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Weekday and weekend sedentary time and physical activity in differentially active children

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ABSTRACT

Objectives: To investigate whether weekday–weekend differences in sedentary time and specific intensities of physical activity exist among children categorised by physical activity levels.
Design: Cross-sectional observational study.
Methods: Seven-day accelerometer data were obtained from 810 English children ($n = 420$ girls) aged 10–11 years. Daily average min day^{-1} spent in moderate to vigorous physical activity were calculated for each child. Sex-specific moderate to vigorous physical activity quartile cut-off values categorised boys and girls separately into four graded groups representing the least (Q1) through to the most active (Q4) children. Sex- and activity quartile-specific multilevel linear regression analyses analysed differences in sedentary time, light physical activity, moderate physical activity, vigorous physical activity, and moderate to vigorous physical activity between weekdays and weekends.
Results: On weekdays Q2 boys spent longer in light physical activity ($p < 0.05$), Q1 ($p < 0.001$), Q2 boys ($p < 0.01$) did significantly more moderate physical activity, and Q1–Q3 boys accumulated significantly more vigorous physical activity and moderate to vigorous physical activity than at weekends. There were no significant differences in weekday and weekend sedentary time or physical activity for Q4 boys. On weekdays Q2 and Q3 girls accumulated more sedentary time ($p < 0.05$), Q1 and Q2 girls did significantly more moderate physical activity ($p < 0.05$), and Q1–Q3 girls engaged in more vigorous physical activity ($p < 0.05$) and more moderate to vigorous physical activity ($p < 0.01$) than at weekends. Q4 girls' sedentary time and physical activity varied little between weekdays and weekends.
Conclusions: The most active children maintained their sedentary time and physical activity levels at weekends, while among less active peers weekend sedentary time and physical activity at all intensities was lower. Low active children may benefit most from weekend intervention strategies.

1. Introduction

Regular physical activity (PA) during childhood provides an array of health benefits.[1] Insufficient childhood PA and excessive sedentary time (ST) however are independently associated with negative health outcomes such as obesity and cardiometabolic risk.[2] To establish healthy lifestyles in children efforts to increase PA and reduce ST are public health priorities. To maintain good health, guidelines state that school-age youth accumulate at least 60 min day^{-1} of moderate-to-vigorous PA (MVPA) and reduce ST.[1]

Children's PA behaviours vary in bout frequency, duration, and intensity depending on the setting where they occur. For example, there is greater uniformity in school day activity compared to after-school and weekends, which allow more behavioural choice.[3] Within such contexts ST and PA levels can vary markedly due to the influence of multidimensional correlates.[4,5] Perhaps unsurprisingly, children tend to be less sedentary and active at weekends than on weekdays.[6–8] Weekends present more discretionary time for ST and PA, but also lack the regular routines and structures of school weekdays which determine a significant proportion of children's daily ST and PA.[3] It is unclear though whether engagement of high and low active children in ST and PA differs between weekdays and weekends. Previous research found weekend PA to be lower than on weekdays regardless of children's PA

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classification,[9–11] but seldom have such trends been examined by intensity-specific PA[11] or with ST as the outcome. Furthermore, weekends are an important context for activity promotion but it is unknown whether targeting specific groups of children may be a more efficient and efficacious intervention approach than a population-based one. Thus, the study objectives were to investigate whether hypothesised differences in weekday and weekend ST and specific intensities of PA exist among English children categorised by their PA levels.

2. Methods

Seventeen schools situated in a north-west England borough of over 300,000 people participated in this cross-sectional research during 2008, 2009, and 2010. Eight schools were recruited in 2008 and 2009 as part of a two year study of children's PA and health outcomes. In 2010 three of these schools were joined by nine others for the baseline phase of a school-based PA and nutrition intervention. In each year the same data collection procedures were applied and so for the purposes of this paper the data were aggregated. To be eligible to participate, children had to be in school Year 6 (aged 10–11 years) and be free from any physical disabilities preventing them for taking part in routine physical activities. A fixed available sample of all Year 6 children ($N = 992$; 307 in 2008, 295 in 2009, 390 in 2010) were informed of the research by their class teachers, received project and consent information, and were invited to participate. Written informed parental consent and child assent were received from 818 children (230 in 2008, 270 in 2009, 318 in 2010; 82.5% participation rate). Children participated at one time point only (i.e., 2008, 2008, or 2010). The ethnic origin of the children was white British, which reflects the ethnic demographic of the borough's school-age population.[12] In each year data were collected in one school per week between October and December. Ethical approval was obtained from the University Ethics Committee for each year of study (reference numbers 8.56 and 10/ECL/039). Ethical principles of the Declaration of Helsinki were adhered to throughout this research.

Stature was measured to the nearest 0.1 cm using a portable stadiometer (Leicester Height Measure, Seca, Birmingham, UK). Body mass was measured to the nearest 0.1 kg using calibrated scales (Seca, Birmingham, UK) with the children in light clothing and barefooted. Body mass index (BMI) was calculated (body mass (kg)/stature^2 (m^2)) and BMI *z*-scores were assigned to each child.[13] International Obesity Task Force age and sex-specific BMI cut-points were used to classify children as normal-weight or overweight/obese.[14] Home postal codes were used to generate indices of multiple deprivation (IMD) scores which indicated area-level socio-economic status (SES). IMD scores are a composite of seven domains of deprivation with higher scores representing higher degrees of deprivation.[15]

PA was objectively measured using ActiGraph accelerometers (GT1M and GT3x, ActiGraph LLC, Pensacola, FL) which were worn over the right hip for 7 consecutive days from waking until bedtime. Accelerometers were set to record data using 5 s epochs. ActiGraph cut points of 100 counts min^{-1},101–2295 counts min^{-1}, 2296 counts min^{-1}, and 4012 counts min^{-1} classified the boundaries of ST, light intensity PA (LPA), moderate intensity PA (MPA) and vigorous intensity PA (VPA), respectively.[16] In the absence of universally agreed cut-points to classify children's PA intensities, the cut-points of Evenson et al.,[16] were selected on the basis of a methodologically rigorous comparison study, which concluded that they have acceptable classification accuracy across a range of intensities and are appropriate for use with 5–15 year olds.[17] MPA and VPA are influenced by different factors and both may affect health outcomes differently.[7] Taking these reasons together provided a rationale for studying MPA and VPA separately from overall moderate to vigorous PA (MVPA). Non-accelerometer wear time was defined as at least 20 min periods of consecutive zero counts.[18] Wear time criteria were at least 540 min day^{-1} on week days and 480 min day^{-1} on weekend days, for at least two week days and one weekend day. These criteria have been shown to yield a reliability of 0.9 suggesting a high degree of consistency across days.[19] One hundred and seventy seven children did not achieve the wear time criteria, and technical failures downloading accelerometer data were experienced for a further 10 children. Missing data analysis was completed using missing at random (MAR) assumptions. There is no way to directly test these assumptions but relationships between health-related variables and missing data can indicate whether they hold true.[20] In our sample there were no differences in BMI, BMI *z*-score, weight status, and SES between the children who did and did not achieve the accelerometer wear time criteria ($p > 0.05$). On this basis we were satisfied that the data were MAR rather than missing in a systematic manner. To replace the missing data, multiple imputation[18] consisting of 100 iterations was undertaken separately for boys' and girls' missing weekday and weekend accelerometer data values using the Markov Chain Monte Carlo algorithm. Following five imputations, pooled values were generated and subsequently integrated into the data set prior to analysis.

Table 1
Descriptive characteristics of participants (M (SD)).

PA quartile and cut-off values (MVPA min day^{-1})	Boys				Girls			
	Q1 <57.8 ($n = 97$)	Q2 ≥57.8–64.3 ($n = 90$)	Q3 ≥64.4–72.4 ($n = 103$)	Q4 ≥72.5 ($n = 100$)	Q1 <47.7 ($n = 97$)	Q2 ≥47.7–52.7 ($n = 105$)	Q3 ≥52.8–60.1 ($n = 107$)	Q4 ≥60.2 ($n = 111$)
Age (year)	10.7 (0.3)	10.7 (0.3)	10.7 (0.3)	10.6 (0.3)	10.7 (0.3)	10.6 (0.3)	10.6 (0.3)	10.6 (0.3)
Stature (cm)	144.3 (6.6)	143.7 (7.1)	144.0 (6.4)	142.8 (7.5)	144.6 (7.2)	144.3 (7.4)	144.4 (6.5)	143.7 (8.3)
Body mass (kg)	38.6 (8.7)*	36.8 (8.4)	37.0 (8.3)	35.3 (6.6)	39.0 (9.9)*	39.4 (9.0)	38.1 (8.8)	37.1 (8.7)
BMI *z*-score	0.44 (4.46)	0.12 (1.36)	0.28 (1.16)	0.10 (1.10)	0.30 (1.34)	0.37 (1.27)	0.14 (1.24)	−0.01 (1.34)
Weight status								
Normal-weight (%)	71.1	82.2	82.5	88.0	72.2	70.5	80.4	80.2
Overweight/obese (%)	28.9*	17.8	17.5	12.0	27.8	29.5	19.6	19.8
IMD score	22.8 (15.3)	21.3 (14.3)	19.0 (11.4)	22.0 (14.9)	21.1 (14.9)	23.0 (15.7)	20.3 (13.8)	21.8 (14.9)
PA status								
Achieve 60 min MVPA day^{-1} (%)	12.4‡	82.2	98.1	99.0	0.0**	3.8**	27.1†	76.6

* Q1 > Q4, $p < 0.05$.
‡ Q1 < Q2–4, $p < 0.001$.
** Q1 and Q2 < Q3 and Q4, $p < 0.001$.
† Q3 < Q4, $p < 0.01$.