Physical education contributes to total physical activity levels and predominantly in higher intensity physical activity categories

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Word Count: 4318

Abstract

Children's engagement in physical activity of a vigorous intensity or higher is more effective at promoting cardiorespiratory fitness than moderate physical activity. It remains unclear how higher intensity physical activity varies between days when schoolchildren participate in physical education (PE) than on non-PE days. The purpose of this study was to assess how PE contributes to sedentary behaviour and the intensity profile of physical activity accumulated on PE-days than on non-PE days. 53 schoolchildren (36 girls, 11.7 ± 0.3 years) completed 5-day minute-by-minute habitual physical activity monitoring using triaxial accelerometers to determine time spent sedentary (<1.5 METs) and in light (1.5-2.9 METs), moderate (3-5.9 METs), vigorous (6-8.9 METs), hard (9-11.9 METs) and very hard intensity (≥12 METs) physical activity on PE-days and non-PE days. Sedentary time was higher on non-PE days than on PE-days (mean difference: 62 minutes, $p < 0.001$). Hard and very hard intensity physical activity was significantly higher on PE days compared with non-PE days (mean total difference: 33 minutes, all significant at $p < 0.001$). During the PE lesson, boys spent more time in hard ($p < 0.01$) and very hard ($p < 0.01$) physical activity compared to girls. Schoolchildren spent significantly more time in higher intensity physical activity and significantly less time sedentary on PE-days than on non-PE days. As well as reducing sedentary behaviour, the opportunity to promote such health-promoting higher intensity physical activity in the school setting warrants further investigation.

Keywords

Physical education, exercise, health, pedagogy, youth.

Introduction

Regular physical activity in youth is associated with improved health and wellbeing and a decreased risk of chronic disease (Andersen et al., 2006; Department of Health, 2009; Janssen and LeBlanc, 2010). However, children in England are currently not meeting physical activity guidelines (Department of Health, 2013) with only 21% of boys and 16% of girls aged 5-15 years undertaking the recommended guidelines of sixty minutes of at least moderate intensity physical activity on a daily basis (Department of Health, 2013). Physical activity promotion within schools and, in particular, during physical education (PE) lessons has been a focus of attention (Association for Physical Education [AfPE], 2015; United States Department of Health and Human Services, 2010).

Given that children and adolescents should achieve at least sixty minutes per day in moderate intensity physical activity, a Comprehensive School Physical Activity Program (CSPAP) has been suggested, particularly in the United States (Erwin et al., 2013). There are five suggested components of a CSPAP: a) a quality PE program; b) physical activity during the school day (i.e. recess and in class physical activity); c) physical activity before and after school (i.e. active commuting, before and after school programs and outside school clubs); d) staff involvement (such as classroom teachers); and e) family and community involvement.

A quality PE program is placed at the forefront of the CSPAP initiative (Erwin et al., 2013). The Institute of Medicine (2013) in the United States propose that students should be engaged in moderate-vigorous physical activity for at least 50% of PE lesson time (Institute of Medicine, 2013), and similarly, the United Kingdom (UK) Association for Physical Education (AfPE) proposed 'that pupils be actively moving for 50%-80% of the available learning time' (AfPE, 2015). Such targets have not typically been met in the past (Fairclough, 2003; Fairclough and Stratton, 2005b). However, research shows that students are more active on PE days than on non-PE days (Alderman et al., 2012; Dale et al., 2000; Morgan et al., 2007), and that this activity carries over as students are also more active in after school periods on PE days than on non-PE days (Alderman et al., 2012; Dale et al., 2000). In addition, students do not compensate when they are not offered opportunities to be active in school-based programs (Alderman et al., 2012; Dale et al., 2000).

Given that time in the PE lesson is limited (for example to twice a week in most UK schools, and once a week in US elementary schools) physical activity opportunities during the school day (i.e. recess, classroom physical activity integration, after school clubs and programs) are critically important to children meeting current guidelines for sixty minutes of daily physical activity, especially on non-PE days. Research has demonstrated that opportunities for physical activity in the classroom (Erwin et al., 2009) and during recess (Erwin et al., 2012) and particularly outside recess (Reznik et al., 2013) can increase contributions to daily physical activity and therefore reduce sedentary behaviour when provided. These ‘breaks’ have also been suggested by AfPE (2015) in their recent Health Position Paper. Supported by physical activity before and after school, alongside effective partnerships with families (van Sluijs et al., 2007), all of these interacting CSPAP components are imperative to providing daily physical activity opportunities for children and reducing sedentary behaviour. Time spent sedentary is associated with higher body fat, lower cardiorespiratory fitness and reduced psychosocial health in children (Tremblay et al., 2011) and specific guidance for children to minimise the amount of time spent in this behaviour are now included in the activity guidelines (Department of Health, 2011).

A further aspect of current physical activity guidelines is that children and adolescents should participate in *vigorous intensity* physical activity specifically, on *at least three days of the week* (Department of Health, 2011). Such emphasis is critically important given that vigorous physical activity (or higher) is a stronger predictor of cardiorespiratory fitness (Aires et al., 2010; Dencker et al., 2008; Denton et al., 2013; Gutin et al., 2005), body fatness

(Abbott and Davies, 2004; Parikh and Stratton, 2011; Ruiz et al., 2006) and vascular function (Hopkins et al., 2009) in children compared to moderate intensity physical activity. Cardiorespiratory fitness plays an important role in children's health with a number of studies demonstrating that low cardiorespiratory fitness is associated with both individual and clustered cardiometabolic risk factors (Bailey et al., 2012; Ruiz et al., 2007). However, few studies exploring relationships between health parameters and physical activity have measured vigorous intensity specifically or higher than vigorous such as above ≥ 9 METs or ≥ 12 METs (Rowlands et al., 2004). Vigorous intensity physical activity levels during the PE lesson (AfPE, 2008; Fairclough, 2003) have been shown to constitute around one fifth of lesson time (Fairclough and Stratton, 2005a). However, no previous studies have reported physical activity levels across all subcomponents including up to a very hard intensity (≥ 12 METS) during the PE lesson or reported such contribution to total daily physical activity levels or in relation to sedentary time. The purpose of this study was therefore to: 1) compare the amount of time spent sedentary and at various physical activity intensity levels between 11-12 year old boys and girls during the PE lesson, and 2) compare the amount of time spent sedentary and in each physical activity subcategory during PE and non-PE days in 11-12 year old boys and girls.

Methods

Participants & settings

This study was conducted in three co-educational state middle schools in the East of England following an invitation to the headteacher. A total of 53 participants (36 girls, 11-12 years old) were recruited into the study (school one n=21, school two n=9, school three n=23). To limit the effect of extraneous variables, recruited schools provided a single sex PE lesson and participated in a unit of invasion games (e.g. football, rugby, hockey) during the winter period (November-February), which accounted for the potential bias of seasonal effect (Tucker and Gilliland, 2007). Representative of the demographic differences among East of England Schools, ethnicity varied at each school with the average proportion as follows: White (87%), Black (2%), Indian (3%), Pakistani (1%), Bangladeshi (1%), Chinese (1%) and any other ethnic minority (5%). Socioeconomic status of the three state schools recruited, as represented by free school meal (FSM) eligibility was 4.3%, 9% and 12%, respectively.

Written parental consent and verbal assent was obtained from participants before the study, which received ethical approval from a University in Eastern England, UK commenced. Participants were excluded if they had any contraindications to taking part in physical exercise, e.g. unable to walk, musculoskeletal injury that has affected normal movement within the last month, disturbance of vision, congenital heart disease, uncontrolled exercise-induced asthma, diabetes, epilepsy or chronic obstructive pulmonary disease (COPD).

Measurements

Age was recorded as a decimal value for each participant. Socioeconomic status was calculated at school level based on FSM eligibility (Department of Education, 2010). Ethnicity was determined at school level using OFSTED (Office for Standards in Education, Children's Services and Skills, UK) data. Stature was measured to the nearest 0.1 cm using the portable Leicester Height Measure (Seca, Birmingham, UK). Body mass was recorded to the nearest 0.1 kg and body fat recorded using the Tanita bioelectrical impedance scales (BC-418MA). Body mass index (BMI) was calculated as body mass (kg) ÷ standing height^2 (m^2).

RT3® triaxial accelerometers were used to measure 5-day minute-by-minute habitual physical activity. PE lesson activity was measured each second but was converted into minute-by-minute epochs to be consistent with sampling times employed for non-PE habitual physical activity measurements, which were determined by memory restrictions of the RT3®

triaxial accelerometer. This avoided potential bias towards higher vigorous activity detection during 1 second sampling phases compared to minute phases (Edwardson and Gorely, 2010). Rowlands et al. (2004) cut-off points were used to determine time spent in each subcomponent, which included sedentary behaviour (< 288 counts per minute; < 1.5 METs), light physical activity (≥ 288 counts per minute; ≥ 1.5 METs), moderate physical activity (≥ 970 counts per minute; ≥ 3 METs), vigorous physical activity (≥ 2333 counts per minute; ≥ 6 METs), hard physical activity (≥ 3201 counts per minute; ≥ 9 METs) and very hard physical activity (≥ 4101 counts·min^{-1}; ≥ 12 METs), which were validated against oxygen consumption (r = .87). The inclusion criteria were a minimum wear time of three days (at least one PE day) (Mattocks et al., 2008; Trost et al., 2000) and acquiring a minimum daily wear time of nine hours (Mattocks et al., 2008). Data were analysed from 6am to 9pm (Rowlands et al., 2008). Data were checked for non-wear time and sustained 10 minute periods of zero counts removed during the data reduction process (Riddoch et al., 2004).

As with all PE research, extraneous variables may influence physical activity time. To limit the influence of these variables, PE was taught in single sex classes, lessons were scheduled for 50 minutes at each school, and all classes monitored were invasion team games (football, rugby, hockey). All children were requested to attach an accelerometer onto their waistband whilst in the changing rooms prior to each PE lesson. Lesson start and end time (i.e. excluding change time) was recorded for each of the PE lessons so data could be accurately extracted from the data downloaded. Lesson length was similar between schools (range 36.8 – 38.79 minutes); data are expressed as a proportion of total PE time to account for differences in PE lesson length.

Statistical analysis

All data were analysed using the R statistics programme (R Core Development Team, 2014). Descriptive characteristics of the participants are presented as mean ± SD, and independent t-tests were employed to ascertain any differences between boys and girls. The dependent variable (activity time) was square root transformed for each activity category prior to analysis to address non-normality of the model residuals. A 2 × 6 mixed design analysis of variance assessed the differences in sedentary behaviour and physical activity subcomponents between sexes during the PE lesson. In the presence of a significant interaction effect, pairwise *t* tests were conducted with Bonferroni adjustment, with statistical significance accepted at a two-tailed alpha level of $P \leq 0.05$. In addition, the magnitude of the observed effect is reported as a standardised mean difference (i.e. Cohen's *d*). Effect sizes were interpreted using Cohen's scale for effect sizes (Cohen, 1988) using the following qualitative descriptors; *"trivial"* (<0.2), *"small"* (0.2-0.6), *"moderate"* (0.6-1.2), *"large"* (1.2-2.0), *"very large"* (2.0-4.0). Cohen's *d* effect sizes are expressed with 95% confidence intervals to denote the imprecision of the estimate.

A hierarchical linear mixed model with participants (level 1 variance) nested within schools (level 2 variance) was fit using the *lme* package (Pinheiro, 2013) to analyse whether students' sex influenced the amount of time spent sedentary and in each physical activity subcomponent during PE and non-PE days. A marginal and conditional pseudo R^2 value was calculated in the *MuMIn* package (Barton, 2016) to estimate variance explained by the fixed (marginal pseudo R^2) and random (conditional pseudo R^2) effects of the model (Nakagawa and Schielzeth, 2013). Model fit was assessed using Akaike Information Criteria (AIC) (Akaike, 1976), where parsimonious model fit is represented by the lowest AIC value. In the presence of a significant interaction effect, a Holm-Bonferroni follow up test was performed with statistical significance accepted at a two-tailed alpha level of $P \leq 0.05$.

Results

Physical characteristics of participants are detailed in Table 1. Body mass (kg), body fat (%) and BMI ($kg.m^2$) was 5 kg [-6.04, -3.94] [t (591.81) = -9.3; $p < 0.01$], 6 % [-6.8, -5.2] [t (452.2) = -15.3; $p < 0.01$] and 1.8 $kg.m^2$ [t (571.0) = -10.1; $p < 0.01$] lower in boys compared with girls, respectively. All children met the physical activity guidelines on PE-days but only 85% of participants met the guidelines on non-PE days (88% of boys, 83% of girls).

Physical activity during the PE lesson

The mean (± standard deviation) amount of time spent by boys and girls in sedentary behaviour and each of the physical activity subcomponents during the PE lesson is presented in Table 2. On average, girls spent a larger amount of time than boys engaged in light physical activity [$F(1, 52) = 16.30$, $p < 0.001$]). In contrast, boys spent more time in hard [$F(1, 52) = 9.96$, $p < 0.01$] and very hard [$F(1, 52) = 7.41$, $p < 0.01$] physical activity, respectively, compared with girls. The amount of time spent in sedentary, moderate and vigorous activity was not statistically significantly different between boys and girls during the PE lesson (all $p > 0.05$).

Physical activity performed on PE day and non-PE days

The mean (± standard deviation) amount of time spent by boys and girls in sedentary behaviour and each of the physical activity subcomponents during PE and non-PE days is presented in Table 3. The interaction effect of the linear mixed model examined whether the amount of time spent sedentary and in each physical activity subcomponent varied between sexes on PE and non-PE days. When controlling for the effect of sex, the amount of time participants spent involved in sedentary [$F(1, 51) = 7.76$, $p = 0.005$], hard [$F(1, 51) = 6.00$, $p = 0.02$] and very hard [$F(1, 51) = 6.02$, $p = 0.01$] physical activity was statistically significantly different between PE and non-PE days.

The main effect of day (2 levels: PE-day, non-PE day) was significant for the categories of sedentary behaviour [$F(1, 51) = 15.4$, $p < 0.001$], hard physical activity [F(1,

51) = 57.05, $p < 0.001$], and very hard physical activity [$F(1, 51) = 66.11$, $p < 0.001$] (Table 3). After the Bonferroni adjustment for multiple comparisons, sedentary time was significantly greater on non-PE days compared with PE days in boys [$F(1, 49) = 20.44$, $p < 0.001$] but not in girls [F (1, 49) = 2.76, $p = 0.10$]. Both boys [$F(1, 49) = 39.64$, $p < 0.001$] and girls [$F(1, 49) = 23.41$, $p < 0.001$] spent more time engaged in hard physical activity on PE days compared with non-PE days. Similarly, the amount of time spent in very hard physical activity was higher on PE days compared with non-PE days in both boys [$F(1, 49) = 43.92$, $p < 0.001$] and girls [$F(1, 49) = 28.21$, $p < 0.001$].

The main effect of sex (2 levels: boys, girls) indicated statistically significant differences in sedentary behaviour [$F(1, 49) = 14.41$, $p = 0.005$] and hard physical activity [$F(1, 49) = 4.10$, $p = 0.04$] on PE-days and non-PE days (Table 3). After the Bonferroni adjustment for multiple comparisons, girls spent more time involved in sedentary activity than boys during PE days [$F(1, 49) = 21.92$, $p < 0.001$], but not on non-PE days [$F(1, 49) = 0.87$, $p = 0.35$]. Boys spent more time involved in hard physical activity than girls on PE days [$F(1, 49) = 7.92$, $p = 0.01$], but there was no statistically significant difference in the amount of time spent in hard physical activity on non-PE days between boys and girls [$F(1, 49) = 0.85$, $p = 0.36$].

Discussion

This study investigated the contribution of the PE lesson to total physical activity than on non-PE days by assessing time spent in six different sedentary behaviour and physical activity subcomponents. Results from this study highlight that the PE lesson provides a significant contribution to total physical activity by increasing time spent in higher intensity physical activity categories in particular. On PE days, all children achieved the recommended levels of physical activity, whereas on non-PE days, 85% achieved these guidelines, mirroring results from previous studies (Alderman et al., 2012; Dale et al., 2000; Department of Health, 2013; Fairclough and Stratton, 2005b; Morgan et al., 2007). Despite participants achieving the current physical activity guidelines on PE-days, evidence from the European Youth Heart Study (EYHS) (Andersen et al., 2006) suggests that children may need to accumulate 120 $min.d^{-1}$ of moderate to vigorous physical activity to reduce their risk of developing a number of cardiovascular disease risk factors. In the current study, this higher physical activity target was largely achieved on days which included PE (mean total minutes = 131.02 $min.d^{-1}$) whereas on non-PE days, the mean total minutes of moderate physical activity levels was below these recommendations (97.76 $min.d^{-1}$) (i.e. table 3). However, caution is applied to these interpretations due to the comparison between accelerometer brands, cut-points employed and the different processing methods used to create the proprietary counts (Welk et al., 2012).

Physical activity guidelines (Department of Health, 2011) for children have been recently updated, emphasising the importance of including vigorous physical activity on at least 3 days a week, in the context of the daily sixty minutes moderate-vigorous physical activity target. When investigating overall differences between PE days and non-PE days, an additional 19 minutes of higher intensity physical activity (vigorous physical activity and above) components during the PE day is highly important given that vigorous physical activity (or higher) is a stronger predictor of cardiorespiratory fitness (Aires et al., 2010; Dencker et al., 2008; Denton et al., 2013; Gutin et al., 2005), body fatness (Abbott and Davies, 2004; Parikh and Stratton, 2011; Ruiz et al., 2006) and vascular function (Hopkins et al., 2009) in children compared to moderate intensity physical activity. Moreover, during the PE lesson boys engaged in significantly more physical activity at higher intensities (hard and very hard physical activities) than girls (table 2). However, the amount of vigorous (mean average = 5.6 $min.d^{-1}$), hard (4.0 $min.d^{-1}$) and very hard (3.5 $min.d^{-1}$) physical activity achieved by both boys and girls highlights an important direct contribution of PE to health and fitness promotion over and above its contribution to daily accumulated moderate physical activity (mean average = 13.1 min.d^{-1}). Although previous studies have reported vigorous physical activity to account for approximately 21% of PE lesson time (Fairclough, 2003), there are no studies reporting activity levels across the additional higher intensity activity subcomponents and in relation to habitual physical activity levels on PE-days than on non-PE days. As mentioned above, this is important given that levels of physical activity at vigorous and/or above are strong predictors of cardiorespiratory fitness, body fatness and vascular function e.g. (Abbott and Davies, 2004; Gutin et al., 2005; Hopkins et al., 2009).

The additional 13 minutes of physical activity at a vigorous level and/or above achieved during PE lesson enhanced the overall mean daily total of higher intensity activity to almost forty minutes (39.58) min.d^{-1} compared with 20.56 minutes on non-PE days. This contribution to physical activity at a vigorous level and/or above on PE days may have important implications for cardiovascular health (O'Donovan et al., 2005). This supports previous evidence suggesting for some less physically active children, PE is the only time they can accumulate and participate in structured activity to contribute to daily moderate-to-vigorous physical activity levels (Fairclough and Stratton, 2005b; Jago et al., 2005; McKenzie, 2001). Current findings highlight that on PE days, and as a result of the PE lesson, there are important opportunities for engagement in higher intensity physical activity in particular.

Sex differences in physical activity were apparent on both PE-days and non-PE days and is consistent with previous research reporting that boys are generally more active than girls from as early as six years old through to adolescence (Nyberg et al., 2009; Riddoch et al., 2007; Wilkin et al., 2006). Boys spent more time in vigorous and hard physical activities on non-PE days than girls, but on PE days a significant difference in hard physical activity between sexes was also highlighted. On PE days, this heightened number of minutes spent in hard physical activity may have possibly been due to the focus of the PE lesson on invasion games, which have been previously shown to offer higher levels of PE-based physical activity to boys (Kulinna et al., 2003). In addition, boys completed an extra 31 minutes in vigorous physical activity or above during PE-days (17 minutes of which were accumulated during the PE lesson) than on non-PE days (i.e. table 3) and were more vigorously active than girls outside of PE lesson time on a PE day (Morgan et al., 2007). Previous research has highlighted that boys achieve greater levels of moderate, high and very high intensity physical activity along with longer durations of activity during recess than girls (n = 228; 5-10 year olds) (Ridgers et al., 2006).

During PE days an additional 26.81 min.d^{-1} of at least moderate intensity was accumulated by girls with the majority of this accounted for by the PE lesson itself. In boys, however, PE provided an additional 29.85 minutes of at least moderate intensity physical activity, but a further 17.05 minutes was accumulated outside of the structured lesson time. It may be that boys compensated physical activity on PE days by increasing sedentary time on non-PE days, which is a phenomenon supported by previous research in children aged between 8-11 years old (Fremeaux et al., 2011). However, this compensatory effect was less apparent in girls whose sedentary time varied by only 33 minutes between PE-days and non-PE days (table 3). Further research is required to examine what factors may explain apparent compensatory changes in children's physical activity and sedentary time and whether there are sex differences (Ridgers et al., 2014). It could also be argued that children were less active on non-PE days because there were no compensatory measures in place. Interestingly, AfPE's 2015 Health Position Paper (AfPE, 2015) shows that schools do not offer physical activity opportunities within the classroom, thus there may need to be a more targeted focus on training teachers in schools about the benefits of physical activity throughout the school day and how they can get children to be more active (Erwin et al., 2013) .

This study was not without limitations. The use of 1-minute epochs to record habitual physical activity levels may have potentially underestimated higher intensity physical activities (Aibar and Chanal, 2015). For example, more recent findings support the recommendation of using shorter epochs of less than ten seconds to assess habitual physical activity in children (Baquet et al., 2007) due to the typically short and sporadic nature of their vigorous activity bouts (Nilsson et al., 2002). Given the controversies found between accelerometry cut-points (Cliff and Okely, 2007; Guinhouya et al., 2006) the advance in devices such as the GENEActiv (Activinsights Ltd, UK) which capture raw, unfiltered accelerations allow for data processing procedures to be driven by the researcher rather than the proprietary developed manufacturer 'counts' (Fairclough et al., 2016; Rowlands and Stiles, 2012). However, activity cut-points for raw accelerations and counts are not yet comparable (Fairclough et al., 2016). In addition, this investigation was limited to a PE lesson that covered team invasion games only so it is not clear whether it is possible to generalise findings to other lesson types such as dance and movement skills. Therefore, replicating the study with a range of activities within PE and using different devices needs to be made in order to further substantiate the findings of this current paper. Finally, future research should use a greater sample size since the relatively small sample size (n=53) observed during this study may increase the sample variation, although this variation was controlled for in our analyses. A larger sample size would ensure that results would allow a more precise estimate of the true sample population.

Conclusion

The current study demonstrated that the PE lesson enhanced the physical activity profiles of 11-12-year-old schoolchildren, and was particularly beneficial in increasing physical activity of at least vigorous intensity, compared to non-PE days. The PE lesson itself had the most direct impact on physical activity levels for girls, although the possibility of increased compensatory sedentary time warrants further investigation. Interestingly, in boys, activity outside of PE on PE-days was also enhanced compared to non-PE days, a phenomenon which has not been reported in previous studies. Finally, there needs to be a targeted focus on training teachers in schools about the benefits of physical activity throughout the school day and how they can assist in increasing physical opportunities for children.

Funding

The Eileen Alexander Trust generously funded the work conducted for this study.

Acknowledgements

The authors would like to thank the participants who gave their time to the study. We would also like to thank the schools who helped facilitate the research.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article

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Table 1. Demographics for all participants and separated by sex.

Variables	All (n = 53)	Boys (n = 17)	Girls (n = 36)
Age (years)	11.65 ± 0.28	11.61 ± 0.33	11.67 ± 0.27
Height (cm)	148.25 ± 6.89	145.99 ± 6.78	149.31 ± 6.77
Body Mass (kg)	39.00 ± 7.36	35.61 ± 5.81	40.60 ± 7.53**
BMI (kg.m^2)	17.42 ± 2.58	16.21 ± 1.80	18.00 ± 2.71**
Body fat (%)	20.15 ± 5.64	16.09 ± 4.51	22.08 ± 5.11**

Notes: Significant difference between boys and girls scores (**$p < 0.01$).

Table 2. Time spent sedentary and in different physical activity subcomponents for the PE lesson for all participants and separated by sex. Data are mean ± standard deviation. Cohen's *d* effect sizes are reported with 95% confidence intervals.

Variables	All (n = 53)	Boys (n = 17)	Girls (n = 36)	Cohen's *d*	Descriptor
Physical Education lesson					
Sedentary ($min.d^{-1}$)	3.86 ± 4.14	5.03 ± 5.63	3.31 ± 3.15	-0.43 [-1.51, 0.65]	Small
Light physical activity ($min.d^{-1}$)	6.16 ± 4.41	3.03 ± 2.45***	7.64 ± 4.38***	1.21 [0.19, 2.24]	Large
Moderate physical activity ($min.d^{-1}$)	13.14 ± 5.73	11.90 ± 6.75	13.73 ± 5.19	0.36 [-1.19, 1.84]	Small
Vigorous physical activity ($min.d^{-1}$)	5.63 ± 3.29	6.81 ± 4.11	5.07 ± 2.71	-0.55 [-1.40, 0.20]	Small
Hard physical activity ($min.d^{-1}$)	3.98 ± 3.25	6.02 ± 4.27**	3.01 ± 2.08**	-1.04 [-1.82, -0.26]	Moderate
Very hard physical activity ($min.d^{-1}$)	3.51 ± 3.13	5.12 ± 3.86**	2.75 ± 2.43**	-0.82 [-1.60, -0.04]	Moderate

Notes: Significant difference in physical activity time between boys and girls (**p < 0.01; ***p < 0.001).

Table 3. Time spent sedentary and in different physical activity subcomponents on PE days and non-PE days for all participants and separated by sex.

Variables	All (n = 53)	Boys (n = 17)	Girls (n = 36)
PE day			
Sedentary (min.d^{-1})	413.08 ± 88.44 **¥¥ +++**	334.76 ± 67.81**	450.06 ± 71.65**
Light physical activity (min.d^{-1})	152.48 ± 43.97	116.50 ± 43.29	169.47 ± 33.02
Moderate physical activity (min.d^{-1})	91.44 ± 26.51	97.85 ± 34.37	88.42 ± 21.78
Vigorous physical activity (min.d^{-1})	22.07 ± 16.19	31.41 ± 21.73	17.65 ± 10.55
Hard physical activity (min.d^{-1})	10.40 ± 8.92 **¥ +++**	16.41 ± 11.30*	7.56 ± 5.82*
Very hard physical activity (min.d^{-1})	7.11 ± 7.35 **¥ +++**	9.91 ± 8.08	5.79 ± 6.69
Non-PE day			
Sedentary (min.d^{-1})	474.60 ± 87.11**¥¥ +++**	454.79 ± 91.68	483.95 ± 84.56
Light physical activity (min.d^{-1})	157.22 ± 48.41	131.31 ± 48.24	169.46 ± 44.02
Moderate physical activity (min.d^{-1})	77.20 ± 23.25	82.23 ± 22.19	74.83 ± 23.66
Vigorous physical activity (min.d^{-1})	13.94 ± 9.27	17.95 ± 11.53	12.05 ± 7.45
Hard physical activity (min.d^{-1})	4.43 ± 3.63 **¥ +++**	6.05 ± 4.58	3.67 ± 2.86

Very hard physical activity ($min.d^{-1}$)	2.19 ± 2.63 ¥ +++	2.45 ± 2.68	2.06 ± 2.63
Total wear time			
PE-day ($min.d^{-1}$)	696.58 ± 101.90	606.85 ± 85.93	738.94 ± 79.35
Non-PE day ($min.d^{-1}$)	729. 59 ± 90.01	694.79 ± 108.92	746.01 ± 75.82
Overall total wear time ($min.d^{-1}$)	713.08 ± 75.10	650.82 ± 67.21	742.48 ± 59.53

Notes: Data collected between 2010-2011 in the East of England.

Significant difference between boys and girls scores, * $p< 0.05$; *** $p < 0.001$. Significant main effect of time (PE-days *versus* non-PE days), +++ $p < 0.001$. Significant time x sex interaction ¥ $p < 0.05$, ¥¥ $p < 0.01$.