

**From Primary to Secondary School: Changes
in Scottish Girls' Physical Activity and the
Influence of Maturation and Perceptions of
Competence**

Research Report no. 113

*A research study for **sportscotland***

by

*AG Niven, SG Fawcner, AM Knowles and JM Henretty
Teenactive Research Group
School of Life Sciences Heriot Watt University
Edinburgh
EH14 4AS*

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Summary of Study and Main Findings

A number of research studies have revealed a high rate of decline in girls' participation in sport and other physical activity during adolescence. The aim of this study was to examine changes in physical activity as girls make the transition from primary to secondary school, and then progress through the early stages of secondary school, and to identify psychological and physical factors that may influence these changes in physical activity. Over 200 girls were recruited from 17 Edinburgh primary schools in May 2006 and volunteered to complete questionnaires to measure demographic characteristics, physical activity levels, maturation status, perceptions of competence, and motives for physical activity, and also participate in physical assessments of height, weight and body fat. The girls were tracked to six secondary schools and re-assessment was undertaken in November 2006 (S1; n = 162), May 2007 (S1; n = 156), and November 2007 (S2; n = 131).

Changes in Physical Activity

- Over the eighteen month period, from May 2006 to November 2007, there was an overall decrease in physical activity. This picture wasn't consistent across all types of physical activity and across all phases of data collection. Specifically there were significant decreases in:
 - physical activity during lunchtime and breaktime (particularly in the transition from primary to secondary school);
 - physical activity immediately after school (particularly in the transition from primary to secondary school); and
 - physical activity during spare time.
- There were *no* significant changes in the extent to which girls walked or cycled to school.
- The girls reported that they spent more time being very active in PE at secondary school than primary school.

Influence of maturation and body size variables on changes in physical activity

- There was no relationship between self reported maturation and the body size variables measured (ie, body weight, sum of skinfolds, waist circumference and BMI) and physical activity at any time point.
- Self-reported maturation and body size variables had no influence on changes in physical activity across the four phases.

Influence of perceptions of competence on changes in physical activity

How competent the girls perceived themselves to be in a physical environment was consistently positively associated with how active they were. The influence of perceptions of competence on physical activity appeared to get stronger across the four phases.

- Perceptions of competence relating to the sport environment and physical conditioning (eg, fitness, ability to maintain exercise) were particularly important predictors of physical activity.
- Self-efficacy to be physically active (ie, how confident girls are that they have the ability to overcome barriers and be regularly physically active) was a very strong predictor of physical activity.

Relationship between body size variables, perceptions of competence and physical activity

- The body size variables (ie, body weight, sum of skinfolds, waist circumference and BMI) were related to some of the psychological measures (eg, the physical self-perceptions physical condition and body attractiveness, and overall physical self-worth) which could suggest the influence of body size variables on physical activity may be indirect, through the influence on perceptions of competence, and could become more apparent with time.

Relationship between sedentary behaviour, physical activity and body size variables

- There were limited significant changes in sedentary behaviour from S1 to S2.
- TV viewing was negatively associated with physical activity, although this significant relationship was small.
- There were some, but inconsistent and weak correlations between body size variables and time spent in sedentary activities.

Relationship between motives to be active and physical activity

- Individuals who were strongly motivated to take part in physical activity for reasons associated with interest and enjoyment, and being challenged and developing skills had higher levels of physical activity.
- Being motivated to participate in physical activity for social reasons alone may have a negative influence on physical activity participation, perhaps because social needs are not being met by the physical activity opportunities.

Background to the Report

Physical inactivity has become a global problem, with more than half the world's population not reaching modest physical activity levels (World Health Organisation, 2005). Moreover, through several longitudinal studies it has been shown that physical activity levels decline drastically during adolescence (eg, Aaron et al, 2002). Cross-sectional population studies support these findings and in particular, statistics from the Scottish Health Survey indicate that among Scottish girls physical activity levels decline with age after the age of 8-10. By the age of 13-15 only 41% of Scottish girls achieve the recommended level of physical activity for health (i.e., 60 minutes of physical activity 7 days per week) compared with 68% of boys (Scottish Executive, 2005). As a result, teenage girls have been identified as a priority in the National Physical Activity Implementation Framework 2008-2011 (Lowther & Reid, 2008).

Additionally, **sportscotland's** survey of participation in sport and physical recreation also demonstrates a significant drop in levels of activity by adolescent girls, particularly between the 8-11 and 12-15 age groups. In addition, the gap between the participation rates of boys and girls begins to widen at that point (**sportscotland**, 2007).

The purpose of this current project is to focus on this critical time period for changing levels of physical activity in teenage girls. Specifically, the project has monitored a group of Scottish girls at six-monthly intervals over 18 months as they progressed from primary to secondary school. Limited longitudinal research (see later) has been undertaken with this age group and therefore this project provides a unique data set.

The aim of the project is to examine changes in different aspects of physical activity and consider both physical and psychological factors that may be influencing these changes. The project ultimately aims to make recommendations for interventions to increase the physical activity levels of adolescent girls.

The purpose of this report for **sportscotland** is to:

- Provide background information on the research area and purpose of the study;
- Provide details on the methodology used;
- Identify trends in physical activity behaviour within and outwith school as girls proceed from primary to secondary school;
- Consider the influence of specific factors including maturation, body size, perceptions of competence and motives on changes in physical activity;
- Examine changes in sedentary activities and consider the relationship with physical activity;
- Make recommendations for consideration by policy makers and providers of sport and other physical activity opportunities for girls.

Reports on the results of phase one and phases one and two were produced in 2006 and 2007 (Teenactive, 2006, 2007). This report provides the full results from the four data collection phases.

Introduction

Physical activity behaviour is complex, and there are likely to be a number of factors influencing physical activity in children and adolescents (Sallis, et al, 1999). Several studies have identified key correlates of physical activity in children and adolescents, and two systematic reviews have summarised the findings. Sallis et al (2000) reviewed studies that identified correlates of physical activity in children and adolescents, and Biddle et al (2005) reviewed studies focused specifically on correlates of physical activity in adolescent girls. These researchers identified five types of correlates of physical activity behaviour (see Figure 1): demographic and biological variables; psychological variables; behavioural variables; social and cultural variables; and physical environment variables.

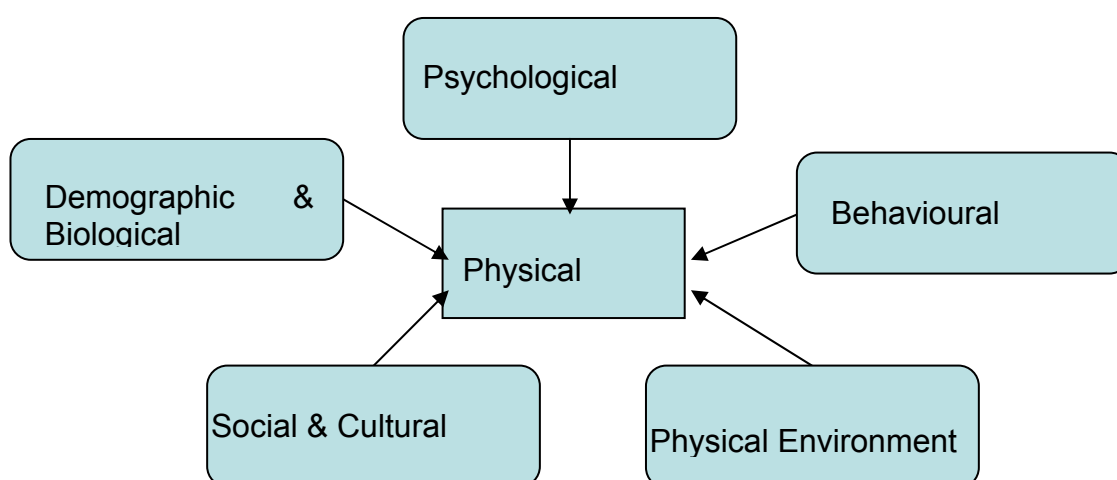


Figure 1. Main Correlates of Physical Activity in Children and Adolescents

Whilst studies examining correlates of physical activity are useful in identifying potential determinants of physical activity, these studies are limited because they are based on cross-sectional data and therefore cannot infer a directional link between the identified variables and physical activity. Longitudinal studies however offer an opportunity to alleviate some of the concerns with cross sectional analysis, and the longitudinal monitoring of each of the correlates of physical activity identified in Figure 1 would be ideal. However, one of the key constraints to longitudinal research is the logistics of tracking population samples over a period of time, and the resources required to do this whilst also collating meaningful data with samples of sufficient size. Therefore, researchers have tended to discretely explore the influence of one or other correlate of physical activity when using a longitudinal design. It might however be hypothesised that these correlates of physical activity impose an interrelated influence on physical activity, and should not be treated in a mutually exclusive manner. Two such correlates that may be interrelated are biological and psychological determinants of physical activity behaviour. Biological factors (eg, age and maturation) are typically viewed as non-modifiable determinants of behaviour. However, the psychological factors (eg, perceptions of competence, body image) related to how the individuals experience their biology are modifiable. For example, two equally mature girls may

hold different views on how their bodies influence their physical activity levels. What is important is that whilst it may not be possible to change a girl's stage of maturation, or to an extent body size, it might be possible to change her and others' attitudes to maturational status and body size. Thus the factors are inextricably linked and it is both the variables themselves and the interaction between them which are of critical importance, a concept which is developed further below.

Maturation, physical changes and physical activity

The decrease in physical activity evident in adolescent girls is coincident with maturation, which usually occurs around the age of 12-13 years. In general, maturation is associated with a certain pattern of physical changes, and the influence of maturation on physical activity may be as a result of the impact of these physical changes associated with maturation on ability and choice to be active.

The physical changes that accompany maturation are characterised by an increase in fat mass which is not matched by an increase in muscle mass or skeletal tissue as it is in males (Malina et al, 2004), along with changes in body shape and size that are generally opposed to physical activity participation and may directly impact on girls' ability to participate in physical activity. For example, maturation related changes in body size change an individual's centre of gravity and the ratio of leg length to torso length that may instigate coordination problems. Additionally, breast development may directly reduce spontaneous physical activity because of the need for appropriate clothing (Baker et al, 2007). Further, the natural increase in body fat can result in body changes that are opposed to competence in certain activities. For example individuals who develop additional body fat through the natural process of maturation may find participation in gymnastics difficult and can become slower and less powerful than their leaner and less mature peers. As a result earlier-maturing girls may self-select out of sport and other physical activity because of competency-related issues (Malina et al, 2004). As well as the possible direct effects of physical changes on participation on physical activity, it is possible that the way in which these changes interact with adolescent girls' perceptions of being competent when being physically active is equally, if not more important.

Body shape and size are commonly assessed when exploring the influence of maturation on behaviour. However, it is not possible to easily tease out the differential effect of lifestyle factors (eg, diet and exercise) and the normal process of maturation on changes in body size, and indeed there is likely to be considerable overlap between these determinants. In this study, maturation and body size are dealt with as independent variables.

Few studies have examined the direct influence of maturation or the physical changes generally associated with it, on physical activity. Early research by Armstrong et al (1990) suggested that maturation (assessed by Tanner stages, ie rating the physical observation of secondary sexual characteristics) had no influence on the number of 10-20 minute periods of physical activity in both boys and girls. Contradictory to these early findings, research by Thompson et al (2003) has provided preliminary evidence of a possible influence of pubertal development on physical activity behaviour. More recently, Baker et al (2007) assessed the maturation levels of 11 year old girls using Tanner stages, levels of estradiol in the blood and mother's assessment of pubertal development, and identified that early-maturing girls, relative to their peers at age 11,

had significantly lower physical activity levels at age 13 years compared to their later-maturing peers, suggesting that early maturation relative to peers may lead to a decline in physical activity among adolescent girls. However, it is not clear whether this is potentially due to the physical or emotional and psychological changes that accompany maturation.

Perceptions of competence

Biddle et al (2005) highlighted psychological factors as being consistently related to physical activity and of particular importance in understanding and enhancing adolescent girls' physical activity participation. The focus in this project is on psychological factors that we have labelled 'perceptions of competence'. This term is used as a general term to refer to an individual's perceived ability, and can relate to specific environments (eg, perceptions of competence in a physical, academic, or social environment). In this project we have focused on two factors; physical self-perceptions and physical activity self-efficacy.

Physical self-perceptions relate to how we feel about our physical abilities and appearance, and are of particular interest when considering physical activity behaviour. Researchers in this area (Fox & Corbin, 1989) have identified that physical self-perceptions are made up of perceptions of competence in four areas defined as:

Body attractiveness: perceived attractiveness of figure or physique, ability to maintain an attractive and confidence in appearance;

Physical condition: perceptions of level of physical condition, stamina and fitness, ability to maintain exercise, and confidence in the exercise and fitness setting;

Physical strength: perceived strength, muscle development and confidence in situations requiring strength; and

Sport competence: perceptions of sport and athletic ability, ability to learn sports skills and confidence in the sports environment.

Together these four areas influence an overall perception of physical self-worth (see Figure 2).

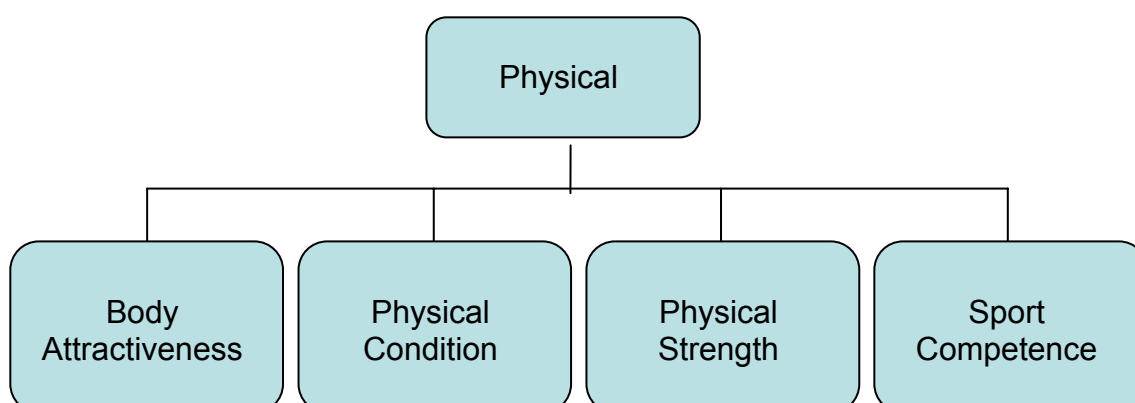


Figure 2. Physical Self-Perception Hierarchy (Fox & Corbin, 1989)

Physical self-perceptions have been linked to a number of theories of motivation for being physically active, and it has been shown that individuals who feel competent in the physical domain will be more likely to participate in physical activity. A number of studies show a positive relationship between physical activity and physical self-perceptions (Crocker et al, 2000; Welk & Eklund, 2005; Crocker et al, 2006) with sport competence and physical condition shown to be important positive correlates of physical activity in adolescent girls (Biddle et al, 2005). Further, a recent longitudinal study indicated that decreases in the physical activity of adolescent girls aged 14-17 years could partly be explained by changes in physical self-perceptions (Crocker et al, 2006). These findings provide support for the contention that the physical self plays an important role in the adoption and maintenance of physical activity (Sonstroem, 1997), but research examining physical self-perceptions and physical activity during early adolescence is somewhat sparse.

Physical self-perceptions provide insight into general perceptions of competence in an environment with a focus on physical activities (eg, sport, and fitness related activities), whereas self-efficacy is a concept that provides insight into perceived competence related to more specific behaviours. Within much physical activity research, self-efficacy has been defined as how confident an individual is that he/she has the ability to overcome specific barriers and be regularly physically active (eg, I could exercise even if I had other things I wanted to do). Self-efficacy is one of the most consistent correlates of physical activity. Specifically, previous studies have shown that self-efficacy is associated with physical activity in adolescent girls (eg, Biddle et al, 2005).

Maturation and perceptions of competence

As identified above, any influence of maturation on physical activity may be both direct (ie, maturational changes lead to a decrease in activity), and indirect (through the influence of maturation on emotional and psychological changes, or perceptions of competence). It is possible that the physical changes associated with maturation (eg, increased body fat, development of secondary sexual characteristics) may also result in less positive physical self-perceptions (Crocker et al, 2000; Crocker et al, 2003). Indeed previous research showed perceptions of body attractiveness to be negatively associated with both percentage of body fat (Welk & Eklund, 2005) and body mass index (BMI) (Crocker et al, 2003; Raustorp et al, 2005; Welk & Eklund, 2005; Crocker et al, 2006), but studies that have considered the influence of maturation on perceptions of competence, and thus a potentially indirect influence on physical activity, are lacking.

Additional factors

The main focus of this study is on the influence of maturation and perceptions of competence on physical activity behaviour, but additional variables are also considered and reported. These additional variables included demographics (ie, socioeconomic status and secondary school), sedentary behaviour and motives to be active, and the literature related to these variables is discussed below.

Demographics

Previous research has shown that family income (a common measure of socioeconomic status), are positively related to physical activity in adolescent girls (Biddle et al, 2005). As identified in Figure 1, the environment in which individuals function and interact can also influence physical activity behaviour. Specifically, the social (eg, teacher support, school ethos), and physical environment (eg, facilities available, safety) may vary from school to school and therefore the school attended could influence levels of physical activity.

Sedentary behaviour

As highlighted in Figure 1, certain behaviours are related to physical activity. Recent research has focused on the relationship between sedentary behaviours (eg, watching television, reading etc) and physical activity. Although these sedentary behaviours have been commonly blamed for keeping young people from being active, the research findings are less supportive. For example, Marshall et al (2004) reviewed several studies and reported that there was only a small, negative relationship between TV viewing and physical activity in all studies. Further, Koezuka et al (2006) reported that although TV viewing was negatively associated with physical activity in a 7000+ sample of Canadian youths, computer use was positively associated with physical activity in boys and girls, and reading was positively associated with physical activity in girls. Consequently, researchers have suggested that sedentary behaviours and physical activity are conceptually distinct and should be considered as separate behaviours. Specifically, further research focusing on the nature and pattern of sedentary behaviours, and their relationship with physical activity and other health variables, such as body size variables, would be of value.

Motives to be active

The reasons why girls choose to be active may influence their physical activity behaviour. Simply, according to self-determination theory the reasons why individuals chose to be active can be divided into intrinsic and extrinsic motives (Deci & Ryan, 1985). Intrinsically motivated behaviours are undertaken for the satisfaction gained from engaging in the activity itself. Intrinsic motives are driven by free choice and challenge and include motives related to competence, interest and enjoyment. Extrinsically motivated behaviours are undertaken in order to obtain rewards or outcomes that are separate from the behaviour itself. Extrinsic motives are driven more by external pressures and in a physical activity context can include body appearance and fitness motives (Frederick & Morrison, 1996). Being extrinsically or intrinsically motivated to be active will lead to different thoughts, feelings and behaviours. Specifically, intrinsic motives have been associated with greater exercise adherence and enjoyment than extrinsic motives (Ryan et al, 1997). Examining changes in motives for physical activity over time, and the influence of different motive types on physical activity could provide increased understanding of changes in girls' activity levels.

Aims of the project

The current project was therefore designed to explore the influence of both the physical and psychological determinants of physical activity in adolescent girls.

The main aims and hypotheses were to:-

- Describe changes in overall physical activity and type of physical activity in adolescent girls as they move from primary to secondary school, and in the early years of secondary school. It was hypothesised that consistent with previous studies, overall girls would become less active as they progress through school. No prediction was made regarding changes in types of physical activity.
- Consider changes in maturation, body size and perceptions of competence as girls move from primary to secondary school, and in the early years of secondary school. It was hypothesised that the girls would become more mature and their body size would increase. Related to these changes, it was expected that perceptions of competence would also decrease.
- Examine the influence of maturation and body size variables on changes in physical activity. It was hypothesised that as girls mature and increase in body size then they will become less active.
- Examine the influence of perceptions of competence on changes in physical activity. It was hypothesised that higher levels of perceived competence would be associated with higher levels of physical activity.
- Examine the relationship between maturation, body size variables, perceptions of competence and physical activity. It was hypothesised that more mature and larger girls will have lower levels of perceived competence and therefore will have lower levels of physical activity.
- Consider the relationship between sedentary behaviour, physical activity and body size variables. It was hypothesised that sedentary behaviour would have a small negative relationship with physical activity. No specific hypothesis was made about the relationship between sedentary behaviour and body size variables.
- Examine the relationship between motives to be active and physical activity. It was hypothesised that being motivated for intrinsic reasons (eg, enjoyment, interest focused) would be more strongly related to physical activity than extrinsic motives.

Methods

Overview

The study involved recruiting girls in Primary 7 in 2006 and tracking them for 18 months, with data collected every six months. At the start of the study, the average age of the girls was just under 12 years. Information was collected, at the four data collection periods, using both questionnaires and physical measurements of height and body fat (skinfold method). The questionnaires included items on demographic variables (eg, age, ethnicity, socio-economic status), physical activity, sedentary behaviour, maturation status and a number of questions designed to explore perceptions of competence and motives for participation. More detail on the methods is provided below.

Participants

Following approval from the Edinburgh City Council, schools were recruited by initially approaching six state secondary schools in the Edinburgh area to secure their participation. Subsequently, the respective feeder primary schools for each secondary school were approached. All secondary schools agreed to participate and 17 out of 19 primary schools agreed to participate.

Data were collected in four phases: May 2006 (P7), November 2006 (S1), May 2007 (S1), and November 2007 (S2). At Phase one, the researchers visited each primary school and talked to the girls about the project. Each girl received written information on the project and an information sheet and consent form for their parent/guardian. From this, 204 girls were recruited (mean 11.8 years). Phases two through four of data collection took place across the six secondary schools with 162 of the original sample participating in phase two (November 2006), 156 in phase three (May 2007), and 131 in phase four (November 2007).

The primary reason for non-participation at phase two was not attending a secondary school participating in the study (n=33). Subsequent decreases in participation have been due to participants being absent on the day of data collection, or choosing to opt out of the study. The number of girls choosing not to participate increased across the phases of data collection, and may reflect a decreased interest in physical activity. Nevertheless there was no significant difference between any of the key variables at phase one (physical activity levels, body size, maturation or self perceptions) between those present throughout the four phases and those who dropped out over the course of the study.

Measures

The data collection involved two parts; completion of a questionnaire and collection of physical data. The Girls' Health Questionnaire Booklet (see Appendix 1 for details of accessing the questionnaires) was initially developed in phase one and subsequently modified to include additional variables of interest. The Girls' Health Questionnaire Booklet included six sections and all questionnaires have previously been used with similar populations (for more information on the process of administering the questionnaire see below 'Procedure').

Demographic information

Information was collected on school attended, age at testing date, ethnicity and socioeconomic status. Socioeconomic status was assessed using the Family Affluence Scale (FAS) from the Health Behaviour in School-aged Children survey that assesses family wealth based on responses to items on car ownership, bedroom sharing, family holidays and computer ownership (Currie et al, 1997). A composite score of the FAS was calculated and participants were divided into low, middle or high affluence using the FAS criteria.

Physical activity

Physical activity was assessed using the self-report Physical Activity Questionnaire for Children (PAQ-C; Crocker et al, 1997). The PAQ-C is a 7-day recall instrument developed to assess general levels of physical activity during school term time and provides a summary physical activity score derived from nine items. These nine items are scored on a scale of 1-5 and relate to i) frequency of participation in specific spare time activities¹; ii) activity level in PE; iii) activity level at break-time; iv) activity level at lunchtime; v) frequency of participation in physical activity right after school; vi) frequency of participation in physical activity in the evening; vii) frequency of participation in physical activity at the weekend; viii) activity level during free time; and ix) level of activity on each day of the previous week. From the nine items a total measure of physical activity is calculated on the scale of 1-5 (1 = little or no activity and 5 = very high levels of activity). Each of the nine items was also considered individually to provide a more detailed insight into activity levels. Strengths of the PAQ-C are that it uses memory cues to stimulate accurate recall, provides a general measure of physical activity, and has established reliability and validity from several studies (eg, Crocker et al, 1997).

Self-report maturation

Maturation was self-assessed using the Pubertal Development Scale (PDS; Petersen et al, 1988). The PDS is a five-item scale that assesses on a four-point scale five physical changes in pubertal development (ie, growth spurt, breast development, body hair, skin changes, onset of menstruation), An overall pubertal score is calculated as a mean of the five items to generate a four-stage score of development, and was treated as a continuous variable.

Perceptions of competence

Physical self-perceptions were assessed using the Children and Youth's Physical Self-Perception Profile (CY-PSPP; Whitehead, 1995) which is designed to assess self-perceptions in areas relating to the physical self. These include:

Body attractiveness: perceived attractiveness of figure or physique, ability to maintain an attractive body and confidence in appearance;

¹ Activities included cycling, football, rollerblading/skateboarding, walking for exercise, jogging/running, swimming, gymnastics, aerobics, active games, dance, rugby, basketball/netball/volleyball, tennis/badminton/squash, hockey, golf, karate/judo/taekwondo, other

Physical condition: perceptions of level of physical condition, stamina and fitness, ability to maintain exercise, and confidence in the exercise and fitness setting;

Physical strength: perceived strength, muscle development and confidence in situations requiring strength; and

Sport competence: perceptions of sport and athletic ability, ability to learn sports skills and confidence in the sports environment.

The sport competence subscale is drawn from Harter's (1982) Self Perception Profile as this instrument had previously been validated with a similar age group (Whitehead, 1995). A fifth subscale measures overall physical self-worth (PSW). Each scale contains six items and the item score can range from one (low) to four (high) on a structured alternative scale, offering two opposing statements. The participant is first asked which of two statements best describes them and then decides whether it is 'really true' or 'somewhat true' of them.

The Children's Physical Activity Self-Efficacy Scale (Garcia et al, 1998) was added at phase two to assess self-efficacy. The questionnaire includes eight items (eg, I could exercise even if I was tired), and respondents indicate the extent to which this statement is 'very true' to 'not at all true' on a scale of one through four.

Sedentary behaviour

A measure of sedentary behaviour was also included to explore the relationship between sedentary activities and physical activity behaviour. The items relating to TV use, computer use and homework were modified from the Health Behaviour in School-aged Children survey (Todd & Currie, 2004). Three additional items deemed to reflect sedentary activities of adolescent girls were added, including reading books or magazines, 'hanging out' with friends and listening to music or the radio. The questions were split into weekday and weekend and provided a measure of the number of hours spent in each activity.

Motives for physical activity

Motives for physical activity were assessed using the revised Motivation for Physical Activity Measure (MPAM-R; Ryan et al, 1997). The MPAM-R is a 30-item questionnaire that assesses the strength of five general motives for participation in physical activity: enjoyment, competence, appearance, fitness and social. Participants respond to the items on a seven-point Likert scale.

Body Size variables

Body mass was assessed using a Seca precision dial scale (Seca, Vogel and Halke, Hamburg, Germany) and height and seated height was assessed using a portable Holtain stadiometer (Holtain, Crymych, Dyfed, UK), from which trunk and leg length were derived.

Skinfolds were assessed using Harpenden skinfold calipers at five sites on the right side of the body; the bicep, tricep, subscapular, iliac crest and medial calf. Assessments were carried out by accredited level one anthropometrists according to the procedures identified by the International Society for the Advancement of Kinanthropometry (ISAK).

Procedure

The original methodology and any subsequent amendments were approved by the School of Life Sciences Ethics Committee at Heriot-Watt University. All girls and parents/guardians provided written informed consent. The girls were reminded at each phase of the study that they were free to withdraw at any time. At each of the four data collection points, the researchers visited each of the schools and met with the appropriate staff members a month before data collection. The logistics of the data collection were confirmed and any questions the staff had were answered. A confirmation email, including a timetable (with details of the girls' times and rooms to be used) was sent back to the schools to be distributed to the girls.

Typically the data was collected over several days in each school. All the girls completed the questionnaire in a classroom setting prior to anthropometric assessment. It was sometimes necessary to split the girls into several groups throughout the day to ensure minimal disruption to lessons. A full explanation of the questionnaire was given before the girls started and, where appropriate, examples were given to ensure full understanding. The questionnaire was split up into 3 sections and there was a break in between each section. The girls were provided with a puzzle if they finished a section early so that they did not distract the other participants. On average the procedure took 1 hour and overall, with assistance from the research assistants, the girls were able to easily complete the questionnaires and no major problems were encountered.

Following completion of the questionnaire, the girls were allocated paired timetabled slots when they came to a private room to complete the physical measures of height, weight, five skinfolds and girth measurements. The measures took approximately 10-15 minutes per pair.

The phases of data collection were separated by 6 months. As a result, data was collected for phases 1 and 3 in summer, and 2 and 4 in the winter and the results may reflect seasonality differences (Tucker & Gilliland, 2007).

Data management and analysis

Data entry and analysis was undertaken using the Statistical Package for the Social Sciences (SPSS). The main statistical tools used were; analysis of variance (repeat measure ANOVA) to determine whether there were significant changes in physical activity, physical characteristics, maturation and perceptions of competence over the period of the study; correlation analysis to identify relationships between variables and multiple regression analysis and multilevel modelling to further investigate relationships between variables and inform understanding of causation. Further information on analysis used is included in appendix 1.

Results

The following section presents the main data and results. For more detailed results tables, please see appendix 2 and 3.

Demographic Characteristics

Table 1 shows the age of the girls at each stage of the data collection.

Table 1. Age of participants at each phase of data collection

	Period of Data Collection			
	May 2006 P7 Phase 1	Nov 2006 S1 Phase 2	May 2007 S1 Phase 3	Nov 2007 S2 Phase 4
Average age of participants	11.8 years	12.3 years	12.7 years	13.3 years
	N=207	N=163	N=154	N=119

Socioeconomic status was assessed at phase one and 26.3% were classified as low affluence, 39.5% as medium affluence and 34.1% as high affluence. Data on ethnicity was collected at phase two and 92% of the girls classified themselves as White British (93%) and 7% as minority ethnic groups.

Changes in physical activity levels from primary school to secondary school over an 18-month period

Table 2 shows the total scores for self-reported physical activity and a breakdown of the score into type of activity throughout the period of the study (please refer to methods section for more detail on the questionnaire). This is also represented in figure 2.

Table 2. Physical Activity Scores at each phase of data collection

Measure	n	Max score	Period of Data Collection			
			May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Total physical activity	117	5	3.0	2.6	2.8	2.6
Physical activity during spare time	116	5	1.8	1.8	1.7	1.6
Physical activity during school day (break & lunch time)	114	5	3.4	2.2	2.2	2.1
Physical activity after school	112	5	3.0	2.5	2.7	2.5
Level of activity during PE	114	5	3.7	4.0	4.2	4.1
Active travel to school	115	5	3.9	3.9	3.8	3.8
Number of days active for 60 mins+	113	7	No data	4.0	4.2	3.8

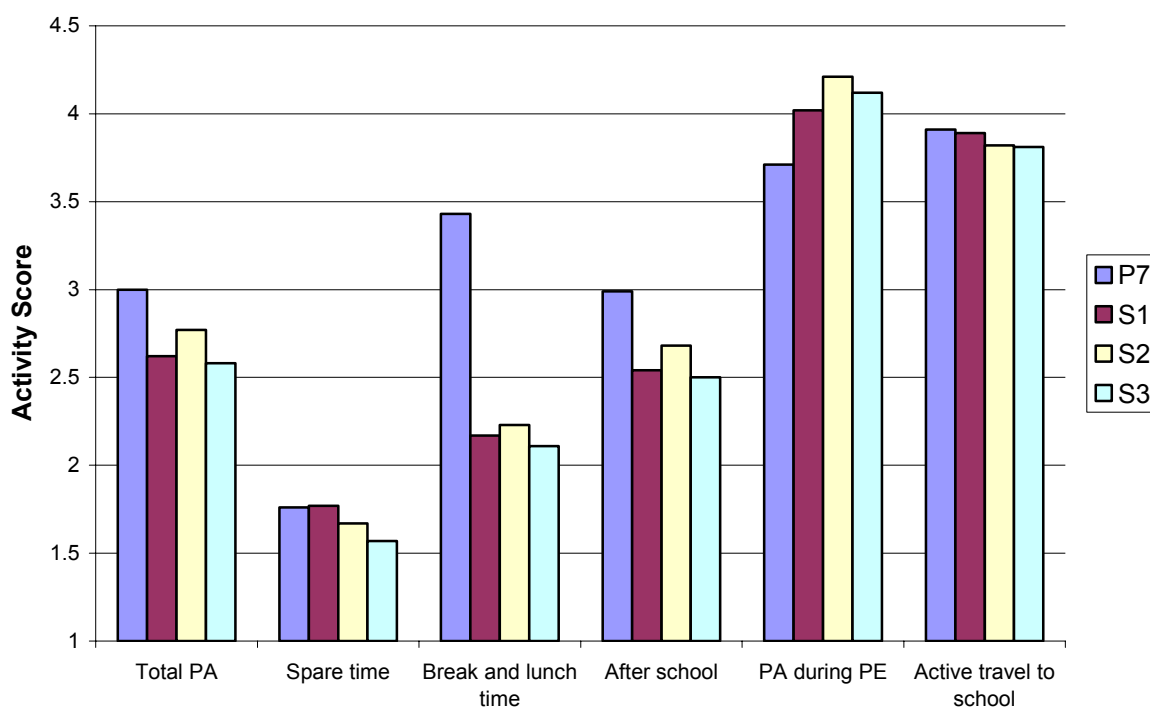


Figure 2. Average Physical Activity Scores over the Survey Period

Total physical activity

There was a significant overall decline in physical activity from May P7 to November S2, with the main drop between P7 and November of S1. Although there was a slight increase in activity from November S1 to May S1, this was not a significant change and may reflect seasonal effects.

Spare time activity

The measure of physical activity during spare time assesses the number of times that girls engaged in a range of 16 activities (eg, swimming, dance, hockey) outside of school time in the last seven days. The maximum score on this item is five, scored as follows: 1= no activities; 2 = 1-2 activities; 3 = 3-4 activities; 4 = 5-6 activities; 5 = 7 or more activities per week. Throughout the study the girls scored less than two, indicating a low level of physical activity during spare time. Overall, the number of times the girls participated in spare time activities in the last seven days significantly decreased across the period of the study and the number of times the girls did specific activities, either stayed the same or decreased across the time period. Interestingly, there were no activities that the girls became more involved in across the study period.

Of note is that levels of spare time activity did not decline between primary and secondary school, but they did decline with progression through the early stages of secondary school. In contrast, time spent active in lunch and break times during school, and immediately after school fell sharply from primary to secondary school, and thereafter the decline was less evident.

Level of activity during PE

Of importance is that the girls perceived that they spent more time being very active in PE in secondary than in primary school. Whether this is due to a change of perception of the level of activity (ie the girls may perceive organised sports as more 'active' than play and games more likely to be associated with primary school PE) or an actual change in activity levels during PE is not known.

Changes in body size variables, maturation and perceptions of competence

Over the period of data collection, the girls increased in height and weight, there were significant increases in sum of skinfolds between phases 1 and 2 and significant increases in waist circumference between phases 1 and 2 and between phases 3 and 4. BMI increased significantly between phases 2 and 3 (Table 3). The girls' stage of maturation increased steadily across the four phases as would be expected.

Table 4 shows the changes in perceptions of competence across the data collection period. There were few significant changes over the study period, but there was a significant decrease in perceptions of body attractiveness at phase three and four compared to phase one, and self-efficacy at phase four was significantly lower than at phase two.

Table 3. Body size variables and maturation at each phase of data collection

Measure	n	Period of Data Collection			
		May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Waist girth(cm)	108	63.3	65.0 **	65.3 *	66.4 **§§
Sum of 5 skinfolds (mm)	103	65.2	74.4 **	75.7 **	76.7 **
Body mass index	108	No data	19.4 **	20.0	19.9
PDS (indicative of stage of maturation) †	111	2.18 †	2.47 †	2.70 †	2.89 †

PDS, pubertal development scale; ** significantly different from phase 1 ($p < 0.01$); §§ significantly different from phase 3 ($p < 0.01$); †, all significantly different from each other

Table 4. Perceptions of competence at each phase of data collection

Measure (n=116)	Period of Data Collection			
	May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Sport competence	2.8	2.7	2.7	2.7
Physical condition	2.8	2.8	2.8	2.7
Body attractiveness	2.6	2.5	2.4 **	2.4 **
Physical strength	2.5	2.5	2.5	2.5
Self-efficacy	No data	2.9	2.8	2.7 ⁺⁺

** significantly different from phase 1 ($p < 0.01$); ++ significantly different from phase 2 ($p < 0.01$)

Influence of different factors on physical activity and changes in physical activity across the period of study

Data were collected on a number of variables that were considered to be influential on physical activity and thought to increase our understanding of why physical activity decreases in this sample. These are described below.

Age

Multilevel regression analysis identified a significant and negative effect of age on physical activity, but between phases two and four, age did not have a significant influence (Appendix 3, Table 1). This supports the interpretation of the descriptive data presented above (Table 2, above).

Demographic data

On socioeconomic status, there were no differences between the low, medium and high affluence groups on physical activity levels at any of the four phases or the change in physical activity across the four phases. There was a significant decline in physical activity levels between primary school (phase 1) and secondary school (phase 2) for all secondary schools apart from school F. Changes in physical activity over the study period are illustrated in Figure 3. Between phases 2 and 4, there was a significant decline in physical activity for only two of the secondary schools (C and D)

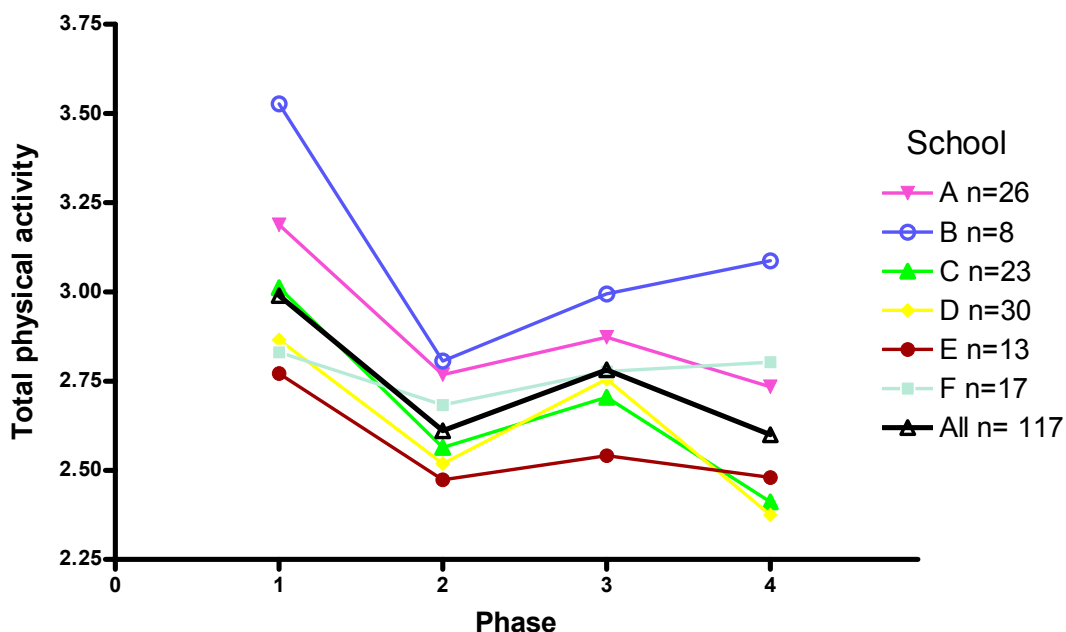


Figure 3. Overall physical activity scores across secondary schools.

Self-reported maturation

At each time point, and in changes across the four phases, self-reported maturation appeared to have limited influence on physical activity, or any interactive influence with other variables on physical activity. During the transition from P7 to S2, the experience of maturation does not appear to directly affect physical activity behaviour.

Body Size variables

There was no relationship between any of the body size variables and physical activity at any time point, and multilevel analysis identified none of the body size variables to be significant predictors of physical activity over the four phases.

Perceptions of competence

How competent the girls perceived themselves to be in a physical context was consistently related to how physically active they were. Table 5 shows the identified correlations between the measures of perceived competence and physical activity at

each stage². The variables of sport competence (ie, perceptions of sport ability, ability to learn sport skills), physical condition (ie, perceptions of level of physical condition, stamina and fitness), and self-efficacy (ie, confidence in ability to be active in the face of barriers) consistently have the strongest relationship with physical activity.

Table 5. Correlations between perceptions of competence variables and total physical activity at each phase of data collection.

Perceptions of competence at each phase	Data Collection			
	May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Sport competence	.44**	.35**	.48**	.44**
Physical condition	.46**	.39**	.46**	.47**
Body attractiveness	.21*	.09	.23**	.21**
Physical strength	.38**	.24**	.29**	.40**
Self-efficacy	No data	.28**	.57**	.61**
Total variance in physical activity accounted for by these variables	24%	21%	39%	41%

*Significant correlation between variables and total physical activity, * p<0.05; ** p<0.01

This was supported by multilevel modelling analysis which identified that even with age controlled for, sport competence and physical conditioning were important predictors of physical activity (Appendix 3, Table 2). This analysis also demonstrated that the physical self-perceptions of body attractiveness and strength, although identified through linear regression (see below) to be related to physical activity, are not important predictors of physical activity once age and other physical self-perceptions have been accounted for. The same trend was identified for data from phases two to four only, but interestingly, when self-efficacy was introduced to the model, self-efficacy was demonstrated to have a strong significant influence on physical activity whilst physical condition was no longer significant.

Further simple regression analysis can provide an indication of how much all of these variables together influence physical activity. The results indicated that at each phase these variables accounted for a meaningful proportion of physical activity levels (ranging from 21 to 41%), and that this proportion increased as the girls progressed through school (see Table 5).

² A correlation examines the relationship between two variables. A correlation score can range from -1 (a perfect negative relationship – as one variable increases in value the other decreases to the same extent) to +1 (a perfect positive relationship – as one variable increases in value, the other increases to the same extent). A simple rule of thumb is that a correlation value of ±0.1 represents a small effect, ±0.3 represents a medium effect and ±0.5 represents a large effect.

Interaction between body size variables, perceptions of competence and physical activity

Consistently across the four phases, body weight, sum of skinfolds, waist circumference and BMI were all strongly significantly and negatively correlated with the perceptions of competence; conditioning and body attractiveness and overall physical self worth, but not with self-efficacy.

Multilevel modelling identified that, between phases 2 and 4, with physical conditioning and sport competence controlled for, BMI was positively related to physical activity (no other body size variable or maturation had a significant influence on PA with self perceptions controlled). This means that when the most important perceptions of confidence are controlled for, girls who have a greater BMI (ie are heavier for their height) are actually more active than their peers.

Additional Variables of Interest

Sedentary behaviour

In contrast to the changing levels of physical activity across the study period, the number of hours of engagement in a number of sedentary behaviours both during the week and at the weekend has remained relatively stable (see Table 6). Exceptions include homework, where the girls did significantly less homework during the week and at the weekend at phases three and four than at phase two, and reading where the girls reported reading less at the weekend at phases three and four than at phase two.

At phases two, three and four there was a significant and negative correlation between hours spent watching TV during the week and total physical activity ($r=-.19$, $r=-.22$, $r=-.31$, respectively). Additionally, there was a significant negative correlation between hours spent watching TV at the weekend and total physical activity at phases 2 ($r=-.21$) and 4 ($r=-.31$).

Table 6. Hours spent in sedentary activities on weekdays and weekends at phases two, three and four

Behaviour	n	Period of Data Collection		
		Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
W-day TV	112	2.9	2.7	2.9
W-end TV	112	3.4	3.3	3.5
W-day Computer use	111	2.4	2.6	2.4
W-end Computer use	111	2.6	2.8	2.6
W-day Homework	109	2.1	1.5 **	1.6 **
W-end Homework	109	1.6	1.1 **	1.3 *
W-day Reading	110	1.5	1.2	1.2
W-end Reading	110	1.5	1.2 *	1.2 *
W-day Friends	108	3.7	3.8	3.6

W-end Friends	108	3.8	4.1	4.1
W-day Music	108	1.8	1.8	1.6
W-end Music	108	1.8	2.1	2.0

* significantly different from phase 1 ($p < 0.05$, ** ($p < 0.01$); W-day, week day; W-end, week end.

There was also a significant positive correlation between time spent with friends during the week and total physical activity at phase one ($r = .23$) and during the weekend and total physical activity at phase one ($r = .28$).

There were significant correlations between some of the body size variables and time spent in sedentary activity, but these were inconsistent across the phases of the study, and the correlations were weak.

Motives to be active

Table 7 shows the average scores for the five different motives at each of the four stages. As is evident, analysis indicated that motives for fitness and interest and enjoyment were consistently higher than the other three motives across each phase. Being motivated for social reasons and appearance related reasons increased in strength from primary to secondary school.

Table 7. Motives for physical activity at each phase of data collection

Measure (n=115)	Period of Data Collection			
	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4	Nov 06 (S1) 2
Motives - Social	3.91 + §†	4.36 ** +§†	4.41 ** +§†	4.27 + §†
Motives - Fitness	5.20	5.07	5.35	5.13
Motives - Appearance	3.84+ §†	4.28 **+†	4.64 ** +†	4.57 ** †
Motives - Competence	4.69 + †	4.86 + †	4.92 +†	4.71 + †
Motives – Interest and Enjoyment	5.06	5.20	5.19	5.01

** significantly different from phase 1 ($p < 0.01$); †significantly different from interest and enjoyment at same phase ($p < 0.01$); §significantly different from competence at same phase ($p < .01$); †significantly different from fitness at same phase ($p < .01$).

Table 8 summarises the relationships between motives to be active and physical activity using correlation analysis. In this study it was found that if girls were strongly motivated to take part in physical activity for reasons associated with interest and enjoyment, and being challenged and developing skills, then they were likely to have higher levels of physical activity. Being motivated for fitness-related reasons and social reasons were also associated with higher levels of physical activity; however, this was not as strong as the interest and challenge-related motives. Being motivated for reasons associated with improving one's appearance was not consistently related to being active.

Table 8. Correlations between motives for physical activity variables and total physical activity at each phase of data collection

Motives at each phase	Data Collection			
	May P7	Nov S1	May S1	Nov S2
Interest & Enjoyment	.23**	.38**	.53**	.59**
Competence	.30**	.39**	.50**	.60**
Appearance	.20**	.01	.04	.20*
Fitness	.23**	.32**	.34**	.46**
Social	.19**	.16*	.27**	.35**
Total variance in physical activity accounted for by these variables ¹	16%	15.6%	27%	37%

*Significant correlation between variables * p<0.05; ** p<0.01

¹Not all variables significantly contributed to the regression calculation

As shown in Table 8, regression analyses indicated that the motives for physical activity did account for a proportion of the variance in physical activity behaviour ranging from 16% to 37%. Interestingly, the amount of variance in physical activity accounted for by motives increased across the period of study, suggesting that as the girls progressed through school their motives had a stronger influence on their physical activity behaviour. An interesting preliminary finding of note, is that at May S1 and Nov S2, being motivated for social reasons had a negative contribution to the explained variance of physical activity. This is supported by the multilevel modelling analysis (appendix 3, table 3), whereby it is evident that with age and other motives controlled for, motivation for social reasons appears to be a negative predictor of physical activity.

Discussion

This longitudinal study examined changes in physical activity levels and patterns as girls progressed from primary school and through secondary school, and aimed to identify physical and psychological factors that may explain changes in activity levels.

Physical activity levels

The mean physical activity levels of the girls ranged from 3.0 (\pm 0.68) at phase 1 to 2.6 (\pm 0.60) at phase 4 using the PAQ-C multiple item self-report measure. This finding is consistent with previous research with similar age groups using the same questionnaire (Crocker *et al*, 2000; Welk and Eklund, 2005) from Canadian and Australian samples, respectively and indicates a medium to low level of physical activity.

Physical activity patterns

The data shows that physical activity levels decreased throughout the four phases with the main drop evident as the girls moved from primary to secondary school. This finding supports other research that has also shown a drop in physical activity around the time of transition from primary to secondary school (Inchley *et al*, 2008).

Most notable were decreases in physical activity during lunch and break indicating that at secondary school girls are less likely to engage in physical activity during 'free time' at school. Additionally, the girls' involvement in spare time physical activity (eg, gymnastics, hockey etc) decreased across the period of the study indicating that the girls were becoming less inclined to choose to engage in physical activity during their spare time. There was some evidence that level of involvement in some activities remained constant. However, overall the pattern indicated a decrease in spare time physical activity.

On average, girls reported that they spent more time being very active in physical education classes in secondary school compared with primary school. This finding may be due to the classes being more intensive with specialist physical education teachers.

In summary, these findings suggest that the decrease in physical activity evident can mainly be accounted for by decreases in physical activity when the girls have free choice of whether or not to be active. Specifically, girls are less active during free time at school and during their spare time.

Changes in maturation, body size and perceptions of competence

As expected, the girls became more mature across the period of the study and by the end of the study 54 girls had reached the latest stages of maturation. Additionally, the girls increased in body fat, waist circumference and BMI (but not across all four phases). These changes in body size and shape will be due to the influence of maturation, and also lifestyle factors including diet and physical activity levels.

The perceptions of competence did not change a great deal between primary and secondary school, with only perceptions of body attractiveness and self-efficacy becoming significantly less positive. This finding may suggest that it is not so much the individual's absolute levels of competence that are important, but their levels of competence relative to their environment. For example, in primary school low sport competence may not bother a girl, whereas in secondary school to be seen to be unable to do sport may be more of a barrier to being active. Additional research examining the perceived importance of each of the domains of physical self would be of interest to consider this further. Interestingly, self-efficacy for exercise did significantly decrease from phase two to phase four showing that the girls were becoming less confident in their ability to maintain regular activity.

Influence of different factors on changes in physical activity

Demographic factors

As the girls got older between phases 1 and 2, they became less active indicating that chronological age was influential on activity levels at this time. However, between phases 2 and 4, age was identified as not having an independent influence on physical activity highlighting that other factors were more influential on understanding the changes in physical activity. Existing literature reports inconsistent findings relating to the effect of age on physical activity. For example, Sallis et al (2000) reported that

only 19 out of the 27 studies reviewed showed a negative association between age and PA levels.

There were no differences in physical activity levels at each phase, or changes in physical activity across the period of the study between socio-economic groups. This finding is consistent with the general findings from the PASS study that showed there were no differences between high, medium and low affluence families on moderate to vigorous physical activity participation (Inchley, *et al*, 2008).

There was evidence that school attended could influence changes in physical activity. Specifically, one secondary school did not exhibit a significant change in physical activity from primary to secondary school, which may be due to the influence of either the primary or secondary school. Additionally, declines in physical activity across phases 2 and 4 were not evident in every school. These findings indicate that a decrease in physical activity is not inevitable, and that the school can be influential in preventing this decrease. Environmental factors relating to the school such as facilities, availability of activities and social support from teachers may be influential on the girls' choice to be physically active. Clearly, further in-depth research of the school environment and the specific impact that it has on physical activity would be of value.

Maturation and body size variables

Throughout the phases of data collection, maturation had no direct influence on physical activity levels. This finding supports some previous research (Armstrong *et al*, 1990) but is contradictory to other findings (Thompson *et al*, 2003). Additionally, body size had no direct influence on physical activity levels. In their review, Sallis *et al* (2000) described the findings regarding the relationship between PA and adolescent body weight and adiposity as 'indeterminate'. In contrast to this, in their review of the correlates of PA in adolescent girls, Biddle, *et al* (2005) concluded that in the majority of studies examined, increased BMI was found to be negatively related to PA; however this association was relatively small. These are critical findings, as they suggest that anecdotal preconceptions that larger, more mature girls are likely to be less active may not be as simple as hypothesised. That is, a girl's choice to be active may depend more on the way she perceives her ability to be active rather than directly on her physical attributes (see below for further discussion on this). As well, in this study, with perceptions of competence controlled for (see below), BMI was actually positively related to physical activity. This may suggest that where girls are equally competent, girls with higher BMI are more likely to be active (although it should be noted that this could be due to BMI representing greater muscle mass rather than greater body fat for height).

Perceptions of competence

How competent the girls perceived themselves to be in a physical context was consistently related to how physically active they were, and this is in line with previous literature in the area (eg, Crocker *et al*, 2006). These findings cannot indicate a causal relationship, but they do suggest that, for this age group girls' perceptions of competence in a physical setting are related to physical activity behaviour and that the impact of these perceptions appears to become increasingly important with age. Physical self-perceptions relating to sport competence were consistently identified as being most strongly related to physical activity. Sport competence relates to perceptions of sport and athletic ability, ability to learn sports skills and confidence in

the sport environment, and its importance suggests that being 'sporty' may lead to higher levels of physical activity and not being 'sporty' may result in lower levels. Additional research would be required to investigate this further and perhaps qualitative research could provide greater insight.

Consistent with previous research (eg, Biddle et al, 2005) self-efficacy for exercise was strongly positively associated with physical activity. Self-efficacy relates to how confident girls are that they have the ability to overcome barriers and be regularly physically active. Recently, Dishman et al (2004) suggested that physical activity interventions with adolescent girls should focus on increasing self-efficacy, and the current findings add further support to this suggestion. Strategies such as appropriate goal setting, role models and encouragement are all recognised methods of promoting self-efficacy that could be considered in an applied context.

Interaction between body size variables and perceptions of competence

The data also indicate that body size variables (eg, BMI, girth and skinfold measures) were negatively correlated with some perceptions of competence (ie, physical condition, body attractiveness and physical self-worth). Given that perceptions of competence are related to physical activity, this finding could suggest that there may be some marginal indirect influence of physical size on physical activity, via the influence of physical size on perceptions of competence. This provides further support for the concept that to improve physical activity levels, a focus on improving perceptions of competence may be critical to success. Further research would be of value to continue to monitor the changing influence of perceptions of competence over the later adolescent years.

Additional variables of interest

Sedentary behaviour

The majority of time spent in spare time sedentary activities did not significantly change over the study period in secondary school, and this is in contrast to other research that has shown time spent in sedentary activity increases with age over a five year period (Brodersen et al, 2007). In contrast, time spent in spare time physical activity did decline and this may suggest that these behaviours are relatively independent. However, there was a negative relationship, albeit relatively small, between time spent watching TV and physical activity across the phases in this group suggesting that those who watch TV may be less likely to be active. This finding supports some previous work (eg, Koezuka et al, 2006) but not all (eg, Sallis et al, 2000). At phase one, spending time with friends was positively related to physical activity and this may suggest that at primary school girls may be more likely to spend time together being active. This relationship disappeared at later phases.

We found a significant, though weak, relationship between measures of body size and sedentary activity at phases two and three. This finding shows that body size is related to sedentary behaviour, and could mean that sedentary behaviour leads to increased body size, or that increased body size leads to increased sedentary behaviour. However, no such relationship was evident between body size variables and physical activity across the period of data collection. These findings provide support to previous research that has highlighted that physical activity and sedentary activity should be

considered independently with respect to their contribution to overweight and obesity (Biddle, 2007).

Motives to be active

The reasons why people choose to be active can influence their physical activity behaviour. It is encouraging that the girls indicated that being active for interest and enjoyment reasons was one of the highest scoring motives across the four phases. This type of motive is intrinsic because it is related to satisfaction gained from the activity itself, and is generally associated with a more positive experience and longer term involvement. Being motivated to be active in order to improve fitness was also found to be a strong motivator. This is also encouraging as it shows the girls have an interest in improving their fitness and health. However, it should be noted that this type of motive is extrinsic and therefore not focused on the behaviour itself but the outcome, and if the girls no longer feel that they are improving their fitness then they would be more likely to stop engaging in physical activity.

It is of interest that being motivated for social reasons and appearance related reasons increased in strength from primary to secondary school. Although interest and enjoyment and fitness motives were still stronger, these changes may suggest that appearance and social reasons for being active were becoming more prominent for the girls. This could indicate that the secondary school environment has more of a focus on encouraging activity for social and appearance related reasons, or that the needs of the girls in relation to physical activity are changing. Both social and appearance related motives are extrinsic, and therefore individuals motivated by such reasons would be likely to maintain activity levels only if these needs were met. In contrast, girls who are motivated for intrinsic reasons are focused on the satisfaction gained from the activity itself.

All motives were positively associated with physical activity at each stage. Specifically, being motivated for interest and enjoyment was consistently strongly related to physical activity levels, supporting the suggestion above that this motive type is related to greater involvement in activity. Being motivated to enhance competence was also strongly related to physical activity. Fitness-related reasons and social reasons for participating were also positively related to physical activity; however, these relationships were not as strong as the interest and challenge-related motives. Being motivated for reasons associated with improving one's appearance was not consistently related to being active and at phases two and three there was no relationship evident. This could suggest that being motivated for appearance-related reasons is not a good indicator of activity levels and parents and teachers should be wary of over-emphasising such reasons. Interestingly, it was evident that the influence of motives on predicting physical activity increased across the four phases of data collection, perhaps reflecting the increasing autonomy of the girls in determining their own physical activity behaviour.

Longitudinal analysis undertaken over the 18 months of this study generally supported the cross-sectional findings and highlighted the importance of interest and enjoyment and fitness motives in influencing physical activity. Of note is that motivation for social reasons was a negative predictor of physical activity, suggesting that being motivated for social reasons does not lead to physical activity; perhaps because social needs are not being met by the physical activity opportunities available. Further research would be of value to consider this in more detail.

Conclusions

Girls' physical activity levels change considerably when moving from primary to secondary school. This study (based on over 200 pupils from on 17 primary and 6 secondary schools in the Edinburgh area) suggests that the change from primary to secondary school plays an important role in this fall in activity levels, and is possibly more influential than other physical changes generally associated with the changes in age, maturation and body size during this life stage. Of significant importance appears to be the way in which the girls perceive their competence in a physical environment, and in light of the above, interventions which aim to improve the confidence of girls to be active in structured physical education, and providing opportunities to be active in situations where their competencies are maximised, might provide a positive step towards minimising the fall in physical activity during this period.

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Appendix 1. Data Analysis

All data were double inputted into SPSS version 14.0 and subsequently screened for inconsistencies between the two spreadsheets. Prior to further analyses, the data were tested for the assumptions of parametric tests. Descriptive data (ie, frequencies, means etc) for the demographic variables were calculated.

Repeated measure ANOVAs were used to determine whether there were significant changes in total physical activity, different elements of physical activity, body size variables, maturation, and perceptions of competence across the period of the study. Subsequently, if significant changes were identified, paired sample t-tests with Bonferroni correction were used to identify specifically where these changes occurred across the time period.

In order to examine the influence of school and maturation group on changes in total physical activity, repeated measure ANOVAs with between subject variables (school or maturation group) and appropriate follow-up analyses were undertaken.

Consideration of the relationship between the main variables (ie, maturation, body size variables and perceptions of competence), and physical activity was undertaken using correlation analyses, simple multiple regression analyses and multilevel modelling analyses. Correlation analysis provides insight into associations between variables, but does not infer a causal relationship between the variables. Multiple regression analysis was also undertaken to provide insight into the extent to which groups of variables can predict variance in physical activity levels.

Changes in physical activity were also investigated using the multilevel modelling approach, and programme MLwiN (version 2.02). This approach is an extension of simple multiple regression analysis, and one of the key advantages of using this method of analysis is that it can deal with incomplete data sets by treating missing data at various time points as randomly distributed – ie if an occasion of data collection for a participant is missing, data on other occasions can still be included in the analysis.

Models are constructed such that variables are introduced in succession to explore their influence on the outcome variable, physical activity. All variables relating to body size, maturation, physical self perceptions and self-efficacy were introduced as fixed effect explanatory variables, with physical activity as the dependent variable.³

³ Multilevel modelling is appropriate for analysing hierarchically structured data, such as the present data set where by a simple two level hierarchy is defined as repeated measurements (level one) of individual participants (level two). In this data, a simple model is used where all parameters are fixed with the exception of the constant (or intercept term) which varies randomly at both levels one and two. The fixed part of the model describes underlying population trends, whereas the random part models the variation around this mean response. Significance is accepted if a variable's parameter estimate is twice that of its standard error (i.e t-ratio >2). Where a variable is introduced to the model, it is accepted to make a significant improvement to the model fit when the deviance statistic is reduced relative to the number of fitted parameters. Age was centred around the sample mean.

The additional variables (ie, sedentary behaviour and motives for physical activity) were examined using repeated measure ANOVAs with appropriate follow-up tests to examine changes across the study period. Further, repeated measure ANOVAs with appropriate follow-up tests were undertaken to identify the predominant types of motives at each phase. Consideration of the relationship between motives and physical activity was undertaken using correlation analyses, simple multiple regression analyses and multilevel modelling analyses.

Appendix 2. Results tables

Table 1. Age of participants at each phase of data collection

	Period of Data Collection			
	May 2006 (P7) Phase 1 (n= 207)	Nov 2006 (S1) Phase 2 (n=163)	May 2007 (S1) Phase 3 (n=154)	Nov 2007 (S2) Phase 4 (n=119)
Age	11.8 (0.3)	12.3 (0.3)	12.7 (0.3)	13.3 (0.3)

Mean (\pm standard deviation)

Table 2. Physical Activity Scores at each phase of data collection

Measure	Max score	Period of Data Collection			
		May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Total physical activity (n=117)	5	3.0 (0.7)	2.6 (0.6)	2.8 (0.6)	2.6 (0.6)
Physical activity during spare time (n = 116)	5	1.8 (0.4)	1.8 (0.5)	1.7 (0.5)	1.6 (0.4)
Physical activity during school day (break & lunch time) (n=114)	5	3.4 (1.0)	2.2 (0.5)	2.2 (0.6)	2.1 (0.6)
Physical activity after school (n= 112)	5	3.0 (1.3)	2.5 (1.1)	2.7 (1.2)	2.5 (1.2)
Level of activity during PE (n =114)	5	3.7 (1.1)	4.0 (0.9)	4.2 (0.8)	4.1 (0.9)
Active travel to school (n =115)	5	3.9 (1.3)	3.9 (1.4)	3.8 (1.0)	3.8 (1.5)
Number of days active for 60 mins+ (n = 113)	7	No data	4.0	4.2	3.8

Mean (\pm standard deviation)

Table 3. Body size variables and maturation at each phase of data collection

Measure	Period of Data Collection			
	May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Waist Girth (cm) (n= 108)	63.3 (6.3)	65.0 (6.8)**	65.3 (8.0)**	66.4 (6.6)**§§
Sum of 5 skinfolds (mm) n=103)	65.2 (25.1)	74.4 (30.6)**	75.7 (30.0)**	76.7 (28.2)**
Body Mass Index (n= 108)	No data	19.4 (3.3)**	20.0 (3.5)	19.9 (3.2)
PDS (indicative of stage of maturation) (n = 111) †	2.18 (0.6)	2.47 (0.6)	2.70 (0.6)	2.89 (0.5)

Mean (\pm standard deviation); PDS, pubertal development scale; ** significantly different from phase 1 ($p < 0.01$); §§ significantly different from phase 3 ($p < 0.01$); †, all significantly different from each other

Table 4. Perceptions of competence at each phase of data collection

Measure (n=116)	Period of Data Collection			
	May 06 (P7) 1	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
Sport competence	2.8 (0.6)	2.7 (0.7)	2.7 (0.6)	2.7 (0.6)
Physical condition	2.8 (0.6)	2.8 (0.6)	2.8 (0.6)	2.7 (0.5)
Body Attractiveness	2.6 (0.7)	2.5 (0.6)	2.4 (0.7)**	2.4 (0.6)**
Physical Strength	2.5 (0.6)	2.5 (0.5)	2.5 (0.5)	2.5 (0.6)
Self-efficacy	No data	2.9 (0.6)	2.8 (0.6)	2.7 (0.7)**

Mean (\pm standard deviation); ** significantly different from phase 1 ($p < 0.01$); **significantly different from phase 2 ($p < 0.01$)

Table 5. Hours spent in sedentary activities on weekdays and weekends at phases two, three and four

Behaviour	Period of Data Collection		
	Nov 06 (S1) 2	May 07 (S1) 3	Nov 07 (S2) 4
W-day TV (n=112)	2.9 (1.7)	2.7 (1.5)	2.9 (1.6)
W-end TV (n=112)	3.4 (1.7)	3.3 (1.7)	3.5 (1.8)
W-day Computer use (n=111)	2.4 (2.0)	2.6 (2.1)	2.4 (1.9)
W-end Computer use (n=111)	2.6 (2.1)	2.8 (2.3)	2.6 (2.2)
W-day Homework (n=109)	2.1 (1.2)	1.5 (0.9)**	1.6 (1.2)**
W-end Homework (n=109)	1.6 (1.3)	1.1 (1.1)**	1.3 (1.2)*
W-day Reading (n=110)	1.5 (1.4)	1.2 (1.1)	1.2 (1.2)
W-end Reading (n=110)	1.5 (1.4)	1.2 (1.4)*	1.2 (1.3)*
W-day Friends (n=108)	3.7 (2.3)	3.8 (2.3)	3.6 (2.5)
W-end Friends (n=108)	3.8 (2.6)	4.1 (2.6)	4.1 (2.7)
W-day Music (n=108)	1.8 (1.8)	1.8 (1.5)	1.6 (1.5)
W-end Music (n=108)	1.8 (1.8)	2.1 (1.9)	2.0 (1.8)

** significantly different from phase 1 ($p < 0.01$); W-day, week day; W-end, week end.

Appendix 3. Multilevel regression analysis

Table 1. Multilevel regression analysis for effect of age on physical activity

Fixed Effects		Phases 1-4		Phases 2-4	
		Coefficient	Standard Error	Coefficient	Standard Error
	Constant	2.775	0.043	2.671	0.042
	Age	-0.224	0.034	-0.034	0.047
Random	Level 2 Constant	0.220	0.032	0.188	0.030
	Level 1 Constant	0.173	0.013	0.136	0.013
Deviance Statistic		791.813		518.401	

A variable is considered statistically significant if the coefficient is more than twice that of the standard error ($p < 0.05$)

Table 2. Multilevel regression analysis for effect of physical self perceptions on physical activity

Fixed Effects		Model 1		Model 2	
		Coefficient	Standard Error	Coefficient	Standard Error
	Constant	1.551	0.166	1.590	0.152
	Age	-0.199	0.034	-0.195	0.033
	PSP sport competence	0.256	0.062	0.274	0.058
	PSP physical condition	0.151	0.064	0.161	0.062
	PSP body attractiveness	-0.016	0.046		
	PSP physical strength	0.061	0.057		
Random	Level 2 Constant	0.147	0.023	0.149	0.024
	Level 1 Constant	0.167	0.012	0.167	0.012
Deviance Statistic		730.744		731.934	

Table 3. Multilevel regression analysis for physical activity and motives to be active

Fixed Effects		Coefficient	Standard Error
	Constant	2.031	0.025
	Age adjusted	-0.199	0.035
	Interest & Enjoyment	0.098	0.031
	Competence	0.056	0.032
	Appearance	-0.009	0.020
	Fitness	0.069	0.029
	Social	-0.082	0.025
Random	Level 2 Constant	0.148	0.023
	Level 1 Constant	0.166	0.012
Deviance Statistic		729.192	