Journal of Public Health | Vol. 36, No. 4, pp. 599–607 | doi:10.1093/pubmed/fdt123 | Advance Access Publication 22 December 2013

Physical activity and screen time in adolescents transitioning out of compulsory education: a prospective longitudinal study

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ABSTRACT

Background Within the UK context, it is unclear whether physical activity and screen time changes between completing compulsory education and the period afterwards, and the factors associated with any change.

Methods A prospective population-based longitudinal design among adolescents ($n = 2204$ at baseline) was adopted. A self-report questionnaire was administered at baseline (final year of compulsory education) and follow-up (i.e. post compulsory education) to measure physical activity over the previous 7 days and screen time (weekday and weekend) in relation to recommended guidelines. Magnitude of change in physical activity and screen time and key influencing variables associated with changes were analysed.

Results For physical activity, there was a significant change in participants meeting guidelines at baseline but not meeting guidelines at follow-up with 81.0% not meeting guidelines at baseline and follow-up. For screen time, there was no significant change between baseline and follow-up, with 70.6% not meeting guidelines at baseline and follow-up. Gender was associated with the change in physical activity with a decline less likely in females.

Conclusions Findings reinforce the importance of reducing physical inactivity and sedentary behaviour during this transition. Factors associated with changes in physical inactivity and sedentary behaviour need further investigation.

Keywords correlates, inactivity, observational, school, sedentary behaviour, self-report, youth

Introduction

Many adolescents in the UK are insufficiently physically active and spend too much time engaged in sedentary behaviour.[1] In line with many other countries, UK guidelines for physical activity recommend that children and young people accumulate at least 60 min (and up to several hours) per day of moderate-to-vigorous intensity physical activity.[2] Moderate-to-vigorous intensity physical activity includes physical activities that range between breathing faster and an increase in heart rate (moderate) to breathing very hard and having a rapid heartbeat (vigorous).[2] The UK does not have a specific recommendation for sedentary behavior, although it is generally suggested that children and young people limit sedentary 'sitting' time for extended periods.[2] Studies investigating adolescents' compliance with sedentary behaviour guidelines commonly use screen time (time spent watching television and using a computer) as the measured 'proxy' variable, since total time in sedentary behaviour is difficult to measure, and it is has been shown that screen time constitutes a large proportion of total sedentary behaviour.[3] Some guidelines (e.g. American Academy of Pediatrics) recommend that children and young people should not spend >2 h a day engaged in screen-based activities.[4–6] In some studies, sedentary behaviour has been misunderstood to be solely a lack of physical activity (i.e. physical inactivity).[7,8] It has been suggested that

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sedentary behaviour is both a subset of physical inactivity[9] and also an independent behaviour that may or may not be associated with overall inactivity.[10,11] Sedentary behaviours, such as television viewing, are characterized by a postural position of 'sitting' or 'lying' and very low-energy expenditure.[2,12]

Studies have shown a decline in physical activity throughout adolescence; however, many of these studies are cross sectional in nature.[13] Investigations of sedentary behaviour are less conclusive, and this may be a result of both the limited number of studies and the use of varied proxy measures. Very few studies have simultaneously investigated physical activity and sedentary behaviour, especially beyond cross-sectional research. A key transition phase during adolescence in the UK is the period between completing compulsory education at age 16 years and then beginning further education (e.g. sixth form) or training/employment.[14] More specifically, school leavers have a number of options when they complete compulsory education including sixth form at school/sixth form at a further education college, more generally going to a further education college with no sixth form, starting an apprenticeship/training programme, general employment or unemployment. The common perception is that physical activity declines and sedentary behaviour increases during this period, but no studies in the UK provide clear evidence for this assertion based on a longitudinal design. The development of chronic diseases may be influenced by such behaviours during adolescence, and this transition phase is also important in determining on-going patterns of behaviour into adulthood.[15]

The study of factors associated with adolescents' physical activity is developing demonstrated by systematic reviews of correlates,[16–19] determinants[20,21] and reviews of systematic reviews.[22–24] In comparison, research into the factors associated with adolescents' sedentary behaviour (typically 'screen viewing') is less developed but gaining momentum as evidenced in systematic reviews of correlates[18,25,26] and determinants.[21] These reviews indicate that cross-sectional studies dominate the evidence base. Prospective longitudinal studies investigating factors associated with a 'change' in adolescents' physical activity and/or sedentary behaviour are rare, and none focus on the important transition out of compulsory education in the UK. Factors associated with adolescents' physical activity and sedentary behaviour may be identified through an ecological model that involves the interaction between intrapersonal, interpersonal and environmental factors, which influence health behaviours such as physical activity and sedentary behaviour.[27] The present study aimed to investigate a possible change in physical activity and screen time (as the proxy measure for sedentary behaviour), and associated factors, longitudinally during the transition out of compulsory education.

Methods

Study design and recruitment

This study was granted ethical approval by the Institutional Ethics Committee in February 2008. A prospective population-based longitudinal design was used. Data were collected via self-report questionnaire at two time points: at baseline, participants were still in compulsory education (Year 11) and at follow-up (post-compulsory education), participants had just completed the transition into further education [sixth form (e.g. at school) or further education college], employment/training or unemployment. At baseline, 24 out of 53 schools, in 1 county in the UK, consented for the questionnaire to be administered to pupils. The baseline sample consisted of 2204 participants (male, $n = 1191$; female, $n = 1009$; unknown, $n = 4$) aged between 14 and 17 years (some 14 year or 17 year olds ($n = 13$) were placed in this particular year group for academic reasons). At follow-up, questionnaires were administered via school sixth form (Year 12) visits at 13 of the original 24 schools by these schools agreeing for the researcher to go back into the schools and administer the questionnaire with questionnaires being completed by 544 participants from the baseline cohort. The remainder of the baseline cohort were no longer in a school, and were therefore contacted via mail where contact details were available ($n = 1255$) and 342 completed questionnaires were received (27.3% response). At follow-up, in total, 886 (40.2%) participants of the original 2204 participants completed a questionnaire. For analyses, it was decided that two separate data sets would be considered: analysis one (A1) ($n = 663$) contained participants with complete data, including both postcode and associated output area (OA) code (male, $n = 362$; female, $n = 301$) and analysis two (A2) ($n = 834$) contained participants with complete data, but missing postcode and/or associated OA code (male, $n = 447$; female, $n = 387$). The reason for having two separate data sets was due to both postcode and the associated OA code being required to determine the predictor variables of socioeconomic status and area of residence, thus A1 included these predictor variables but A2 did not. Figure 1 summarizes the cohort progress from baseline to follow-up.

Procedures

Data at baseline and follow-up were collected using a pre-piloted questionnaire, which was based on the physical activity and screen time questions used in a validated questionnaire: the modifiable activity questionnaire for adolescents.[28] The validity and reliability of the questionnaire has been reported in studies with adolescent populations.[29,30] The physical activity and screen time questions were amended to align to the

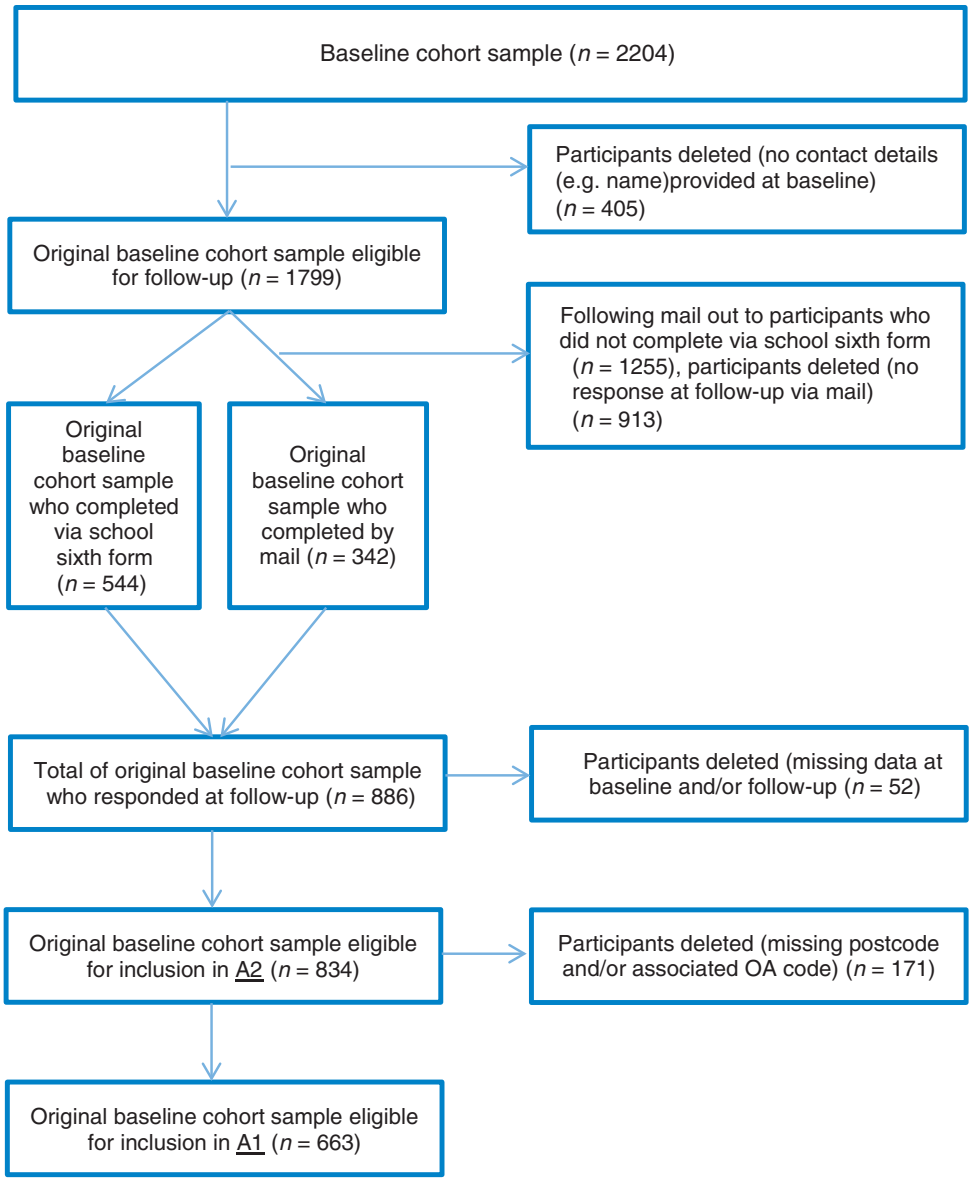

Fig. 1 Cohort progress and inclusion in final analyses (A1 and A2).

most recent UK recommended guidelines for physical activity[31] and general screen time guidelines[4,5] at the time of collecting data.

The outcome variables in this study were whether participants did or did not meet guidelines for physical activity[31] (dichotomized as 7 days × 60 min versus <7 days × 60 min) and screen time[4,5] (dichotomized as ≤14 h a week versus >14 h a week) at baseline and follow-up respectively. Physical activity was determined by asking participants the number of days in the previous 7 days they had undertook a total of at least 60 min of at least moderate intensity sport or physical activity. The outcome variable for screen time was determined by asking participants the number of hours a day (on a weekday and on a weekend) they were engaged in a number of screen-based activities (e.g. television viewing, computer use). Total hours per week of screen time were calculated by multiplying the mid-value of the option response range [e.g. '2 to 3 h' (mid value of 2.5)] by 5 (for the weekday response) or 2 (for the weekend response). These two values were then added together to give the total weekly screen time.

Within the framework provided by an ecological model, and taking account of variables included in previous studies, the selected predictor variables consisted of intrapersonal factors (gender, ethnicity, educational attainment, socioeconomic status) and environmental factors (school type, area of residence). The number of predictor variables included for

A1 and A2 was determined by a sample size assumption checking test being performed as advised by Peduzzi *et al.*[32] The Townsend Index of Deprivation Score[33] was used as the indicator of socioeconomic status and calculated based on 2001 census data (using OA codes corresponding to participants' postcodes). Area of residence was determined using the Rural and Urban Area Classification[34] using a four-level [urban (population density >10 000); small town and fringe; village; and hamlet and isolated dwellings] and dichotomous categorization as urban (population ≥10 000) or rural (population <10 000) based on the OA code.

Statistical analyses

Following data cleaning, statistical analyses were undertaken using the Statistical Package for the Social Sciences version 16.0 (SPSS, Inc., Chicago, IL, USA). Change over time from baseline to follow-up with regard to the outcome variables of meeting or not meeting guidelines for physical activity and screen time (coded 0 for 'not meeting guidelines' and 1 for 'meeting guidelines') was investigated using the McNemar test for significance of changes. Factors associated with any significant 'change' were investigated using binary logistic regression through simultaneous entry of predictor variables. The outcome variable was coded 0 for the 'absence of the relevant change' in physical activity/screen time and 1 for the 'presence of the relevant change' in physical activity/screen time. All predictor variables were treated as categorical variables.

Results

Change in physical activity and screen time

The descriptive statistics for all analyses (outcome variables and predictor variables) are presented in Table 1. As the findings are the same for A1 and A2, only A1 is referred to in the following results. At baseline, only a minority of participants were meeting guidelines for physical activity (14%) with 9.7% being male and 4.4% female (Table 1). For screen time, only 19.3% of participants were meeting guidelines with 10.4% being male and 8.9% female (Table 1). Similarly, at follow-up, only 8.9% were meeting guidelines for physical activity (6.2% male and 2.7% female) and 18.4% were meeting guidelines for screen time (10.1 male and 8.3% female) (Table 1). At baseline and follow-up, most of the sample remained in the same category of meeting or not meeting guidelines for physical activity (84.9%) and screen time (78.9%) (Table 2). Overall, at baseline and follow-up, the majority of participants were not meeting guidelines for physical activity (81.0%) and screen time (70.6%) with only a small minority meeting guidelines for physical activity (3.9%) and screen time (8.3%) (Table 2). However, there was a significant overall shift (i.e. a change) of participants from meeting physical activity guidelines at baseline to not meeting them at follow-up (Table 2). There was no significant change in compliance with screen time guidelines between baseline and follow-up (Table 2).

Investigation of factors associated with the 'change' in physical activity

As there was no significant change found for screen time (Table 2), only factors associated with the change (i.e. the decline) in physical activity were examined which encompassed a binary outcome: (i) 'did not change' from meeting guidelines at baseline to not meeting guidelines at follow-up (included participants 'not meeting guidelines at baseline to not meeting guidelines at follow-up', 'meeting guidelines at baseline to meeting guidelines at follow-up' or 'not meeting guidelines at baseline to meeting guidelines at follow-up') or (ii) 'did change' from meeting guidelines at baseline to not meeting guidelines at follow-up (included participants 'meeting guidelines at baseline to not meeting guidelines at follow-up'). Only gender was associated with the change in physical activity. In comparison with males, females were 42.4% less likely to change from meeting guidelines at baseline to not meeting guidelines at follow-up (Table 3). No significant associations were found for the other predictor variables.

Discussion

Main findings of this study

The first finding to highlight is that the majority of participants were not meeting guidelines for physical activity (81.0%) or screen time (70.6%) at either baseline or follow-up with only a very small proportion of participants meeting guidelines for physical activity (3.9%) or screen time (8.3%) at either baseline or follow-up. These findings confirm the physical inactivity and high screen time levels of adolescents during this transitional period. There was no significant change in screen time between baseline and follow-up. Conversely, there was a decline in physical activity through the transition as demonstrated by the significant movement of participants from meeting guidelines at baseline (still in education), to not meeting guidelines at follow-up (post-compulsory education). The only factor associated with the change in physical activity through the transition was gender. More specifically, compared with males, being female was associated with a lower likelihood of a decline in physical activity during the transition from compulsory education.

Table 1 Outcome variable and predictor variable frequencies (A1 and A2).

Outcome variables	*Frequency (and % of sample), A1 (% of sample male/female)*	*Frequency (and % of sample), A2 (% of sample male/female)*
Physical activity at baseline		
Not meeting guidelines	570 (86) (44.9/41)	713 (85.5) (43.5/42)
Meeting guidelines	93 (14) (9.7/4.4)	121 (14.5) (10.1/4.4)
Physical activity at follow-up		
Not meeting guidelines	604 (91.1) (48.4/42.7)	757 (90.8) (47.4/43.4)
Meeting guidelines	59 (8.9) (6.2/2.7)	77 (9.2) (6.2/3)
Screen time at baseline		
Not meeting guidelines	535 (80.7) (44.2/36.5)	665 (79.7) (43.9/36)
Meeting guidelines	128 (19.3) (10.4/8.9)	169 (20.3) (9.7/10.4)
Screen time at follow-up		
Not meeting guidelines	541 (81.6) (44.5/37.1)	670 (80.3) (44/36.3)
Meeting guidelines	122 (18.4) (10.1/8.3)	164 (19.7) (9.6/10.1)
Change in physical activity through transition		
Did not change from meeting guidelines at baseline to not meeting guidelines at follow-up	596 (89.9) (47.8/42.1)	745 (89.3) (46.4/49.2)
Did change from meeting guidelines at baseline to not meeting guidelines at follow-up	67 (10.1) (6.8/3.3)	89 (10.7) (7.2/3.5)
Predictor variables		
Gender		
Male	362 (54.6)	447 (53.6)
Female	301 (45.4)	387 (46.4)
Ethnicity		
White	625 (94.3)	792 (95.0)
Other	38 (5.7)	42 (5.0)
Educational attainment		
No	54 (8.1)	66 (7.9)
Yes	609 (91.9)	768 (92.1)
School type		
State/mainstream	604 (91.1)	764 (91.6)
Private/independent	59 (8.9)	70 (8.4)
Area of residence		n/a
Urban	462 (69.7)	
Rural	201 (30.3)	
Socioeconomic status		n/a
First quarter (most deprived)	166 (25.0)	
Second quarter	164 (24.7)	
Third quarter	167 (25.2)	
Fourth quarter (least deprived)	166 (25.0)	

What is already known on this topic

Self-report studies have shown that physical activity declines during adolescence in both cross-sectional[35,36] and longitudinal[37–41] studies. In relation to adolescents' compliance with the general recommendation of 60 min moderate-to-vigorous physical activity per day, self-report studies have mainly been cross sectional and have demonstrated varied compliance rates.[42–44] Most self-report studies investigating sedentary behaviour among adolescents have been cross sectional and indicate that screen time prevalence is high[45] and that specifically television viewing occupies the largest amount of total sedentary time.[46–49] However, there are few longitudinal self-report studies examining changes in adolescents' screen time.[41,50] The majority of self-report studies measuring

Table 2 McNemar test for significance of changes in physical activity and screen time at baseline and follow-up (A1 and A2).

Baseline	*Follow-up*		*McNemar test statistics*		
	Not meeting guidelines (frequency/ % of sample)	*Meeting guidelines (frequency/ % of sample)*	χ^2	*df*	P-*value*
Physical activity					
A1 ($n = 663$)					
Not meeting guidelines	537 (81.0)	33 (5.0)	10.89	1	*0.001
Meeting guidelines	67 (10.1)	26 (3.9)			
A2 ($n = 834$)					
Not meeting guidelines	668 (80.1)	45 (5.4)	13.80	1	*<0.001
Meeting guidelines	89 (10.7)	32 (3.8)			
Screen time					
A1 ($n = 663$)					
Not meeting guidelines	468 (70.6)	67 (10.1)	0.179	1	0.673
Meeting guidelines	73 (11.0)	55 (8.3)			
A2 ($n = 834$)					
Not meeting guidelines	575 (68.9)	90 (10.8)	0.086	1	0.769
Meeting guidelines	95 (11.4)	74 (8.9)			

*$P < 0.05$.

Table 3 Binary logistic regression analysis for the change in physical activity through transition as the outcome (A1 and A2).

	Odds ratio (OR)	*95% CI*	P-*value*
Predictor variables (A1)			
Gender (ref, male)	0.576	0.335–0.989	*0.046
Ethnicity (ref, white)	0.242	0.032–1.824	0.169
Educational attainment (ref, no)	0.836	0.333–2.099	0.703
School type (ref, state/mainstream)	0.501	0.150–1.674	0.262
Area of residence (ref, urban)	0.691	0.382–1.250	0.221
Socioeconomic status			0.168
First quarter (most deprived) (ref)	1.000		
Second quarter	1.798	0.855–3.777	
Third quarter	0.864	0.369–2.025	
Fourth quarter (least deprived)	1.608	0.760–3.406	
Predictor variables (A2)			
Gender (ref, male)	0.524	0.329–0.836	*0.007
Ethnicity (ref, white)	0.613	0.185–2.038	0.425
Educational attainment (ref, no)	0.996	0.438–2.267	0.992
School type (ref, state/mainstream)	0.498	0.176–1.407	0.188

*$P < 0.05$.

adolescents' compliance with sedentary behaviour guidelines have also been cross-sectional and investigated screen time (or television viewing only) having adopted the recommended guideline of 2 h a day for screen time and identified that screen time compliance rates are low.[44,51] No UK self-report studies have studied adolescents' compliance with recommended guidelines for physical activity or screen time over a longitudinal period during the transition out of compulsory education.

Systematic reviews on correlates of adolescents' physical activity[16–19] and sedentary behaviour[18,25,26] have mainly included cross-sectional studies with limited inclusion of prospective longitudinal studies thus have not specifically focused on factors associated with changes in either behaviour. Across these reviews, there is limited consensus on the consistency for the factors of interest in the present study and their association as correlates with either behavior, although gender (male) is consistently positively associated with adolescents' physical activity.[16–19] Regarding the factors of interest in the present study and their association with a change in adolescents' physical activity, one systematic review on 'determinants of change' has specifically summarized prospective studies in this area.[20] This review summarized that ethnicity (white Caucasian) is not associated and that the evidence is indeterminate for gender (male) and socioeconomic status. Area of residence, school type and educational attainment were not reported in this review due to no identified prospective studies. Another review summarized 'determinants' of adolescents' physical activity and sedentary behaviour (e.g. screen viewing) in prospective studies but did not focus specifically on factors associated with changes.[21] Regarding the factors of interest in the present study and their association with a change in adolescents' sedentary behaviour (screen

viewing), evidence is scarce reflected in a lack of prospective studies.[21]

What this study adds

First, the longitudinal decline in adolescents' physical activity during this transitional period has not been previously confirmed in the UK, and thus provides further insight into this area of research and builds on previous UK longitudinal studies showing a decline in adolescents' physical activity prior to this transitional point.[41] Secondly, the finding that females were less likely than males to decline in their physical activity contradicts the majority of studies which have concluded that female adolescents' physical activity declines more than male adolescents' physical activity.[37,40] Finally, this study has highlighted the large number of adolescents who were not meeting guidelines for physical activity or screen time at either time point, thus the high levels of physical inactivity and screen time of adolescents through this transition; a finding that has not been reported in the UK to date. Although all of these findings highlight the necessity to tackle physical inactivity and screen time use during the period of adolescence studied, intervention is needed before adolescence in order to halt the decline in physical activity in late adolescence. Despite no associations being found for the other intrapersonal and environmental factors and the change in physical activity, some of these factors have rarely been studied before, especially in relation to a longitudinal change in adolescents' physical activity, thus this contributes to the existing limited evidence base.

Limitations of this study

Social desirability and self-report bias were a main limitation whereby participants possibly over/under-reported their amount of physical activity or screen time. Consequently, in over-reporting physical activity or under-reporting screen time, compliance with recommended guidelines could be lower than reported. To limit social desirability bias, the researcher explained to participants at baseline, where possible in the school setting, that they were not being assessed or tested on the basis of their responses. Seasonality was possibly a limitation as there is seasonal variation in physical activity with the lowest physical activity levels among adolescents reported to be in the winter season and higher levels in the summer season.[52–55] In the present study, baseline data were collected between March and May (Spring season) and follow-up data were collected between September and December (Autumn season) and consequently there is relative comparability. Despite the possibility that seasonality was a limitation, there was no consistent message from the literature suggesting that it was necessary to design the study to control for the factor of season. Additionally, the period in which these data were collected was determined by school-term structures and in order to ensure that data collection timing was appropriate to capture the transition being studied. Finally, although data were collected from schools at baseline and follow-up, the resulting clustering of observations was not taken into account as each participant regardless of school attended was analysed as the unit of interest. Overall, strengths of this study include, first, the longitudinal design as physical activity and screen time were able to be monitored over a period of time, thus identifying if there were significant changes in each behaviour during this transitional period. Secondly, having achieved a final sample size (for analysis) that comprised 30% (A1) and 37.8% (A2) of the original baseline cohort is a significant strength. Thirdly, there was sufficient power to detect important associations having performed a sample size assumption checking test.

Acknowledgements

We would like to thank participants who took part in the study and staff at each of the schools for their co-operation. Special thanks to John Stevens and Rhiannon Wright at Active Gloucestershire.

Funding

C.S.O. was supported in this work by a PhD research studentship which was jointly funded by the University of Gloucestershire and Active Gloucestershire.

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