



The contribution of active play to the physical activity of primary school children

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ABSTRACT

Objective. To examine associations between active play and the physical activity of 10- to 11-year-old children.
Method. Cross-sectional study of 747, 10- to 11-year-olds, conducted between February 2008 and March 2009 in Bristol, UK. Mean minutes of moderate to vigorous physical activity (MVPA) and mean activity levels (counts per minute, CPM) were assessed by accelerometer. Frequency of active play was self-reported.

Results. Regression models indicated that frequent active play (5 or more days per week) was associated with mean daily activity levels (CPM) (girls: $p < 0.01$; boys: $p < 0.01$), but was only associated with mean daily MVPA for girls ($p < 0.01$). For leisure-time physical activity, active play was associated with children's CPM (girls: $p = 0.02$; boys: $p < 0.01$) and MVPA (girls: $p < 0.01$; boys: $p = 0.03$) on weekdays after school, but was only associated with weekend day CPM for boys ($p < 0.01$).

Conclusion. Active play is associated with children's physical activity with after-school potentially being a critical period. Strategies to promote active play may prove to be a successful means of increasing children's physical activity.

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Introduction

Many young people do not meet current UK physical activity guidelines (Craig et al., 2009). Preventing the well-established decline in physical activity that occurs as children enter adolescence may reduce future risk of cardiovascular disease and obesity (Department of Health, 2004). Previous childhood physical activity interventions have had little success (Van Sluijs et al., 2007), which could be due to a limited understanding of the complex factors which influence children's physical activity.

Time spent outdoors is a consistent predictors of children's physical activity (Sallis et al., 2000), and physical activity levels are greater out of school than during school (Gidlow et al., 2008). Weekday evenings and weekend days are leisure time. Young people have more freedom of choice for physical activity in leisure periods than during the structured school day, when organised physical activity may be more easily promoted (Cardon et al., 2009; Loucaides et al., 2009). Unstructured outdoor physical activity in children's free time, ("active play") could be a major contributor to total physical activity levels (Veitch et al., 2008). This study examined the contribution of active play to children's objectively measured physical activity.

Methods

Participants were recruited from 40 primary schools selected by location and the Index of Multiple Deprivation (IMD) score (a government-produced

area level measure of deprivation) for each school postcode. The final sample approximately reflected IMD tertiles of all state schools within a 15-mile radius of the University of Bristol, with twelve, sixteen and twelve schools respectively from high, middle and low IMD tertiles. In total, 1684 Year 6 children were invited to take part in the study and 986 children provided data (a response rate of 58.6%). Informed parental consent was obtained. The study was approved by a University of Bristol ethics committee.

Physical activity was assessed using ActiGraph GT1M accelerometers (ActiGraph, LLC, Pensacola, FL). A 10-s epoch was used to capture the intermittent nature of children's physical activity. Consistent with previous studies, data were collected for 5 continuous days, including 2 weekend days. Participants were included in the analyses if they provided ≥ 500 min of data for at least 3 days ($n = 747$) (Steele et al., 2009).

Mean activity levels (CPM) and minutes of moderate to vigorous intensity physical activity per day (MVPA), which is regarded as "health-enhancing" (Department of Health, 2004), were calculated. Both measures were averaged across the whole day and for the after school period (3 pm–6 pm) on weekdays, across both weekend days and across the whole week. Leisure-time physical activity was defined as the period from 3 pm until 6 pm on weekdays and all day at weekends. Physical activity that resulted in ≥ 3200 CPM was treated as MVPA (Puyau et al., 2002). While acknowledging the considerable debate over cut-points, we opted for 3200 because it was obtained from highly robust laboratory calorimetry (Puyau et al., 2002). However, given that there is a 9% difference in values between the GT1M monitors and the 7164 monitors, (Corder et al., 2007), a correction factor of 0.91 was used to give a cut-point of 2912 counts per minute.

Contextual information regarding children's physical activity was provided by children's self-reported active play. A single question asked: "How often do you play with your friends or family outside near your home?" Response categories were "Never," "1–2 days per week," "3–4 days per week" and "5 or more days per week." A pilot test of the reliability of this question with 47 Year 6 children produced a test-retest correlation of 0.72 and an alpha of 0.84, indicating good reliability. For regression analysis the four categories were converted to indicator variables with "Never" as the reference category.

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Table 1
Descriptive statistics for all participants with valid accelerometer data and stratified by gender.

| | All (n = 747) | | Boys (n = 341) | | Girls (n = 406) | |
|--|---------------|-------|----------------|-------|-----------------|-------|
| | n | % | n | % | n | % |
| Frequency of active play | | | | | | |
| Never | 78 | 8.3 | 27 | 6.2 | 51 | 10.1 |
| 1–2 days per week | 349 | 37.2 | 141 | 32.4 | 208 | 41.4 |
| 3–4 days per week | 288 | 30.7 | 140 | 32.2 | 148 | 29.4 |
| 5 or more days per week | 223 | 23.8 | 127 | 29.2 | 96 | 19.1 |
| Parental education | | | | | | |
| Up to GCSE | 397 | 46.3 | 183 | 46.0 | 214 | 46.5 |
| A level | 230 | 26.8 | 117 | 29.4 | 113 | 24.6 |
| First degree | 187 | 21.8 | 82 | 20.6 | 105 | 22.8 |
| Higher degree | 44 | 5.1 | 16 | 4.0 | 28 | 6.0 |
| Missing | 80 | 8.5 | 37 | 8.5 | 43 | 8.6 |
| | Mean | SD | Mean | SD | Mean | SD |
| IMD score | 21.4 | 16.5 | 21.3 | 16.1 | 21.4 | 16.9 |
| BMI SDS | 0.5 | 1.2 | 0.6 | 1.1 | 0.4 | 1.2 |
| Hours of daylight | 11.3 | 2.5 | 11.2 | 2.6 | 11.5 | 2.5 |
| Weekday physical activity | | | | | | |
| Mean minutes MVPA per day | 38.6 | 18.0 | 45.6 | 19.3 | 32.7 | 14.5 |
| Mean minutes MVPA after school (3–6 pm) | 10.4 | 6.9 | 12.0 | 7.7 | 8.9 | 5.7 |
| Mean CPM | 545.4 | 165.1 | 598.6 | 171.8 | 500.9 | 145.2 |
| Mean CPM after school | 678.2 | 332.2 | 719.0 | 336.7 | 634.4 | 315.8 |
| Weekend physical activity | | | | | | |
| Mean minutes MVPA per day | 33.6 | 25.8 | 39.4 | 29.4 | 29.1 | 21.7 |
| Mean CPM | 549.7 | 294.1 | 599.9 | 323.4 | 510.6 | 263.0 |
| Total weekly physical activity | | | | | | |
| Mean minutes of MVPA per day | 35.4 | 17.2 | 41.8 | 18.7 | 30.1 | 13.9 |
| Mean CPM | 545.7 | 168.9 | 597.9 | 175.2 | 501.9 | 150.3 |
| IMD score | 21.4 | 16.5 | 21.3 | 16.1 | 21.4 | 16.9 |
| Child BMI | 18.8 | 3.2 | 18.6 | 2.9 | 19.0 | 3.5 |
| BMI SDS | 0.5 | 1.2 | 0.6 | 1.1 | 0.4 | 1.2 |
| Hours of daylight per day (hours: minutes) | 11.2 | 2.3 | 11.2 | 2.6 | 11.5 | 2.5 |

Data were collected as part of the Bristol 3Ps Project in the Bristol area between February 2008 and March 2009. Abbreviations: BMI: Body Mass Index; MVPA: moderate-to-vigorous physical activity; CPM: counts per minute; SD: Standard deviation; SDS: Standard Deviation Score, IMD Score = Index of Multiple Deprivation Score.

Table 2
Physical activity levels presented by active play categories for girls and boys (Mean (SD)).

| | Girls (n = 406) | | | | p | Multiple comparisons* |
|--|-----------------|-------------------|-------------------|-------------------------|-------|-----------------------|
| | Never | 1–2 days per week | 3–4 days per week | 5 or more days per week | | |
| Weekdays | | | | | | |
| Mean minutes of MVPA per day | 29.1 (11.5) | 30.7 (15.0) | 33.8 (14.0) | 37.4 (14.4) | <0.01 | c, e |
| Mean minutes of MVPA after school (3–6 pm) | 7.5 (4.4) | 8.5 (5.2) | 9.3 (6.1) | 10.3 (6.5) | 0.04 | c |
| Mean CPM | 472.8 (127.1) | 473.4 (139.7) | 515.9 (148.9) | 555.6 (145.0) | <0.01 | c, e |
| Mean CPM after school | 579.1 (288.7) | 596.5 (310.9) | 656.9 (218.4) | 719.2 (323.9) | 0.02 | e |
| Weekends | | | | | | |
| Mean minutes of MVPA weekends | 26.7 (17.2) | 29.8 (22.4) | 29.0 (22.5) | 29.4 (21.5) | 0.89 | n.s. |
| Mean CPM weekends | 475.9 (241.2) | 501.5 (239.7) | 523.8 (321.1) | 532.6 (217.5) | 0.66 | n.s. |
| Whole week | | | | | | |
| Mean minutes of MVPA per day | 26.5 (10.5) | 28.9 (14.4) | 30.8 (13.4) | 33.71 (14.5) | 0.02 | c |
| Mean CPM | 466.7 (128.6) | 480.3 (143.2) | 515.9 (164.0) | 549.4 (142.5) | <0.01 | c, e |
| | Boys (341) | | | | | |
| | Never | 1–2 days per week | 3–4 days per week | 5 or more days per week | p | Multiple comparisons* |
| Weekdays | | | | | | |
| Mean minutes of MVPA per day | 40.9 (19.5) | 42.6 (17.1) | 47.2 (21.3) | 48.6 (19.0) | 0.06 | n.s. |
| Mean minutes of MVPA after school (3–6 pm) | 9.9 (6.6) | 11.0 (6.1) | 12.6 (8.63) | 13.3 (8.5) | 0.06 | n.s. |
| Mean CPM | 536.3 (143.6) | 570.2 (156.0) | 606.0 (184.8) | 642.3 (173.1) | <0.01 | c, e |
| Mean CPM after school | 568.0 (214.2) | 658.7 (268.1) | 721.4 (326.1) | 835.7 (413.7) | <0.01 | c, e |
| Weekends | | | | | | |
| Mean minutes of MVPA weekends | 37.0 (31.0) | 38.0 (27.7) | 39.3 (30.0) | 42.0 (30.8) | 0.84 | n.s. |
| Mean CPM weekends | 384.9 (151.7) | 539.1 (262.1) | 637.3 (370.9) | 680.8 (324.9) | <0.01 | b, c, e, |
| Whole week | | | | | | |
| Mean minutes of MVPA per day | 39.1 (19.9) | 39.5 (16.3) | 42.7 (20.8) | 44.3 (18.4) | 0.23 | n.s. |
| Mean CPM | 509.5 (138.9) | 559.5 (153.6) | 615.0 (189.8) | 650.0 (174.1) | <0.01 | b, c, e |

Data were collected as part of the Bristol 3Ps Project in the Bristol area between February 2008 and March 2009.

Abbreviations: MVPA: moderate-to-vigorous physical activity; CPM: counts per minute; SD: Standard deviation.

*Scheffé follow-up tests of significant multiple comparisons: a = never/1–2 days, b = never/3–4 days, c = never/5 or more days, d = 1–2 days/3–4 days, e = 1–2 days/5 or more days, f = 3–4 days/5 or more days.

Confounders

Body mass index (kg/m^2) was converted to an age and gender specific standard deviation score (BMI SDS) (Cole et al., 1995). IMD was derived from household postcode. Highest education within the household was obtained by parent report, and grouped into one of four categories (“Up to GCSEs/GCEs/O Levels or similar,” “A Levels/NVQs/GNVQs,” “First degree/Diploma/HNC/HND” and “Higher Degree”). To control for potential seasonal differences in physical activity, the hours of daylight available on the first day of data collection were calculated for each participant and treated as a potential confounder in all analyses.

Statistical analyses

Descriptive statistics were calculated for all variables, histograms plotted and skewness and kurtosis checked. Given that children's physical activity behaviours may be gender-specific (Jago et al., 2005), all analyses were run separately for boys and girls. Analysis of variance tests (ANOVAs) and follow-up Scheffé tests were used to examine differences in physical activity levels across the four categories of frequency of active play. Linear regression models were used to estimate the extent to which active play predicted leisure-time and total daily physical activity. All models were adjusted for child BMI SDS, household IMD score, parent education and hours of daylight. Robust standard errors were used to account for the clustering of participants within schools. Analyses were performed in STATA version 10.0 (College Station, Texas) with alpha set at 0.05.

Results

Descriptive statistics are presented for all participants and by gender in Table 1. Independent sample *t*-tests indicated that boys engaged in

more physical activity than girls after school, at the weekend and across the whole week for MVPA ($p < 0.01$) and CPM ($p < 0.01$).

ANOVA results are presented in Table 2. Girls who engaged in frequent active play (5 or more days per week) had higher mean activity levels (CPM) and minutes of MVPA on weekdays and across the whole week than girls who engaged in active play less frequently (never or 1–2 days per week). There were no differences in physical activity (CPM, MVPA) between active play categories at weekends. In contrast, boys who engaged in frequent active play had higher mean activity levels (CPM) on weekdays and weekend days, as well as across the week, compared to boys who engaged in active play less frequently.

Linear regression analyses indicated that frequent active play was associated with mean activity levels (CPM) on weekdays after school (girls: $p = 0.02$; boys: $p < 0.01$), but was only significant on weekend days for boys ($p < 0.01$). Frequent active play was also associated with children's MVPA on weekdays after school (girls: $p < 0.01$; boys: $p = 0.03$) but not on weekend days for either sex. Finally, frequent active play was associated with mean activity levels (CPM) across the whole week (girls: $p < 0.01$; boys: $p < 0.01$), but was only associated with MVPA across the whole week in girls ($p < 0.01$) (Table 3).

Discussion

The frequency of active play was associated with both leisure-time and total daily physical activity in 10- to 11-year-old children, but associations varied by gender and physical activity outcome variable. More frequent active play was associated with a higher mean activity

Table 3

Linear regression model predicting mean minutes of physical activity during leisure time and across the whole week, for girls and boys.

| | Girls ($n = 356$) | | | | | | | | |
|---|-------------------------------|----------------|-----------------|----------------------|----------------|-----------------|--------------------|---------------|-----------------|
| | CPM on weekdays after school | | | CPM on weekend days | | | Mean Daily CPM | | |
| | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> |
| Frequency of active play (Reference: Never) | | | | | | | | | |
| 1–2 days per week | 31.6 | –77.1 to 140.3 | 0.56 | 50.0 | –17.9 to 117.9 | 0.15 | 21.2 | –20.4 to 62.8 | 0.31 |
| 3–4 days per week | 71.1 | –55.2 to 197.3 | 0.26 | 61.9 | –25.0 to 148.8 | 0.16 | 47.1 | –4.2 to 98.4 | 0.07 |
| 5 or more days per week | 119.2 | 21.3 to 217.1 | 0.02 | 44.7 | –37.8 to 127.1 | 0.28 | 68.5 | 23.5 to 113.6 | <0.01 |
| Overall R^2 | Model $R^2 = 0.05$ | | | Model $R^2 = 0.04$ | | | Model $R^2 = 0.10$ | | |
| | | | | | | | | | |
| | MVPA on weekdays after school | | | MVPA on weekend days | | | Mean daily MVPA | | |
| | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> |
| Frequency of active play (Reference: Never) | | | | | | | | | |
| 1–2 days per week | 1.4 | –0.5 to 3.3 | 0.14 | 3.6 | –3.0 to 10.1 | 0.28 | 2.8 | –0.9 to 6.4 | 0.14 |
| 3–4 days per week | 1.9 | –0.1 to 4.0 | 0.07 | 4.4 | –3.5 to 12.3 | 0.27 | 5.0 | 0.8 to 9.3 | 0.02 |
| 5 or more days per week | 3.3 | 1.4 to 5.2 | <0.01 | 3.0 | –5.5 to 11.5 | 0.48 | 7.9 | 4.1 to 11.7 | <0.01 |
| Overall R^2 | Model $R^2 = 0.04$ | | | Model $R^2 = 0.04$ | | | Model $R^2 = 0.07$ | | |
| | | | | | | | | | |
| | Boys ($n = 298$) | | | | | | | | |
| | CPM on weekdays after school | | | CPM on weekend days | | | Mean Daily CPM | | |
| | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> |
| Frequency of active play (Reference: Never) | | | | | | | | | |
| 1–2 days per week | 54.1 | –47.1 to 155.2 | 0.29 | 148.4 | 65.7 to 231.2 | <0.01 | 28.6 | –36.1 to 93.4 | 0.38 |
| 3–4 days per week | 113.1 | 13.8 to 212.4 | 0.03 | 235.4 | 119.2 to 351.6 | <0.01 | 79.5 | 16.3 to 142.6 | 0.02 |
| 5 or more days per week | 257.3 | 113.6 to 401.1 | <0.01 | 301.7 | 182.4 to 421.0 | <0.01 | 132.3 | 60.4 to 204.2 | <0.01 |
| Overall R^2 | Model $R^2 = 0.15$ | | | Model $R^2 = 0.12$ | | | Model $R^2 = 0.17$ | | |
| | | | | | | | | | |
| | MVPA on weekdays after school | | | MVPA on weekend days | | | Mean daily MVPA | | |
| | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> | Coeff | 95% CI | <i>p</i> |
| Frequency of active play (Reference: Never) | | | | | | | | | |
| 1–2 days per week | 0.5 | –2.4 to 3.3 | 0.74 | 1.0 | –13.2 to 15.2 | 0.89 | –1.5 | –9.5 to 6.4 | 0.70 |
| 3–4 days per week | 1.7 | –1.4 to 4.7 | 0.28 | 0.4 | –16.1 to 16.9 | 0.96 | 0.6 | –7.2 to 8.3 | 0.89 |
| 5 or more days per week | 3.6 | 0.3 to 6.8 | 0.03 | 2.9 | –15.0 to 20.8 | 0.75 | 4.3 | –3.9 to 12.5 | 0.30 |
| Overall R^2 | Model $R^2 = 0.09$ | | | Model $R^2 = 0.05$ | | | Model $R^2 = 0.08$ | | |

Data were collected as part of the Bristol 3Ps Project in the Bristol area between February 2008 and March 2009. Analyses adjusted for: body mass index SDS, parental education, IMD Score and hours of daylight. Abbreviations: CPM: counts per minute; MVPA: minutes of moderate-to-vigorous physical activity; Coeff: Coefficient; 95%CI: 95% confidence interval.

levels (CPM) and a greater intensity (MVPA) of physical activity for both genders on weekdays after school. Frequent active play was only associated with higher mean activity levels (CPM) on weekends for boys. For total daily physical activity, more frequent active play was associated with higher mean activity levels in both genders, but was only associated with a higher intensity of physical activity for girls. The closer association between active play and objectively-measured physical activity after-school than at the weekend could be due to children spending more time involved in organised sports clubs or structured family-based physical activities on weekends, reducing opportunities for active play.

The data presented here indicate that active play is associated with more minutes of MVPA and higher mean activity levels (CPM), but the associations are not uniform across time periods or gender. Therefore, the recognition of active play, which could occur in short sporadic patterns, as a means for children to attain physical activity recommendations is an issue worth considering (Troost et al., 2002). Where energy balance and its implications for obesity are concerned, however, all movement and limited sedentary time are important (Fox and Riddoch, 2000) and those children who spend more time outside through active play appear more likely to accumulate larger amounts of total activity.

Study limitations and strengths

To our knowledge, this is the first UK study to assess the contribution of active play to total daily physical activity and MVPA, using objective measurement, in this age group. However, the cross-sectional design prevents us from determining the direction of association between active play and physical activity. Additionally, some statistically significant associations reflect relatively small differences with wide confidence intervals. It is difficult to establish whether the findings are an artefact of more active children choosing to engage in more active play, or that active play encourages children to be more active in general. Longitudinal studies are needed to determine the effect of active play on current and future physical activity levels and associated health outcomes.

Conclusion

Active play makes a significant contribution to health-enhancing physical activity of many primary school-aged children and therefore may be a valuable focus for future interventions. The after school period, when some children have greater freedom of choice, seems to be a critical period for active play. Current UK policy reports many benefits of active play for children such as encouraging social development, learning physical skills, and resilience to mental health problems (Department for Children Schools & Families and Department for Culture Media & Sport, 2008), which may not be obtained through more structured forms of activity such as organised sports clubs and team practices. The evidence presented here suggests that active play is also an important source of health-enhancing activity for many 10- to 11-year-old children.

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The authors declare that the funding source (British Heart Foundation) had no input into the study design, data collection, analysis and interpretation of data, in the writing of the report or the decision to submit the paper for publication.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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