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Associations Between Selected Demographic, Biological, School Environmental and Physical Education Based Correlates, and Adolescent Physical Activity

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The study investigated associations between selected physical activity correlates among 299 adolescents (90 boys, age 12–14 years) from 3 English schools. Physical activity was assessed by self-report and accelerometry. Correlates represented biological, predisposing, and demographic factors as described in the Youth Physical Activity Promotion Model. Boys engaged in more self-reported ($p < .01$) and accelerometer assessed physical activity than girls ($p = .02$). Positive associations between sex (male), BMI, Perceived PE Ability, Perceived PE Worth, number of enrolled students, and physical activity outcomes were evident ($p < .05$). School-based physical activity promotion should emphasize sex-specific enhancement of students' perceived PE competence and enjoyment.

Regular physical activity participation is an important contributor to healthy lifestyles for children and adolescents (22). However, it is a pervasive finding that levels of physical activity decline with age, especially through adolescence (33). Physical activity guidelines have been developed to encourage participation, with the main recommendation being that children and adolescents engage in at least 60 min of moderate to vigorous physical activity (MVPA) every day (27,39). Though the prevalence of youth physical activity varies depending upon assessment method employed (6), current evidence suggests that many young people are not meeting the recommended guideline and that sedentary lifestyles remain a problem (25). The correlates of youth physical activity are multidimensional and affect participation (22). To address declining activity levels there is a need therefore for researchers and practitioners to better understand these correlates.

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The Youth Physical Activity Promotion Model (YPAPM; 40) was developed to facilitate the application of youth physical activity correlates to physical activity promotion. Within the YPAPM physical activity participation is predicted through interactions of four categories of correlates termed *predisposing*, *reinforcing*, *enabling*, and *personal demographic* factors. Though the YPAPM provides a broad perspective on the factors that influence habitual physical activity, it may also be applicable to specific physical activity contexts, such as school Physical Education (PE; 40). PE has been identified as an important setting to help accumulate physical activity as it provides many children with their only regular opportunity to engage in MVPA (37). However, the contribution of PE to youth physical activity is constrained by the limited frequency and duration of classes, and a lack of PE during school holidays (34). Enabling and predisposing correlates such as the PE environment, perceptions of PE competence, PE self-efficacy, PE enjoyment, and PE attitudes may affect youth physical activity most strongly when the YPAPM is applied to PE. In particular, Welk suggests that PE can play a primary role in influencing students' predisposing correlates relating to perceptions of ability and attitudes toward participating (40). It has been frequently reported that self-efficacy and perceived competence are positively associated with physical activity (2). Moreover, if children experience fun and enjoyment, they are more likely to participate, persist, exert effort and be committed to that activity (35). Enabling factors include environmental variables such as the school physical environment, which may also influence physical activity, as the majority of youth spend around 40% of their waking hours there (13) and most of their week day physical activity is accumulated at school (16).

As PE is a central aspect of school-based physical activity promotion one of its fundamental goals is to encourage young people to be physically active (26). However, there is little evidence available to evaluate whether this goal is being met. Therefore, the aim of this study was to investigate the association between selected demographic, biological, school environmental and PE-based correlates, and adolescent physical activity.

Methods

Participants and Settings

After obtaining institutional ethical approval and receiving written parental and student informed consent, data were gathered from 299 Year 8 and 9 students (U.S. grades 7 & 8; 90 boys, age 12–14 years) from three schools in the North West of England. Year 8 and 9 students were invited to participate in the research as physical activity levels decline most during early adolescence (33). Two of the three schools were coeducational community schools and the other school was an independent girls' school. Each school followed the English PE National Curriculum.

Procedures

Anthropometry. Stature, sitting stature and body mass were measured following standardized procedures. Body mass index (BMI) was calculated as (weight (kg) / height (m) ^{2}).

Maturity Status. Somatic maturity was determined by estimating years from attainment of peak height velocity (PHV; 20), which reflects the age at maximum growth rate in stature during adolescence. Years from attainment of PHV for each student were predicted using sex-specific regression equations that include stature, sitting height, leg length, chronological age and their interactions (24). This method has demonstrated acceptable agreement when correlated against skeletal age (r = .83).

Socioeconomic Status (SES). Socioeconomic status was represented by deprivation scores derived from participants' home postcodes using the National Statistics Postcode Directory database. SES was calculated from seven domains of deprivation, which include income deprivation, employment deprivation, health deprivation and disability, education, skills and training deprivation, barriers to housing and services, crime and the living environment deprivation domains (10).

Motivational Predispositions to Physical Education. Motivational predispositions were assessed using the Physical Education Predispositions Scale (PEPS; 18), which consists of 11 items, measured on a 5-point Likert scale. Perceived PE Worth is calculated from the mean of six items representing attitude affective and attitude cognitive. Perceived PE Ability is derived from the mean of the remaining 5 items which are indicative of perceptions of competence and self-efficacy in PE. The PEPS has previously demonstrated acceptable construct validity, internal consistency (Perceived PE Worth: a = .91; Perceived PE Ability: a = .89), and test-retest reliability with adolescent boys and girls (18).

Out of School Physical Activity Impact and Awareness. To assess students' perceptions of the role of PE in relation to their physical activity participation outside of school students were asked to indicate how much they agreed with two statements; (i) *What we learn in PE can have an impact on the types of physical activities, exercise and sports we take part in outside of school*, and, (ii) *PE lessons help make us aware of opportunities and places close to where we live, where we can take part in physical activities, exercise and sports.* These statements were scored on a 5-point Likert scale.

School Environment. A PE environment survey was completed by one PE teacher in each school to assess environmental enabling factors of physical activity. The main outcome variables of interest were number of students enrolled in the school, the percentage of students eligible for free school meals (FSM), number of indoor spaces for physical activity, number of outdoor spaces for physical activity, permanent resources per student, which were defined as facilities or equipment that are fixed and therefore not portable (e.g., basketball court markings, soccer goals), and curricular and extracurricular PE time (minutes). Further details of the survey are available from the authors.

Self-Reported Physical Activity. Habitual physical activity was assessed using the PAQ-C (7), which comprises nine items to derive an overall activity score. Each statement is scored on a 5-point Likert scale ranging from *low* (1) to *very high* (5) levels of activity, with overall the PAQ-C score calculated as the mean of the nine items. The PAQ-C has demonstrated validity and reliability as a measure of general physical activity (7). The PAQ-C, PEPS, and out of school physical activity

questionnaires were included in one packet and were administered together before PE classes commenced. Students were asked to answer all questions as honestly as possible, not to confer with others, and to ask if they were unsure about any of the questions.

Objectively Assessed Physical Activity. Physical activity was objectively assessed every 5 s for seven consecutive days using ActiGraph accelerometers (Model GT1M, ActiGraph LLC, Pensacola, FL). Sustained 20 min periods of zero counts were deemed to indicate that the ActiGraph had been removed, and total "missing" counts for those periods represented the duration that monitors were not worn (5). Inclusion criteria were defined as minimum wearing times of ³ 670 min and ³ 555 min on each week day and weekend day, respectively. These figures represent "non-missing" counts for at least 80% of a standard measurement day, which was defined as the length of time that at least 70% of the sample wore the monitor (5). Data from students with at least 3 valid measurement days (including at least 1 weekend day) were retained. Forty-eight students (27 boys) did not meet the minimum wear time criteria and so were excluded from analysis, leaving a final sample size of 113 (30 boys). Minutes of MVPA were calculated using age and gender-specific cut-points (14).

Data Analysis

Exploratory independent *t* tests were conducted using SPSS v. 15 (SPSS Inc, Chicago, IL) to assess sex differences in descriptive characteristics. ANCOVAs assessed sex differences between predictor and physical activity outcome variables, while controlling for any of the descriptive characteristics that were significantly different. For the main analyses multilevel modeling (MLM) was conducted, which is considered to be the most appropriate technique for nested data (38). A two-level data structure was used, where children were defined as the first level unit and school as the second level unit (38). Data were analyzed using MLwiN 1.10 software (Institute of Education, University of London, UK). An association model was used to assess the effects of the predictor variables on physical activity outcomes (minutes of MVPA, and PAQ-C score). Two analyses were conducted for each outcome variable, the first determined the effect of sex (Model 1), whist the second (Model 2) determined the effect of all other student and school level predictor variables. The effect of the predictor variables on each outcome variable was assessed for significance by comparing the—2 log likelihood (2*LL) for each model on the Chi-square distribution with 2 degrees of freedom and the Wald statistic (38). Alpha was set at $p < .05$ for all analyses.

Results

Descriptive Results

The descriptive characteristics of the students are presented in Table 1. Girls were younger and heavier than boys, and had significantly higher maturity offset scores ($t(293) = -22.48$, $p < .01$). School level characteristics are shown in Table 2. Enrollment in the three schools ranged from 512 to 1650 students. Schools had between 4 and 9 instructional spaces for PE and physical activity and between 42 and 71 permanent resources were reported.

Table 1 Descriptive Characteristics of the Sample (*n* = 295; mean ± *SD*)

	Boys	Girls	*p*
Age (years)	13.16 ± 0.58	13.06 ± 0.59	.20
Body Mass (kg)	52.43 ± 12.46	53.28 ± 13.17	.61
Stature (m)	1.59 ± 0.09	1.59 ± 0.07	.77
BMI (kg • m^2)	20.60 ± 3.78	20.88 ± 4.35	.60
Estimated years from PHV	-1.17 ± 0.88	0.92 ± 0.66	<.01
Deprivation score	34.42 ± 21.76	37.39 ± 21.49	.28

Table 2 School Level Characteristics

	School A	School B	School C
NOR	512	912	1650
% FSM eligibility	11	26	12
Indoor spaces	2	6	5
Outdoor spaces	2	3	4
No. permanent resources	42	71	70
Curricular PE time (mins • week)	90	120	120
Extracurricular PE time (mins • week)	660	600	1200

Exploratory Results: Predictor Variables

Estimated years from age at PHV was covaried into all analyses of sex differences. Students' responses to the statements about PE's influence on out of school physical activity impact and awareness are presented in Table 3. Boys reported higher values on schools' impact and awareness of out of school physical activity compared with girls, though differences were not significant. Boys and girls scored 3.94 (± 0.77) and 3.67 (± 0.59) respectively, on Perceived PE Worth and 4.14 (± 0.60) and 3.78 (± 0.58), on Perceived PE Ability (F 1, 285 = 5.00, p = .03, d = 0.61).

Exploratory Results: Outcome Variables

Mean physical activity counts • min, minutes in MVPA, and PAQ-C scores are presented in Table 3. ANCOVAs revealed that boys engaged in significantly more MVPA (F 1, 110 = 5.53, p = .02, d = 0.95) and reported significantly higher PAQ-C scores than girls (F 1, 285 = 9.24, p < .01, d = 0.57).

Multilevel Analyses Results

Minutes of MVPA were most strongly associated with sex [-15.82 (4.58)], Perceived PE Ability [9.08 (3.06)] and number of students enrolled in the school [0.01

Table 3 Mean (± *SD*) Scores of PE Predictor and Outcome Variables (PAQ-C Scores, Counts • Min, and MVPA) by Sex

	Boys	Girls	*p*	*d*
PE's impact upon out of school physical activity	4.03 ± 0.80	3.88 ± 0.63	.37	0.21
PE's influence of awareness of physical activity opportunities out of school	3.87 ± 0.82	3.69 ± 0.75	.63	0.23
PAQ-C	2.81 ± 0.58	2.50 ± 0.51	<.01	0.57
Counts • min	455.52 ± 157.99	329.29 ± 102.12	<.01	0.95
MVPA (min • day)	76.56 ± 27.61	54.36 ± 18.12	.02	0.95

(0.00); Table 4]. BMI and deprivation score were retained in the model as they significantly improved the fit. As boys were the reference group in the model, the significant negative outcome for sex describes how boys engaged in 15.82 min more of MVPA, compared with girls, and that 9.08 min of MVPA were accumulated for every 1 unit on the Perceived PE Ability scale. In addition, 0.01 min of MVPA were accrued for every 1 student on roll at school.

Table 5 demonstrates that PAQ-C scores were best predicted by sex [-0.22 (0.07)], BMI [0.01 (0.01)], Perceived PE Ability [0.01 (0.01)], and Perceived PE Worth [0.13 (0.06)]. Deprivation score and number of students enrolled in the school were retained as they significantly improved the model fit. Boys' PAQ-C scores were 4.4% higher than girls' and a there was a 0.2% increase in PAQ-C score for

Table 4 Results of MLM Analysis of Predictor Variables on Daily MVPA

	Model 1		Model 2	
	β ***(SE)***	**95% CI**	β ***(SE)***	**95% CI**
Constant	75.08 (3.85)**	67.53–82.63	31.89 (18.78)	-4.96–68.70
Sex	-20.73 (4.49)**	-29.53 to -11.93	-15.82 (4.58)**	-24.80 to -6.84
Perceived PE Ability			9.08 (3.06)**	3.08–15.08
Number of students enrolled			0.01 (0.00)*	-0.01–0.01
BMI			-0.37 (0.55)	-1.45–0.71
Deprivation score			0.08 (0.09)	-0.1–0.26

Note: The reference category for sex was boys.

*$p < .05$

**$p < .01$

Table 5 Results of MLM Analysis of Predictor Variables on PAQ-C Scores

	Model 1		Model 2	
	β *(SE)*	95% CI	β *(SE)*	95% CI
Constant	2.77 (0.06)**	2.65–2.89	0.99 (0.30)**	0.40–1.58
Sex	-0.27 (0.07)**	-0.41 to -0.13	-0.22 (0.07)**	-0.36 to -0.08
BMI			0.01 (0.01)*	-0.01–0.03
Perceived PE Ability			0.29 (0.06)**	0.17–0.41
Perceived PE Worth			0.13 (0.06)*	0.01–0.25
Deprivation score			0.00 (0.00)	0.00–0.00
Number of students enrolled			0.00 (0.00)	0.00–0.00

Note: The reference category for sex is boys.

*$p < .05$

**$p < .01$

every one unit increase in BMI. The findings also suggest a 5.8% increase in PAQ-C score for every one unit on the Perceived PE Ability scale, and a 2.6% increase in PAQ-C score for every one unit on the Perceived PE Worth scale.

Discussion

The study purpose was to investigate the association between selected demographic, biological, school environmental and PE based correlates, and adolescent physical activity.

The results concur with other studies by highlighting the significant predictive nature of sex on self-reported and objectively assessed physical activity, with boys engaging in more activity than girls. The sex difference in PAQ-C scores (0.31) was similar to those reported previously (7) with differences ranging from 0.20 to 0.48. The sex differences in accelerometer counts • min also followed a similar pattern to other studies (30). Comparing sex differences in MVPA with other studies can be problematic where different accelerometer cut-points have been used. However, results were comparable to other studies utilizing Freedson et al.'s (14) regression equations (36). Despite the consistent sex differences in MVPA, these studies generally reported higher volumes of activity than in the current study. Our data were collected during November and December when reduced daylight hours limit opportunities for outdoor physical activity. It is well established that children's physical activity is lowest during winter months (31) and greatest in the spring (19). This may explain why the physical activity levels in our sample were somewhat lower than those described in other studies, which often negated the confounding effects of seasonality by measuring physical activity over the full year (30).

The sex differences in physical activity may be attributed to a combination of factors (33). One of these is maturity status which may exert an influence on adolescents' physical activity (20). One of the consequences of biological maturation among girls is an increase in adiposity from approximately 15–22% body fat (20), which leads to changes in body shape and size that are generally opposed to competence in athletic events and physical activities (29). In contrast, biological maturation for boys involves an increase in muscle mass leading to enhanced speed, strength, power and performance on motor tasks and in physical activity (20). Some girls' responses to the physical changes associated with biological maturity include reductions in self-esteem, self-perceptions and poor body image which may contribute to negative feelings about their physical activity competencies (8). It has recently been reported that when the effect of biological maturation was controlled, the influence of sex on early adolescents' MVPA and physical self-perceptions diminished, suggesting that maturation may be a significant confounder when comparing physical activity of boys and girls matched by chronological-age (12). Differential treatment of boys and girls from their parents and teachers may also influence sex differences in physical activity (28). Evidence from the USA suggests that boys receive more parental support, parental facilitation, and parental encouragement to be physically active than girls (41). It has also been found in Canada and the UK that compared with girls, boys receive more feedback and attention, particularly praise, criticism, and technical information from their teachers (11,15). This enhanced feedback may lead to the advanced development of motor performance which has been found to heighten students' perceptions of competence, effort and enjoyment of PE (28). Though no data were collected to investigate the impact of feedback on physical activity participation in the current study, this should be an area for continued future research to enhance our understanding of teachers' influences on youth physical activity.

Perceived PE Ability was significantly associated with self-reported and objectively assessed physical activity, suggesting that adolescents' judgments about their abilities in PE may influence their habitual physical activity participation. These findings align with Competence Motivation Theory (17) and Cognitive Evaluation Theory (9), which contend that an individual's motivation varies according to changes in perceptions of their competence, autonomy, enjoyment, optimal challenge, and choice. The significant influence of Perceived PE Ability concurs with previous observations that children with high perceived PE competence participated in significantly more physical activity outside of school than peers with lower competence perceptions (3). These findings are consistent with the YPAPM, suggesting that a dynamic relationship exists between Perceived PE Ability and physical activity (40). Number of students enrolled in the school was also significantly associated with MVPA, indicating that more physical activity may be accumulated in schools with greater student numbers. Carron concluded that consequences of larger group sizes included greater availability and range of resources to enable participation in physical activity and sport (4). This is supported by our data (Table 2), which indicated that schools with higher student numbers had more permanent resources.

Other predictor variables that had a significant influence on PAQ-C scores included BMI and Perceived PE Worth. Students with higher BMI values reported greater physical activity levels, which contrast with previous research suggesting an inverse association between BMI and physical activity (1). Rowlands and colleagues suggest that controversy surrounds the relationship between physical

activity and levels of fatness, as this area is plagued with measurement problems (32). Discrepancy between studies may in part be attributable to small sample sizes, differences in the definition of obesity where weight status has been classified in this way, and disparities between the various methods used to assess and quantify physical activity (32). For example, it was observed that children with a BMI ³ 85th percentile increased their PAQ-C scores over time, compared with normal weight peers (1). In addition, another study reported that overweight adolescents tended to over-report physical activity levels (23). These findings are comparable to the current study in which analyses showed that the difference in standardized (z) scores between PAQ-C and MVPA for normal weight children was 0.03, compared with 0.10 for overweight/obese children, suggesting that normal weight children's self-reported physical activity better reflected their objectively measured MVPA. In agreement with previous studies, the results indicate that young people with higher BMIs may over report their physical activity levels possibly due to socially desirable responses, and perceptions that the physical activity is more intense than it actually is when assessed objectively (1,23). In the current study, a combination of over-reporting of physical activity and the acknowledged limitations of using BMI as a measure of body composition (21) may have resulted in the positive association between the two variables.

Perceived PE Worth also had a significant impact upon PAQ-C scores, which highlights the positive consequences of students perceiving PE as enjoyable and stimulating. While the possible affect of social desirability bias on both questionnaire datasets cannot be ignored, the observed association is consistent with Cognitive Evaluation and Self-Determination Theories (9). Findings also concur with previous research concluding that if children experience fun and enjoyment they are more likely to participate, persist, exert effort and be committed to that particular activity (3,35). Moreover, it has been reported that enjoyment in PE contributes to the quality (frequency and intensity) of activity participated in outside of school (3). These findings are consistent with YPAPM model (40) and emphasize the role of Perceived PE Worth in promoting active lifestyles outside school.

Strengths of this study were that it was based on the YPAPM (40) as a conceptual framework, it used a combination of physical activity assessment methods, and the multilevel data analysis allowed for the effects of individual and school level correlates to be considered simultaneously. Limitations include the possibility of sampling bias, the imbalance in the number of boys and girls and that a small number of schools were recruited to the study, which may have affected the statistical power. Therefore, the generalizability of the findings beyond the locale where the study occurred is likely limited. Furthermore, the study was cross-sectional and so causality cannot be inferred from the reported associations. The study took place during winter months thus seasonal effects may have influenced the physical activity data in particular. Finally, although a selection of correlates of youth physical activity was measured other potentially significant factors described in the YPAPM (40) were not included due to resource constraints.

This novel study supports the application of the YPAPM (40) to the school and PE context and suggests that sex, BMI, Perceived PE Ability, Perceived PE Worth and student numbers are most strongly associated with adolescent physically activity. It is recommended that PE teachers maximize opportunities to enhance students' enjoyment and perceptions of competence in PE, which are differentiated to the particular needs of girls and boys.

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