequently outside school. For boys, infrequent participation in individual activities outside school correlated slightly with frequent participation in all activity types outside school (0.20 to 0.23). These correlations may have been picking up the tendency of cohort members with high sporting ability to specialise inside school and have a wider sporting repertoire outside of school, in team activities for girls and individual activities for boys, but the associations were moderate or small.

The highest correlations amongst variables related to whether participation was inside or outside school, within frequency. For girls, the correlations for frequent participation inside school varied between 0.36 and 0.49. For boys, these correlations varied between 0.42 and 0.55. Outside school, the correlations for frequent participation for girls varied between 0.24 and 0.39. For boys, these correlations varied between 0.32 and 0.40. For infrequent participation, the correlations for girls inside school were 0.52 to 0.68 and outside school were 0.31 to 0.40. For boys, these correlations inside school were 0.52 to 0.64 and outside school were 0.31 to 0.51. For both frequent and infrequent participation, these estimates strongly suggested that those cohort members who were more active inside school at that frequency tended to be more active across all activity types, and the same was true for participation outside school.

The correlations between participation inside and outside school within activity types were also moderate to high. For girls, the within-activity correlations for frequent participation varied from 0.24 to 0.32. For boys, these correlations varied between 0.39 and 0.43. The within-activity correlations for infrequent participa-

Table C.4: Polychoric correlation matrix of categorised activity counts at age 16 by frequency of participation, inside/outside school, activity type and sex – correlations for females are shown in the upper right triangle, males in the lower left

		Weekly activity						Monthly activity					
		Inside school			Outside school			Inside school			Outside school		
		Ls.	Tm.	Ind.	Ls.	Tm.	Ind.	Ls.	Tm.	Ind.	Ls.	Tm.	Ind.
Weekly	Ls.		0.36	0.49	0.24	0.17	0.15	0.05	-0.02	0.00	-0.04	0.06	0.04
inside	Tm.	0.42		0.58	0.12	0.30	0.18	0.05	-0.26	0.03	-0.05	0.06	0.02
school	Ind.	0.48	0.55		0.11	0.22	0.32	0.03	-0.07	-0.09	-0.05	0.06	0.05
Weekly	Ls.	0.43	0.17	0.23		0.24	0.36	-0.01	0.04	-0.01	0.01	0.15	0.10
outside	Tm.	0.19	0.39	0.18	0.32		0.39	-0.02	-0.05	-0.02	0.02	0.26	0.08
school	Ind.	0.27	0.26	0.43	0.42	0.40		0.09	0.03	0.02	0.05	0.22	0.08
Monthly	Ls.	0.13	0.10	0.08	0.05	0.03	0.07		0.52	0.68	0.27	0.20	0.19
inside	Tm.	0.07	-0.08	-0.01	0.08	0.04	0.10	0.52		0.64	0.28	0.31	0.24
school	Ind.	0.06	0.11	-0.02	0.07	0.09	0.08	0.66	0.64		0.26	0.21	0.31
Monthly	Ls.	0.04	0.07	0.02	0.10	0.06	0.07	0.43	0.26	0.34		0.31	0.40
outside	Tm.	0.03	0.01	-0.01	0.09	-0.03	0.12	0.25	0.35	0.30	0.31		0.40
school	Ind.	0.07	0.11	0.11	0.20	0.23	0.21	0.30	0.27	0.45	0.51	0.35	

Note: abbreviations used are Ls.(Lifestyle activities), Tm.(Team activities), and Ind.(Individual activities) tion varied between 0.27 and 0.31 for girls, and 0.35 and 0.45 for boys. These estimates suggested that cohort members may also be exercising preferences for particular types of activity – i.e. participation inside school in a particular activity type was associated with participation in the same activity type outside school. However, these associations could also have resulted from the general level of participation if those cohort members who were active inside school were also active outside school.

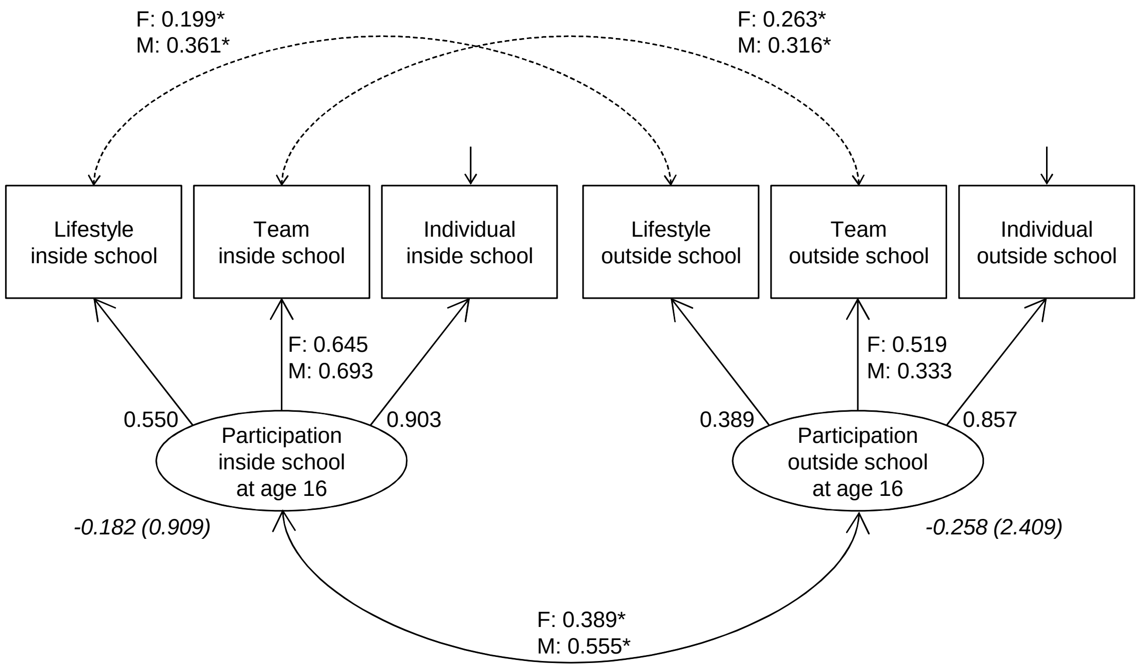
The difference in correlations between the sexes were generally small, with 51 of the 66 differences being below 0.1 and only five being above 0.15. The biggest difference was between frequent and infrequent participation in team activities outside school, which was near zero for boys (-0.03) and moderate for girls (0.26). As previously suggested, this could have been due to female cohort members who strongly identified with sport at school. The minority of girls (p.145) who pursued team sports outside school may have been more likely to be in club teams as well as playing other team sports occasionally.

For boys, playing team sports (particularly football and cricket) outside school was common (p.146) and so perhaps less dependent on sports ability. The second biggest difference between the sexes involved the correlation between frequent participation inside and outside school in lifestyle activities, which was higher for boys (0.43) than girls (0.24). As with team activities for boys, this may have been due to lifestyle activities being a popular choice amongst girls outside school even if they did not participate in those activities within the school environment, e.g. if they were not particularly able.

C.2 Constructing latent trait measures of participation

In order to draw out these two processes from the activity data, two latent trait models of participation were specified in order to isolate the variance attributable to each process. Only the variables derived from the frequent participation data ($\geq$1/week) were used as indicators of the latent traits. This is because cohort members would participate frequently in more activities if they were (a) more active, and/or (b) preferred a particular activity type. Conversely, infrequent participation ($\geq$1/month) represented a sampling mode that could occur irrespective

Figure C.1: Path diagram showing initial measurement model of participation inside and outside school at age 16 (solid paths) and final model with added residual correlations (dashed paths) and estimates from multigroup testing for males (M) and females (F)



Note: estimates in italics are latent means and (variances) for males, these are constrained to 0 and 1 for females, respectively; estimates marked with an asterisk are standardised/correlations; $\chi^2(15)$=63.997 (p=0.0000), RMSEA 0.038 (90% CI: 0.029 to 0.048), CFI 0.989, TLI 0.978

of how active the cohort member was and would be unlikely to demonstrate strong preferences. The initial specification for the first of these models (along with the results of the final model) is shown in Figure C.1.

For girls, the fit of the model for participation inside/outside school to the data was reasonable, with a $\chi^2(8)$=77.542 (p=0.0000), an RMSEA of 0.059 (90% CI: 0.047 to 0.071), a CFI of 0.969 and a TLI of 0.942. In order to improve the fit, modification indices were inspected and residual errors were allowed to correlate where these terms made substantive sense. In this case, residuals were allowed to correlates in order to account for personal preference for activity type. Addition of a residual correlation between lifestyle activity inside and outside school resulted in a significant improvement to model fit ($\chi^2(1)$=32.876, p= 0.0000), resulting in a model with a $\chi^2(7)$=43.533 (p=0.0000), an RMSEA of 0.045 (90% CI: 0.033 to 0.059), a CFI of 0.984 and a TLI of 0.965. A further residual correlation was then added between team activity inside and outside school, which also improved model fit significantly ($\chi^2(1)$=29.703, p=0.0000) and resulted in a model that fit the data extremely well, with a $\chi^2(6)$=15.873 (p=0.0144), an RMSEA of 0.025

(90% CI: 0.010 to 0.041), a CFI of 0.996 and a TLI of 0.989.

The model was re-estimated separately for boys. The fit of the model to the data was initially quite poor, with a $\chi^2(8)=182.632$ (p=0.0000), an RMSEA of 0.105 (90% CI: 0.092 to 0.119), a CFI of 0.923 and a TLI of 0.855. Modification indices suggested that the addition of a residual correlation between lifestyle activity inside and outside school, to account for activity preference would improve model fit considerably, and so it was added ($\chi^2(1)=89.644$, p=0.0000), resulting in a model with a $\chi^2(7)=82.858$ (p=0.0000), an RMSEA of 0.074 (90% CI: 0.060 to 0.089), a CFI of 0.966 and a TLI of 0.928. As with the model for girls, a further residual correlation was then added between team activity inside and outside school, which also improved model fit significantly ($\chi^2(1)=55.082$, p=0.0000) and resulted in a model that fit the data well, with a $\chi^2(6)=21.099$ (p=0.0018), an RMSEA of 0.036 (90% CI: 0.020 to 0.053), a CFI of 0.993 and a TLI of 0.983.

Testing for measurement equivalence between sexes was undertaken to determine whether the functioning of items was invariant for both boys and girls, i.e. that the factors were being measured in the same way and so could be interpreted in the same way. According to Cheung (2002) a difference in CFI of <0.01 can be used as an indicator of measurement invariance in “large samples”, where the χ^2 statistic may be too sensitive. The sample sizes for the models varied between N$\sim$2,500 for females and N$\sim$2,000 for males, which can safely be considered ‘large’ and thus vulnerable to the sensitivity inherent in the χ^2 test of model fit.

Strict measurement equivalence was not supported as the difference between the unrestricted model and the restricted model (where factor covariances, loadings and thresholds were constrained to be equal across groups) was highly significant ($\chi^2(6)=272.790$, p=0.0000) and the CFI of 0.928 was much lower than for the unconstrained model (CFI of 0.995). Modification indices suggested that the way in which team activity related to participation outside school varied by sex. Considering that only a minority of girls participated in team activities outside school, whereas a high proportion of boys participated in football and cricket outside school, this is not particularly surprising. These parameters were allowed to vary between sexes, significantly improving fit ($\chi^2(1)=163.694$, p=0.0000) and resulting in a model with a $\chi^2(17)=137.615$ (p=0.0000), an RMSEA of 0.056 (90% CI: 0.048 to 0.065), a CFI of 0.973 and a TLI of 0.953.

The CFI still did not indicate that this model was invariant across sexes and so a further modification was made. The modification indices suggested that the way in which team activity related to participation inside school also varied by sex. These parameters were also allowed to vary between sexes, significantly improving fit (χ^2(2)=69.856, p=0.0000) and resulting in a model with a χ^2(15)=63.997 (p=0.0000), an RMSEA of 0.038 (90% CI: 0.029 to 0.048), a CFI of 0.989 and a TLI of 0.978. With these variations between sexes, the difference in CFI (0.006) demonstrated *partial* measurement equivalence had been achieved (Byrne et al., 1989). Although the variables measuring participation in team activities were functioning differentially between sexes, the factors still represented reliable and useful measures of participation inside and outside school, and the measurement equivalence can be described as reasonably strong overall (Table C.5 contains detailed estimates from this multigroup model).

Models were also fitted according to the second specification, which focused on participation in particular types of activity (as shown in Figure C.2). For girls, the fit of the model to the data was poor, with a χ^2(6)=282.155 (p=0.0000), an RMSEA of 0.135 (90% CI: 0.121 to 0.148), a CFI of 0.878 and a TLI of 0.694. In order to improve the fit, correlated errors were allowed in order to account for the general level of activity inside or outside school, irrespective of activity preference. Addition of a residual correlation between lifestyle and individual activity outside school resulted in a significant improvement to model fit (χ^2(1)=120.437, p=0.0000), resulting in a model with a χ^2(5)=146.003 (p=0.0000), an RMSEA of 0.105 (90% CI: 0.091 to 0.120), a CFI of 0.938 and a TLI of 0.813. A further residual correlation was then added between team and individual activity outside school, which also improved model fit significantly (χ^2(1)=75.016, p=0.0000), resulting in a model with a χ^2(4)=59.869 (p=0.0000), an RMSEA of 0.074 (90% CI: 0.058 to 0.091), a CFI of 0.975 and a TLI of 0.907. A final residual correlation was then added between lifestyle and team activity outside school, also significantly improving fit (χ^2(1)=44.186, p=0.0000). The resulting model fit the data extremely well, with a χ^2(3)=3.335 (p=0.3427), an RMSEA of 0.007 (90% CI: 0.000 to 0.035), a CFI of 1.000 and a TLI of 0.999.

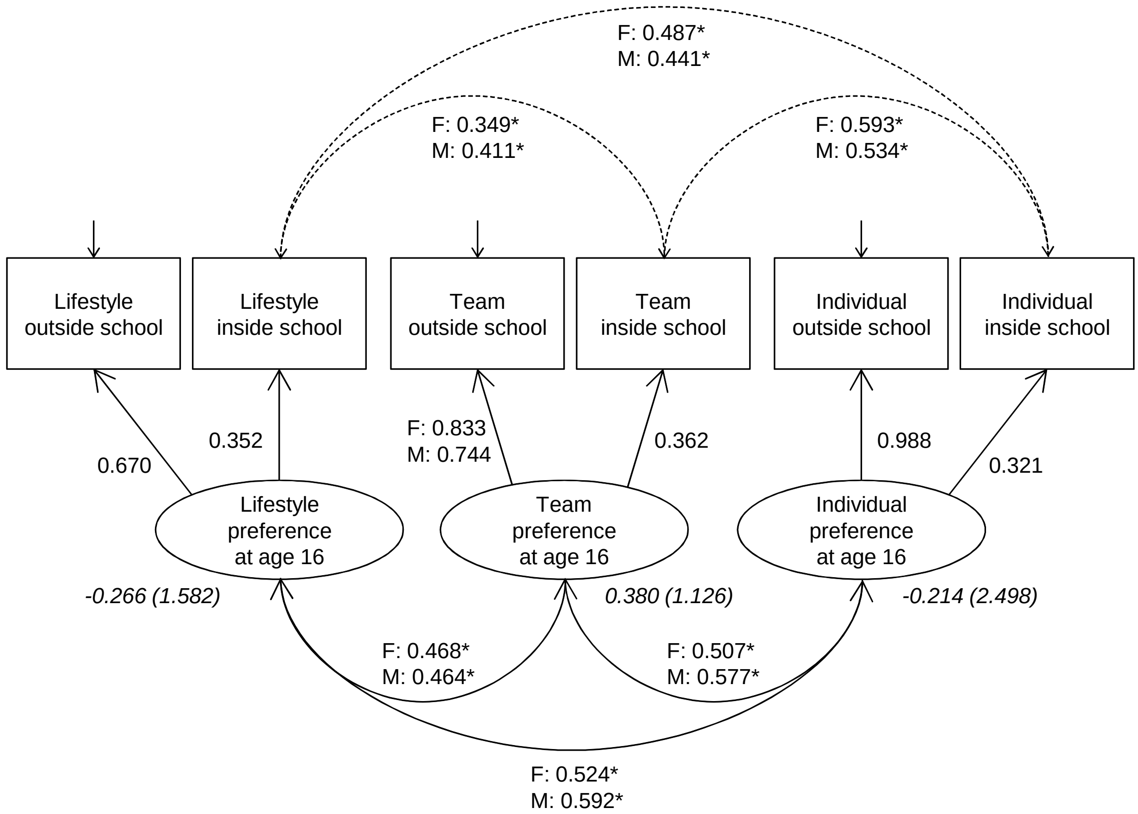
The model was re-estimated separately for boys. The fit of the model to the data was initially quite poor, with a χ^2(6)=241.847 (p=0.0000), an RMSEA of 0.141 (90% CI: 0.126 to 0.157), a CFI of 0.896 and a TLI of 0.739. As with the model for girls, modification indices suggested that the addition of a residual correlation between lifestyle and individual activity outside school would improve model fit considerably, and so it was added (χ^2(1)=66.688, p=0.0000), resulting in a model with a χ^2(5)=172.701 (p=0.0000), an RMSEA of 0.131 (90% CI: 0.114 to

Table C.5: Estimates from the final model used to test for measurement equivalence between the sexes of latent measures of participation inside and outside school at age 16

Description	Factors/indicators	Estimate	S.E.	P-Value
Invariant				
Factor loadings	Part. in sch. → Ls. in sch.	0.550	0.021	0.000
	Part. in sch. → Ind. in sch.	0.903	0.023	0.000
	Part. out sch. → Ls. out sch.	0.389	0.027	0.000
	Part. out sch. → Ind. out sch.	0.857	0.047	0.000
Variant				
Factor loadings (M)	Part. in sch. → Tm. in sch.	0.693	0.046	0.000
	Part. out sch. → Tm. out sch.	0.333	0.037	0.000
Factor loadings (F)	Part. in sch. → Tm. in sch.	0.645	0.023	0.000
	Part. out sch. → Tm. out sch.	0.519	0.041	0.000
Residual correl. (M)	Ls. in sch. ↔ Ls. out sch.	0.361	0.035	0.000
	Tm. in sch. ↔ Tm. out sch.	0.316	0.040	0.000
Residual correl. (F)	Ls. in sch. ↔ Ls. out sch.	0.199	0.029	0.000
	Tm. in sch. ↔ Tm. out sch.	0.263	0.044	0.000
Latent				
Factor means (M)	Part. in sch.	-0.182	0.042	0.000
	Part. out sch.	-0.258	0.087	0.003
Factor variances (M)	Part. in sch.	0.909	0.094	0.000
	Part. out sch.	2.409	0.418	0.000
Factor correlation (M)	Part. in sch. ↔ Part. out sch.	0.555	0.034	0.000
Factor correlation (F)	Part. in sch. ↔ Part. out sch.	0.389	0.034	0.000

Note: females (F), males (M); variable/factor names are abbreviated – Ls.-Lifestyle, Tm.-Team, Ind.-Individual, Part.-Participation, in sch.-inside school, out sch.-outside school; $\chi^2(15)=63.997$ (p=0.0000), RMSEA=0.038 (90% CI: 0.029 to 0.048), CFI=0.989, TLI=0.978; for females, the factor means and variances were fixed to 0 and 1, respectively, for identification purposes

Figure C.2: Path diagram showing initial measurement model of participation in different types of activity at age 16 (solid paths) and final model with added residual correlations (dashed paths) and estimates from multigroup testing for males (M) and females (F)



Note: estimates in italics are latent means and (variances) for males, these are constrained to 0 and 1 for females, respectively; estimates marked with an asterisk are standardised/correlations; $\chi^2(9)$=31.736 (p=0.0002), RMSEA 0.033 (90% CI: 0.021 to 0.047), CFI 0.995, TLI 0.983

0.148), a CFI of 0.926 and a TLI of 0.778. A further residual correlation was then added between team and individual activity outside school, which also improved model fit significantly ($\chi^2(1)$=67.814, p=0.0000) and resulted in a model with a $\chi^2(4)$=99.666 (p=0.0000), an RMSEA of 0.0110 (90% CI: 0.092 to 0.130), a CFI of 0.958 and a TLI of 0.841. A final residual correlation was then added between lifestyle and team activity outside school, also significantly improving fit ($\chi^2(1)$=72.778, p=0.0000). The resulting model fit the data extremely well, with a $\chi^2(3)$=4.491 (p=0.2131), an RMSEA of 0.016 (90% CI: 0.000 to 0.044), a CFI of 0.999 and a TLI of 0.997.

At this point, it was decided to re-estimate these models with an alternative specification, replacing the residual correlations outside school with equivalent terms for the variables related to activity inside school. The rationale for this specification was that participating in a particular activity type outside school was more likely to reflect natural behaviour than inside school – within school, participation is more likely to be compulsory or influenced by social pressure to conform via peers or the school culture. For both girls and boys, the re-estimated models fit the data well. For girls, the specification resulted in a model with a $\chi^2(3)=10.072$ ($p=0.0180$), an RMSEA of 0.030 (90% CI: 0.011 to 0.052), a CFI of 0.997 and a TLI of 0.984. For boys, the specification resulted in a model with a $\chi^2(3)=2.832$ ($p=0.4182$), an RMSEA of 0.000 (90% CI: 0.000 to 0.037), a CFI of 1.000 and a TLI of 1.000.

Again, testing for measurement equivalence between sexes was undertaken to determine whether the loading of the categorised counts of frequent activity onto the latent variables were invariant. The model specification with correlated residuals for the indicators inside school was tested. As with the model for participation inside/outside school, strict measurement equivalence was not supported. Although, the difference between the unrestricted model and the restricted model was significant according to the chi-square statistic ($\chi^2(4)=39.130$, $p=0.0000$), the difference in CFI was small (0.998 compared to 0.990), suggesting sufficient equivalence according to Cheung (2002).

The main issue with the restricted model was that the solution contained a loading onto team activity outside school that resulted in a negative residual variance for this indicator. As with the model for participation inside/outside school, this was due to the striking difference in participation in team activities outside school between the sexes. The parameters related to team activity outside school were allowed to vary between sexes, resulting in a small improvement to the fit ($\chi^2(1)=20.022$, $p=0.0000$) and a proper solution with no negative residual variance. This model fit the data well, with a $\chi^2(9)=31.736$ ($p=0.0002$), an RMSEA of 0.033 (90% CI: 0.021 to 0.047), a CFI of 0.995 and a TLI of 0.983. As in the previous case, the model demonstrated partial measurement equivalence due to the differential functioning of team activity outside school (Table C.6 contains detailed estimates from this multigroup model).

C.3 Constructing latent trait measures of intrinsic motivation and physical self-concept

The indicators of intrinsic motivation and physical self-concept were used to estimate latent trait measurement models of the various specified sub-domains, sep-

Table C.6: Estimates from the final model used to test for measurement equivalence between the sexes of latent measures of participation in particular activities at age 16

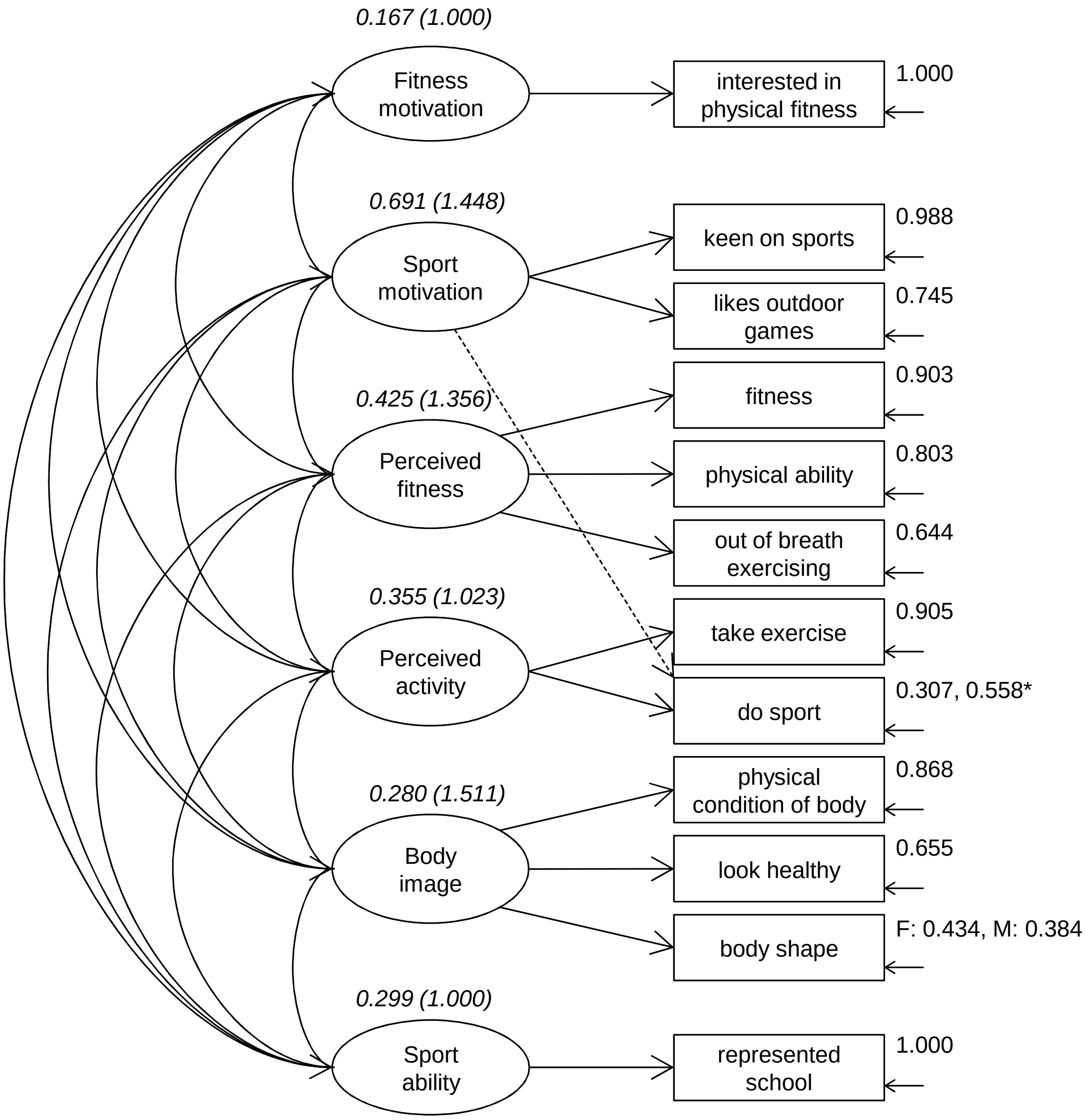
Description	Factors/indicators	Estimate	S.E.	P-Value
Invariant				
Factor loadings	Lifestyle → Ls. in sch.	0.352	0.027	0.000
	Lifestyle → Ls. out sch.	0.670	0.044	0.000
	Team → Tm. in sch.	0.362	0.035	0.000
	Individual → Ind. in sch.	0.321	0.029	0.000
	Individual → Ind. out sch.	0.988	0.072	0.000
Variant				
Factor loadings (M)	Team → Tm. out sch.	0.744	0.114	0.000
Factor loadings (F)	Team → Tm. out sch.	0.833	0.072	0.000
Residual correlations (M)	Ls. in sch. ⟷ Tm. in sch.	0.199	0.023	0.000
	Ls. in sch. ⟷ Ind. in sch.	0.274	0.032	0.000
	Tm. in sch. ⟷ Ind. in sch.	0.309	0.030	0.000
Residual correlations (F)	Ls. in sch. ⟷ Tm. in sch.	0.349	0.027	0.000
	Ls. in sch. ⟷ Ind. in sch.	0.487	0.023	0.000
	Tm. in sch. ⟷ Ind. in sch.	0.593	0.020	0.000
Latent				
Factor means (M)	Lifestyle	-0.266	0.053	0.000
	Team	0.380	0.089	0.000
	Individual	-0.214	0.106	0.043
Factor variances (M)	Lifestyle	1.582	0.226	0.000
	Team	1.126	0.287	0.000
	Individual	2.498	0.547	0.000
Factor correlations (M)	Lifestyle ⟷ Team	0.464	0.043	0.000
	Lifestyle ⟷ Individual	0.592	0.042	0.000
	Team ⟷ Individual	0.577	0.045	0.000
Factor correlations (F)	Lifestyle ⟷ Team	0.468	0.058	0.000
	Lifestyle ⟷ Individual	0.524	0.053	0.000
	Team ⟷ Individual	0.507	0.053	0.000

Note: females (F), males (M); variable names are abbreviated – Ls.-Lifestyle, Tm.-Team, Ind.-Individual, in sch.-inside school, out sch.-outside school; $\chi^2(9)=31.736$ (p=0.0002), RMSEA=0.033 (90% CI: 0.021 to 0.047), CFI=0.995, TLI=0.983; for females, the factor means and variances were fixed to 0 and 1, respectively, for identification purposes arately by sex. The initial and final model specifications are shown diagrammatically in Figure C.3. For girls, the initial model did not fit the data particularly well, with a $\chi^2(41)=$ 738.088 (p=0.0000), an RMSEA of 0.072 (90% CI: 0.067 to 0.076), a CFI of 0.978 and a TLI of 0.965. Modification indices suggested that this was largely due to the 'Sport motivation' factor not being allowed to load onto the measure of self-perceived frequency of doing sport ('do sport'), which had previously been found to be strongly associated with the indicator 'keen on sports' (p.165).

Due to the substantive applicability of this measure to that factor, this loading was added to the model. Fit improved considerably ($\chi^2(1)$=270.142, p=0.0000), resulting in model that fit the data well, with a $\chi^2(40)$=236.209 (p=0.0000), an RMSEA of 0.038 (90% CI: 0.034 to 0.043), a CFI of 0.994 and a TLI of 0.990. For boys, the initial model also did not fit the data particularly well, with a $\chi^2(41)$=709.951 (p=0.0000), an RMSEA of 0.080 (90% CI: 0.075 to 0.085), a CFI of 0.978 and a TLI of 0.964. As with the girls, the modification indices suggested adding a loading of the 'Sport motivation' factor onto the indicator 'do sport'. Fit improved considerably ($\chi^2(1)$=267.157, p=0.0000), resulting in a model that fit the data well, with a $\chi^2(40)$=196.285 (p=0.0000), an RMSEA of 0.039 (90% CI: 0.034 to 0.045), a CFI of 0.995 and a TLI of 0.991.

Testing for measurement invariance between sexes was also undertaken. Strict measurement equivalence was not supported as the difference between the unrestricted model and the restricted model was highly significant ($\chi^2(29)$=401.958, p=0.0000), although the difference in CFI was not that great (0.987 compared to 0.994). Modification indices suggested that the lack of equivalence was predominantly due to differential functioning of the measure of self-perceived body shape. This is not particularly surprising, as previous analyses (p.161) had found that girls' self-perceptions of body shape were negatively biased, a finding that is commonly supported in the academic literature (Croll, 2005). Invariance for this measure was relaxed across groups, significantly improving model fit ($\chi^2(4)$=185.940, p=0.0000) and resulting in a model with a $\chi^2(105)$=544.389 (p=0.0000), an RMSEA of 0.038 (90% CI: 0.035 to 0.041), a CFI of 0.993 and a TLI of 0.991. Detailed estimates from this model are shown in Table C.7.

Figure C.3: Path diagram showing initial measurement model of intrinsic motivation and physical self-concept at age 16 (solid paths) and final model with additional (dashed) path and estimates from multigroup testing for females (F) and males (M)



Note: estimates in italics are latent means and (variances) for males, these are constrained to 0 and 1 for females, respectively; estimates to the right of indicators are the loadings of the latent variables onto that indicator; the estimate marked with an asterisk relates to the loading of 'Sport motivation' onto 'do sport'; the latent correlations are not included in the diagram, but are presented and discussed in section 6.6

Table C.7: Estimates from the final model used to test for measurement equivalence between the sexes of latent measures of intrinsic motivation and physical self-concept at age 16

Description	Factors/indicators	Estimate	S.E.	P-Value
Invariant				
Factor loadings	Fit. mot. → interest in fitness	1.000		
	Sprt mot. → keen on sports	0.988	0.011	0.000
	Sprt mot. → likes games	0.745	0.015	0.000
	Sprt mot. → do sport	0.558	0.019	0.000
	Perc. fit. → fitness	0.903	0.005	0.000
	Perc. fit. → physical ability	0.803	0.007	0.000
	Perc. fit. → out of breath	0.644	0.010	0.000
	Perc. act. → take exerercise	0.905	0.020	0.000
	Perc. act. → do sport	0.307	0.018	0.000
	Body img. → physical condition	0.868	0.010	0.000
	Body img. → look healthy	0.655	0.011	0.000
	Sprt abil. → represented school	1.000		
Variant				
Factor loadings (F)	Body image → body shape	0.434	0.017	0.000
Factor loadings (M)	Body image → body shape	0.384	0.018	0.000
Latent				
Factor means	Fitness motivation	0.167	0.032	0.000
(M)	Sport motivation	0.691	0.041	0.000
	Perceived fitness	0.425	0.036	0.000
	Perceived activity	0.355	0.036	0.000
	Body image	0.280	0.039	0.000
	Sport ability	0.299	0.039	0.000
Factor variances	Fitness motivation	1.000		
(M)	Sport motivation	1.460	0.107	0.000
	Perceived fitness	1.374	0.073	0.000
	Perceived activity	1.014	0.084	0.000
	Body image	1.510	0.093	0.000
	Sport ability	1.000		

Note: females (F), males (M); some variable names are abbreviated; model fit indices $\chi^2(105)=544.389$ (p=0.0000), RMSEA=0.038 (90% CI: 0.035 to 0.041), CFI=0.993, TLI=0.991; for females, the factor means and variances were fixed to 0 and 1, respectively, for identification purposes; the loadings, scale parameters and factor variances of 'Fitness motivation' and 'Sport ability' were fixed to 1 for identification purposes; factor correlations are presented separately in section 6.6

Appendix D

Preliminary longitudinal analysis at age 16

In this preliminary analysis, the variables measuring experiences of sport and exercise at age 16 were regressed on the measures available at age 10, in order to identify whether experiences in primary school were associated with those in secondary school. Out of the variables measuring participation outside school at age 10 (answered by the mother), only the measure of playing sports was included as it was sufficiently general to encompass the majority of sport and exercise behaviour (participation in the other, more specific, activities – riding a bike and swimming – were excluded). The binary version, indicating whether the cohort member participated in sports 'often' or not outside school at age 10, was used. Likewise, the binary version of the variable measuring enjoyment of games at age 10 was also used, which indicated whether the cohort member liked team games (the 'no' and 'don't know' answers were merged into a single category). The age 10 variables were included in the model simultaneously. The specification of model used is known in the literature as a Multiple Indicators Multiple Causes (MIMIC) model (Xue, 2007).

Tables D.1 and D.2 shows the resulting estimates for girls. There were no statistically significant associations of the hours of PE at age 10 with experiences of exercise at age 16. This provides additional support to the findings of the previous analysis at age 10 (p.111), which found that the hours of formal school provision were not generally associated with experiences of exercise in primary school. Enjoyment of games at age 10 was associated with only two outcomes at age 16 for girls: fitness motivation (0.180) and sport motivation (0.406). Thus, it seemed that girls who enjoyed games in primary school were more likely to enjoy sport in secondary school, but that this early enjoyment did not translate to more participation or better physical self-concept at age 16.

In contrast, the measures of perceived ability at age 10 were consistently associated with experiences of exercise at age 16. Perceived ability in gymnastics at age 10 seemed to be more important than perceived ability in games for fitness motivation (0.220 vs 0.178), perceived fitness (0.332 vs 0.205), perceived activity (0.264 vs 0.096) and body image (0.212 vs 0.194) at age 16. Perceived ability in games at age 10 seemed to be more important for sport motivation (0.346 vs 0.288), participation inside school (0.249 vs 0.153) and sport ability (0.396 vs 0.221) at age 16. Perceived ability in games at age 10 (0.336) was associated with participation outside school at age 16, but perceived ability in gymnastics at age 10 was not.

As with the correlation matrix of factors at age 16 (p.171), these estimates suggest a separation of sport and fitness focused experiences: girls who had high perceived ability in games at age 10 had better outcomes at age 16 in measures related to competitive sport, and those who had high perceived ability in gymnastics had better outcomes in measures related to fitness exercise. The strength and consistency of these estimates is worrying. Perceived ability in sport does not work in the same way as intrinsic motivation. Whereas, enjoyment and interest are self-referential – i.e. not directly dependent on other people's enjoyment and interest – perceived ability tends to be relative to an external standard or the ability of peers. Thus, a child may be competent in the sense that they are perfectly able to take part in a sport or activity, but they may have poor perceptions of ability because they are less able than their competitors.

These effects suggest that, even at a very young age, some cohort members may have been developing poor self-perceptions. These perceptions had long-lasting impacts, affecting their motivation, self-concept and participation at age 16. It was particularly striking that the only significant associations of age 10 experiences with participation inside and outside school at age 16 were for perceived ability. The previous analysis at age 10 (p.117) had provided strong support for the theory that perceived ability mediates the relationship between participation and enjoyment. This analysis adds to that evidence by identifying perceived ability as a crucial correlate of ongoing participation and positive psychological outcomes.

Table D.1: Estimates for females of the effect of experiences at age 10 on intrinsic motivation and physical self-concept at age 16

Females Age 16 outcome	Age 10 predictor	Estimate	S.E.	P-Value	
Fitness motivation	← enjoyment of games	0.180	0.086	0.036	*
	← perceived ability in games	0.178	0.069	0.010	*
	← perceived ability in gym.	0.220	0.050	0.000	***
	← plays sports outside school	0.184	0.050	0.000	***
	← hours of PE	-0.029	0.035	0.411	
Sport motivation	← enjoyment of games	0.406	0.086	0.000	***
	← perceived ability in games	0.346	0.071	0.000	***
	← perceived ability in gym.	0.288	0.051	0.000	***
	← plays sports outside school	0.448	0.051	0.000	***
	← hours of PE	0.018	0.035	0.617	
Perceived fitness	← enjoyment of games	0.131	0.085	0.126	
	← perceived ability in games	0.205	0.070	0.003	**
	← perceived ability in gym.	0.332	0.051	0.000	***
	← plays sports outside school	0.174	0.051	0.001	***
	← hours of PE	0.031	0.035	0.377	
Perceived activity	← enjoyment of games	0.072	0.093	0.439	
	← perceived ability in games	0.096	0.076	0.205	
	← perceived ability in gym.	0.264	0.055	0.000	***
	← plays sports outside school	0.155	0.054	0.004	**
	← hours of PE	-0.003	0.038	0.930	
Body image	← enjoyment of games	0.057	0.093	0.539	
	← perceived ability in games	0.194	0.077	0.011	*
	← perceived ability in gym.	0.212	0.054	0.000	***
	← plays sports outside school	0.167	0.054	0.002	**
	← hours of PE	0.053	0.037	0.153	
Sport ability	← enjoyment of games	0.081	0.124	0.517	
	← perceived ability in games	0.396	0.103	0.000	***
	← perceived ability in gym.	0.221	0.065	0.001	**
	← plays sports outside school	0.366	0.065	0.000	***
	← hours of PE	-0.006	0.048	0.902	

Note: N=2,472; the factor means and variances were fixed to 0 and 1, respectively, for identification purposes

Table D.2: Estimates for females of the effect of experiences at age 10 on participation at age 16

Females Age 16 outcome	Age 10 predictor	Estimate	S.E.	P-Value	
Participation inside school	← enjoyment of games	0.136	0.099	0.173	
	← perceived ability in games	0.249	0.081	0.002	**
	← perceived ability in gym.	0.153	0.059	0.010	**
	← plays sports outside school	0.009	0.059	0.878	
	← hours of PE	0.044	0.040	0.272	
Participation outside school	← enjoyment of games	0.117	0.124	0.345	
	← perceived ability in games	0.336	0.106	0.002	**
	← perceived ability in gym.	0.088	0.073	0.227	
	← plays sports outside school	0.136	0.074	0.067	
	← hours of PE	-0.071	0.051	0.159	
Lifestyle activity	← enjoyment of games	0.190	0.126	0.130	
	← perceived ability in games	0.086	0.104	0.406	
	← perceived ability in gym.	0.091	0.076	0.229	
	← plays sports outside school	0.004	0.076	0.955	
	← hours of PE	-0.042	0.053	0.433	
Team activity	← enjoyment of games	0.096	0.156	0.537	
	← perceived ability in games	0.808	0.145	0.000	***
	← perceived ability in gym.	0.144	0.091	0.112	
	← plays sports outside school	0.191	0.092	0.038	*
	← hours of PE	0.001	0.060	0.981	
Individual activity	← enjoyment of games	0.127	0.132	0.339	
	← perceived ability in games	0.286	0.109	0.009	**
	← perceived ability in gym.	0.164	0.079	0.037	*
	← plays sports outside school	0.084	0.079	0.283	
	← hours of PE	-0.008	0.053	0.882	

Note: N=2,472; the factor means and variances were fixed to 0 and 1, respectively, for identification purposes

Playing sports frequently outside school at age 10 was associated with fitness motivation (0.184), sport motivation (0.448), perceived fitness (0.174), perceived activity (0.155), body image (0.167) and sport ability (0.366) at age 16. The associations were particularly strong for sport motivation and sport ability, suggesting that girls who played sports in their spare time when young were much more likely to enjoy sport and have a particularly high ability when they reached secondary school.

The previous analysis at age 10 had strongly supported the theory of socialisation by the family into a physically active lifestyle. The effects for playing sports outside school and perceived ability at age 10 in this analysis suggested a family socialisation had a long-lasting impact on experiences of school sport and physical education – children who were not supported to be active outside school by their families at age 10 were more likely to have negative experiences in both primary and secondary school. In particular, the associations of age 10 experiences with sport ability at age 16 suggests schools selectively coached children who were already more active and physically able.

There was a very large association of perceived ability in games at age 10 with a preference for team activities at age 16 (0.808) and a moderate association with a preference for individual activities at age 16 (0.286) for girls. In contrast, there were no significant associations of the variables measuring age 10 experiences with a preference for lifestyle activities at age 16. These estimates suggest that perceived ability in traditional sports during primary school was highly influential in determining whether girls participated in these kinds of sports during adolescence. The lack of significant associations of age 10 experiences with a preference for lifestyle activities at age 16 suggests that cohort members' early experiences of sport had no bearing on voluntary participation in these activities during adolescence.

It is possible that a preference for lifestyle activities at age 16 tended to develop for reasons related to maturation – fitness, health and physical appearance considerations – similar to the motivations for adult women's participation in these types of activity (Coalter, 1999). Lifestyle activities are also very inclusive, being accessible and not requiring much in the way of skill or ability. Thus, these activities may have simply been popular and available to all, irrespective of their earlier sport aptitude or family socialisation. These results also suggest that the association of perceived ability with participation outside school was driven by its effect on team and individual activity.

The estimates for boys are shown in Tables D.3 and D.4. There were some similarities and differences between the estimates for boys and those for girls. As with girls, there were no significant associations between the number of hours of PE at age 10 and any of the measures at age 16. Also, as with girls, enjoyment of games at age 10 was associated strongly with sport motivation (0.500) and, instead of fitness motivation, perceived fitness (0.236) at age 16, but no other factors.

Perceived ability at age 10 again seemed to be consistently associated with experiences at age 16 for boys, but there were some interesting differences compared to the estimates for girls. Perceived ability in gymnastics at age 10 was not associated with sport motivation at age 16, whereas it was for girls. This supports previous findings from the research at age 10, which found that experiences of exercise at this age were stereotypically gendered, i.e. gymnastics may have been perceived as feminine by boys and was less salient to them than the more stereotypically masculine team games. As with the girls, perceived ability in gymnastics at age 10 was associated with fitness motivation and the physical self-concept factors at age 16.

The effects were similar for fitness motivation (0.180), perceived fitness (0.185), perceived activity (0.206), body image (0.258) and sport ability (0.177). In terms of participation, perceived ability in gymnastics at age 10 was associated with participation outside school at age 16 for boys (0.171) and not associated with participation inside school. This is the reverse of the associations for girls. It is possible that this also reflects gender biases, as gymnastics was more salient to girls inside school at age 10. Early gymnastic ability may have been an identifier of boys who pursued fitness exercise outside of school at age 16. Indeed, in terms of activity types, perceived ability in gymnastics at age 10 was associated only with lifestyle activity participation (0.148) for boys at age 16.

Perceived ability in games at age 10 was strongly associated with sport motivation (0.455), participation outside school (0.373) and preference for team activities (0.467) at age 16 for boys. It was not associated with fitness motivation, perceived activity, or preference for participating in lifestyle activities. This patterning might be expected from a separation of sport and fitness exercise behaviours. However, there were effects that contradicted this pattern. Perceived ability in games was strongly associated with perceived fitness (0.403), but not associated with sport ability, participation inside school or in individual activities.

These effects are unexpected, as one might presume that perceived ability in

Table D.3: Estimates for males of the effect of experiences at age 10 on intrinsic motivation and physical self-concept at age 16

Males Age 16 outcome	Age 10 predictor	Estimate	S.E.	P-Value	
Fitness motivation	← enjoyment of games	0.221	0.124	0.075	
	← perceived ability in games	0.155	0.110	0.158	
	← perceived ability in gym.	0.180	0.060	0.003	**
	← plays sports outside school	0.422	0.064	0.000	***
	← hours of PE	-0.012	0.041	0.761	
Sport motivation	← enjoyment of games	0.501	0.136	0.000	***
	← perceived ability in games	0.455	0.116	0.000	***
	← perceived ability in gym.	0.116	0.062	0.061	
	← plays sports outside school	0.766	0.068	0.000	***
	← hours of PE	-0.033	0.043	0.436	
Perceived fitness	← enjoyment of games	0.209	0.121	0.083	
	← perceived ability in games	0.403	0.099	0.000	***
	← perceived ability in gym.	0.185	0.057	0.001	**
	← plays sports outside school	0.387	0.062	0.000	***
	← hours of PE	0.019	0.039	0.622	
Perceived activity	← enjoyment of games	0.147	0.125	0.240	
	← perceived ability in games	0.162	0.110	0.141	
	← perceived ability in gym.	0.206	0.062	0.001	**
	← plays sports outside school	0.339	0.069	0.000	***
	← hours of PE	0.030	0.041	0.468	
Body image	← enjoyment of games	0.238	0.126	0.058	
	← perceived ability in games	0.255	0.109	0.019	*
	← perceived ability in gym.	0.258	0.060	0.000	***
	← plays sports outside school	0.276	0.066	0.000	***
	← hours of PE	0.051	0.040	0.203	
Sport ability	← enjoyment of games	0.197	0.173	0.255	
	← perceived ability in games	0.066	0.135	0.623	
	← perceived ability in gym.	0.177	0.070	0.011	*
	← plays sports outside school	0.573	0.079	0.000	***
	← hours of PE	0.061	0.047	0.199	

Note: N=1,853; the factor means and variances were fixed to 0 and 1, respectively, for identification purposes

Table D.4: Estimates for males of the effect of experiences at age 10 on participation at age 16

Males Age 16 outcome	Age 10 predictor	Estimate	S.E.	P-Value	
Participation inside school	← enjoyment of games	0.147	0.164	0.371	
	← perceived ability in games	0.254	0.134	0.058	
	← perceived ability in gym.	0.081	0.069	0.242	
	← plays sports outside school	0.294	0.075	0.000	***
	← hours of PE	-0.006	0.044	0.890	
Participation outside school	← enjoyment of games	0.142	0.181	0.432	
	← perceived ability in games	0.373	0.139	0.007	**
	← perceived ability in gym.	0.171	0.080	0.032	*
	← plays sports outside school	0.434	0.087	0.000	***
	← hours of PE	0.001	0.052	0.988	
Lifestyle activity	← enjoyment of games	0.118	0.166	0.477	
	← perceived ability in games	0.150	0.132	0.257	
	← perceived ability in gym.	0.148	0.071	0.038	*
	← plays sports outside school	0.039	0.076	0.602	
	← hours of PE	0.035	0.046	0.445	
Team activity	← enjoyment of games	0.235	0.187	0.208	
	← perceived ability in games	0.467	0.161	0.004	**
	← perceived ability in gym.	0.086	0.083	0.299	
	← plays sports outside school	0.767	0.096	0.000	***
	← hours of PE	-0.027	0.053	0.613	
Individual activity	← enjoyment of games	0.059	0.184	0.747	
	← perceived ability in games	0.311	0.161	0.054	
	← perceived ability in gym.	0.131	0.080	0.102	
	← plays sports outside school	0.299	0.088	0.001	**
	← hours of PE	-0.024	0.053	0.644	

Note: N=1,853; the factor means and variances were fixed to 0 and 1, respectively, for identification purposes

games would be strongly associated with all outcomes at age 16 related to experiences of competitive sport in school. A clue to what might have been going on is present in the very strong estimates for playing sports outside school at age 10. The strength of the estimates varied from 0.276 (for body image) to 0.767 (for participation in team activity) and in most cases represented the strongest association for each outcome at age 16. This suggests that boys' early perceptions of ability could be superseded somewhat by age 16 through practice based gains – i.e. those cohort members who played sports outside school frequently may have been able to overcome any early lack of perceived ability, presumably by becoming more skilful and able through consistent practice over a long time period of time. The estimates for participation in team (0.767) and individual activity (0.299) at age 16 support this notion.

Playing sports outside school at age 10 was a much more important correlate for boys than for girls. For girls, it was strongly associated only with sport motivation and ability, suggesting that it was identifying those girls who were unusually 'sporty' – i.e. interested in competitive sport rather than fitness exercise – when the majority were not particularly into sport. With boys, this was not the case; playing sports outside school at age 10 was much more popular in their case, and so more salient and widely predictive of positive sport and exercise experiences at age 16. Indeed, the only measure at age 16 with which playing sports outside school at age 10 was not associated for boys was participation in lifestyle activities. As with girls, the lack of effects for this type of activity suggests that it was easily available to all, regardless of ability or previous experiences.

The cross-sectional analysis at age 10 (p.124) had shown that those boys who played sports frequently outside school were more likely to have positive perceived ability inside school. Therefore, the estimates for playing sports and perceived ability at age 10 in Tables D.3 and D.4 suggest that, as with girls, school provision built on and exacerbated differences in pre-existing experiences of activity, which were due to family socialisation into sport and exercise. The lack of effects relating to hours of PE at age 10 provides further support for this notion.

In summary:

1. Hours of PE at age 10 was not an important correlate of experiences of exercise, and was not associated with any of the measures at age 16 for boys or girls.

2. Enjoyment of games at age 10 was associated with sport motivation at age 16 for both boys and girls, but little else. This suggests that those cohort members who were enjoying school provision when young continued to enjoy it as they got older, but that early enjoyment did not affect participation or physical self-concept at age 16.

3. Perceived ability at age 10 seemed to be much more important than enjoyment for both boys and girls. For girls, perceived ability in games was more important for experiences associated with competitive sport at age 16, whereas perceived ability in gymnastics was more important for non-competitive, fitness orientated experiences at age 16.

4. For boys, perceived ability in gymnastics was less important in general than for girls, confirming the persistence of gender stereotypes. Perceived ability in games was more important, being associated with perceptions of fitness as well as sport motivation and participation in team activities.

5. Playing sports outside school at age 10 was consistently associated with higher motivation and physical self-concept at age 16, for both boys and girls, and tended to be more strongly associated with sport focused experiences. For girls, it was not associated with participation at age 16, but for boys it was, and very strongly. Indeed, playing sports outside school was the most important of the age 10 correlates for boys.

6. Unexpectedly, boys' perceived ability in games was not associated with sport ability or participation inside school at age 16, but playing sports outside school was. It seemed possible that accumulated experience in sport could overcome early perceptions of ability to some extent.

7. The associations further supported the stereotypical gender bias in experiences. Playing sports outside school at age 10 was associated more strongly with motivation and physical self-concept at age 16 for boys, and was not associated with participation at age 16 for girls.

8. These associations strongly supported the notion that competitive sport was more central to boys' experiences of sport and exercise. Football and cricket were very popular outside school with boys, and it seems plausible their interest and enjoyment of sport would transfer more easily into the school environment.

9. For girls, lifestyle and fitness exercise was more important than competitive sport. Girls only participated in traditional, competitive sport inside school. There was very strong evidence that school provision was antithetical to girls' preferences for physical activity.

10. The age 10 analysis had found that playing sports outside school was associated with greater perceived ability and enjoyment inside school for both boys and girls. This suggests that much of the effect of perceived ability at age 10 on experiences at age 16 was due to the indirect effect of playing sports outside school at age 10. Ultimately, school provision built on, and may even have exacerbated, differences in activity outside of school that were already present at age 10.

11. A striking exception to this general picture was lifestyle activity. Participation in these activities at age 16 was not convincingly associated with any of the age 10 variables, for either sex, despite being very common outside school. In other words, having poor experiences inside school and not playing sports outside school often at age 10 had little bearing on whether you participated in lifestyle activities at age 16 – lifestyle activities were universal in their accessibility and appeal.

Appendix E

Multiple imputation at age 16

The use of data from so many different survey instruments along with the very large amount of missing data in the wave at age 16 (due to the teacher strike) contributed to a challenging problem for simultaneous inclusion of the control variables. The default method to impute missing items in Mplus (FIML) can account for missing responses on outcome variables under the assumption of data being (conditionally) 'missing at random' (i.e. MAR, Rubin (1976)). Unfortunately, a great deal of data was also missing for the control variables, as many came from the wave at age 16. Also, due to the various survey instruments and respondents involved, most cases had at least some missing information on some of the variables.

Table E.1 shows representative sample sizes for the various survey instruments and respondents by sex of the cohort member. The available sample sizes varied considerably. Far more cases were available in general from the wave at age 10 than at age 16. Likewise, more data were available for the survey instruments filled out at home by the mother at age 16 than those filled out at school by either the cohort member or the headteacher (the headteacher response being particularly poor). Also, Table E.1 does not give any indication of how the missing data overlapped between instruments. Table E.2 shows the same four variables along with the various patterns of missing data they exhibit for all cohort members. Only 1,129 cases (7%) had complete data on all four variables. The largest proportion (24%) had missing data on all instruments at age 16 and complete data only on the variable at age 10. A large proportion of the original cohort (22%) had no data at either wave. Despite only 7% of cases being complete, the majority of cases (54%) had at least some data available at age 16, representing a very large sample size (N=9,252) by typical standards.

Table E.1: Available sample sizes for the various survey instruments containing control variables by sex

Wave	Respondent	Representative variable	Female	Male
10	medic	motor coordination	5,862	6,180
16	cohort member	outdoor recreation with parents	2,869	2,074
16	mother	mother exercises	3,983	3,229
16	headteacher	number of pupils in 5th year	1,514	1,515

Table E.2: Missing data patterns for the various survey instruments containing control variables

Wave:		10	16	16	16
Respondent:		medic	cohort member	mother	head teacher
N	%	Missing data pattern			
4,085	24	•	○	○	○
3,848	22	○	○	○	○
2,689	16	•	•	○	○
2,127	12	•	•	•	○
1,129	7	•	•	•	•
603	4	•	○	•	○
502	3	•	○	○	•
483	3	•	○	•	•
427	2	○	•	○	○
424	2	•	•	○	•
868	5	*all other missing data patterns*			
17,185	100				

Note: • indicates complete data; ○ indicates missing data

In order to allow the inclusion of the control variables into a larger model, it was decided to use the available data and a multiple imputation approach to impute missing values. Multiple imputation creates several complete datasets. Variability in the imputed values can then be taken into account in subsequent analyses. The purpose of the imputation was not to thoroughly account for all of the missing data in the BCS70 – e.g. data missing through attrition, wave non-response (such as due to the teachers' strike at age 16), missing items for particular types of respondent, etc. Rather, it was intended to allow the inclusion of the control variables into the models previously estimated in Appendix D without the available sample size being drastically reduced. In this sense, multiple imputation was preferable to either using dummy variables for missing data, which is known to introduce serious biases (Jones, 1996), or using an EM-algorithm to impute a single dataset (Allison, 2002), which ignores the variability introduced by the imputation model.

Because of the importance of sex to experiences of sport and exercise at age 16, missing data was imputed separately for girls and boys. The imputation models contained:

- all of the variables of interest, measuring experiences of exercise at ages 10 and 16;
- all of the variables shown in Table 6.12 (p.176), in order to control for the correlates of physical activity;
- auxiliary variables containing information on the month in which the questions on physical activity at age 16 were completed, the region in which the cohort member lived, and which version of the educational pack was completed (the version for completion in school or at home), in order to control for non-response mechanisms associated with the teachers' strike at age 16; and
- additional socioeconomic controls (parental income, education and social class) from the wave at age 10, to improve imputations of the socioeconomic controls collected in the wave at age 16.

Because the variables measuring experiences of exercise at age 16 comprised the outcomes for the analysis, only those cases with at least some information available on these variables were included in the dataset used for imputation. This was done to reduce the likelihood of bias due to a Not Missing at Random (NMAR, see Rubin (1976)) mechanism, whereby missingness is related to the outcome measure, and also to produce imputed datasets that were comparable in size and source data to that used in the previous analysis with no controls, aiding comparison. Five imputed datasets were created using a sequential approach with chained equations. The functionality available in Mplus for analysing multiply imputed datasets was used to take account of the variability between imputations. The analytical models included the age 10 predictors, the control variables shown in Table 6.12 (p.176), and the auxiliary variables described above.

Appendix F

Recoding of Rutter malaise scores

Table F.1: Derived, categorical versions of reduced (nine-item) Rutter malaise scores, by wave

<table>
<tr><th></th><th colspan="2">age 16</th><th colspan="2">age 26</th><th colspan="2">age 29</th><th colspan="2">age 34</th></tr>
<tr><th>score</th><th>%</th><th></th><th>%</th><th></th><th>%</th><th></th><th>%</th><th></th></tr>
<tr><td>0</td><td>5.1</td><td>|</td><td>28.5</td><td>|||||||</td><td>36.0</td><td>|||||||||</td><td>35.1</td><td>||||||||</td></tr>
<tr><td>1 to 2</td><td>55.4</td><td>|||||||||||||</td><td>43.7</td><td>||||||||||</td><td>40.5</td><td>||||||||||</td><td>39.5</td><td>|||||||||</td></tr>
<tr><td>3 to 4</td><td>31.7</td><td>|||||||</td><td>19.6</td><td>||||</td><td>16.2</td><td>||||</td><td>16.2</td><td>||||</td></tr>
<tr><td>5 to 9</td><td>7.8</td><td>|</td><td>8.2</td><td>||</td><td>7.3</td><td>|</td><td>9.2</td><td>||</td></tr>
<tr><td>Total</td><td>100</td><td></td><td>100</td><td></td><td>100</td><td></td><td>100</td><td></td></tr>
<tr><td>N</td><td>5,091</td><td></td><td>8,266</td><td></td><td>10,256</td><td></td><td>8,872</td><td></td></tr>
</table>

Table F.2: Distributions of reduced (nine-item) Rutter malaise scores, by wave

<table>
<tr><th></th><th colspan="2">age 16</th><th colspan="2">age 26</th><th colspan="2">age 29</th><th colspan="2">age 34</th></tr>
<tr><th>score</th><th>%</th><th></th><th>%</th><th></th><th>%</th><th></th><th>%</th><th></th></tr>
<tr><td>0.0</td><td>5.1</td><td>|||</td><td>28.5</td><td>|||||||||</td><td>36.0</td><td>||||||||||||</td><td>35.1</td><td>|||||||||||</td></tr>
<tr><td>0.5</td><td>10.5</td><td>|||||||</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.0</td><td>13.9</td><td>|||||||||</td><td>24.8</td><td>||||||||</td><td>24.3</td><td>||||||||</td><td>23.5</td><td>|||||||</td></tr>
<tr><td>1.5</td><td>15.6</td><td>||||||||||</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.0</td><td>15.4</td><td>||||||||||</td><td>18.9</td><td>||||||</td><td>16.2</td><td>|||||</td><td>16.0</td><td>|||||</td></tr>
<tr><td>2.5</td><td>12.6</td><td>||||||||</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>3.0</td><td>8.9</td><td>|||||</td><td>12.3</td><td>||||</td><td>9.9</td><td>|||</td><td>10.1</td><td>|||</td></tr>
<tr><td>3.5</td><td>6.1</td><td>||||</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4.0</td><td>4.2</td><td>||</td><td>7.3</td><td>||</td><td>6.3</td><td>||</td><td>6.1</td><td>||</td></tr>
<tr><td>4.5</td><td>2.5</td><td>|</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>5.0</td><td>2.2</td><td>|</td><td>3.5</td><td>|</td><td>3.3</td><td>|</td><td>3.7</td><td>|</td></tr>
<tr><td>5.5</td><td>1.2</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>6.0</td><td>0.8</td><td></td><td>2.6</td><td></td><td>2.0</td><td></td><td>2.4</td><td></td></tr>
<tr><td>6.5</td><td>0.4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.0</td><td>0.4</td><td></td><td>1.2</td><td></td><td>1.2</td><td></td><td>1.5</td><td></td></tr>
<tr><td>7.5</td><td>0.1</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>8.0</td><td>0.2</td><td></td><td>0.6</td><td></td><td>0.6</td><td></td><td>1.2</td><td></td></tr>
<tr><td>8.5</td><td>0.0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9.0</td><td>0.0</td><td></td><td>0.3</td><td></td><td>0.3</td><td></td><td>0.4</td><td></td></tr>
<tr><td>Total</td><td>100</td><td></td><td>100</td><td></td><td>100</td><td></td><td>100</td><td></td></tr>
<tr><td>N</td><td>5,091</td><td></td><td>8,266</td><td></td><td>10,256</td><td></td><td>8,872</td><td></td></tr>
</table>

Appendix G

Multiple imputation for final analyses

As with the longitudinal analysis at age 16 (p.174), the use of data from many different survey instruments (along with the very large amount of missing data in the wave at age 16) had a significant impact on the sample sizes available for the models in the final empirical chapter. Table G.1 shows representative numbers of respondents for various waves and instruments by sex.

Table G.1: Available sample sizes for various waves and survey instruments, by sex

Wave	Variable	Respondent	Female	Male
age 0	sex of the baby	medic	7,976	8,585
age 10	enjoyment (games)	cohort member	6,156	6,366
	social class	parent (mother)	5,492	5,897
	maturation	medic	6,225	6,459
age 16	interested in physical fitness	cohort member	2,929	2,164
	family recreation	cohort member	2,869	2,074
	weight status	medic	2,744	2,549
	parental income	parent (mother)	3,352	3,284
age 29	exercises regularly	cohort member	5,342	4,999
age 34	exercises regularly	cohort member	4,664	4,240

The available sample sizes varied considerably. The available sample size at age 10 (14,350) was lower than that at birth (16,571), mostly due to infant deaths and the difficulty of contacting all members of the original birth study (p.64). Also, mostly due to attrition, the sample sizes at age 10 were larger than those in adulthood, and fewer respondents were available at age 34 than at age 29. However, as expected, the smallest sample sizes were at age 16.

Table G.1 does not show how the missing data overlapped between waves. In order to give a summary indication of this, patterns of missingness were identified. The models estimated in the final chapter focused on childhood experiences and exercise behaviour at age 34. Therefore, the patterns focused on variables representative of experiences of sport and exercise at ages 10 and 16, and exercise behaviour and control variables at age 34. The patterns are presented in Table G.2.

Table G.2: Missing data patterns for key variables from each wave of the BCS70

Wave:		age 10		age 16		age 34	
Variable:		enjoy-ment	plays sports	part. in. sch.	fam. rec.	exer-cises	educ-ation
N	%						
3,398	20	•	•	○	○	•	•
2,859	17	•	•	•	•	•	•
2,761	16	○	○	○	○	○	○
1,847	11	•	•	○	○	○	○
887	5	•	•	○	○	•	○
602	4	○	•	○	○	•	•
513	3	•	•	•	•	○	○
466	3	•	•	•	○	•	•
462	3	•	•	•	•	•	○
453	3	○	•	○	○	○	○
445	3	○	•	•	•	•	•
378	2	○	○	○	○	•	•
297	2	•	○	○	○	○	○
274	2	•	○	○	○	•	•
1,543	6	*all other missing data patterns*					
17,185	100						

Note: • indicates complete data; ○ indicates missing data; variables are: (age 10) enjoyment of games, plays sports outside school; (age 16) participation inside school (latent variable), family recreation; (age 34) exercises regularly, education

2,859 (17%) cases had complete data on all of the variables, but a large proportion (16%, N=2,761) had no data. The effect of the teachers' strike was also clearly evident, with 3,398 cases (20%) having complete data on all variables except those at age 16. A considerable proportion of cases (11%, N=1,847) also had complete data only at age 10. In order to provide good quality imputations on variables relating to experiences of sport and exercise, it was decided to limit the dataset to those cases which had valid data on at least four out of the six variables shown in Table G.2. This gave an available sample size for multiple imputation of 8,795 (4,680 female, 4,115 male).

The purpose of the imputation was not to impute *all* missing data in the BCS70. There is simply too much. Rather, it was intended to allow the inclusion of all the necessary variables into the final models without the available sample size being dramatically reduced, and to provide reassurance that bias due to missingness was minimised. In this sense, multiple imputation was preferable to either using dummy variables for missing data, which is known to introduce serious biases (Jones, 1996), or using an EM-algorithm to impute a single dataset (Allison, 2002), which ignores the variability introduced by the imputation model.

Despite this limit to the imputed dataset, it seems plausible that the resulting analyses would not be greatly affected by missing data bias. Cases are mostly missing due to early non-contact, the teachers' strikes, wave non-contact and attrition – through mechanisms related to socioeconomic factors and sex of the cohort member (Ketende et al., 2010). It is doubtful that childhood experiences of sport and exercise would be highly dependent on these mechanisms. Also, the use of a wide range of variables in both the imputation and analytical models provided assurance that any bias had been accounted for and the MAR criterion had been fulfilled (Rubin, 1976). The imputation models were estimated separately by sex, and included the following variables:

- all the variables used in the analytical models in the final empirical chapter (experiences of sport and exercise at ages 10 and 16, exercise behaviour at ages 29 and 34, and the correlates of physical activity at age 34);
- all of the variables used as controls for the correlates of physical activity at ages 10 and 16 (pp.107, 176);
- measures of BMI at ages 10, 16, 29 and 34; and
- measures of alcohol drinking behaviour at age 34.

Multiple imputation was carried out using the sequential approach with chained equations in Stata version 13.1 (StataCorp, 2013, pp.137-164). This approach is able to impute on multiple variables with various different measurement levels (nominal, binary, ordinal, interval, ratio). Twenty imputed datasets were created. This struck a good balance in terms of enhancing statistical power and allowing the final models to be estimated within a reasonable time span. Variability in the imputed values was taken into account using the functionality of Mplus for analysing multiply imputed datasets.

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