Physical Activity Levels of Normal-weight and Overweight Girls and Boys During Primary School Recess

Gareth Stratton,† Nicola D. Ridgers,*† Stuart J. Fairclough,*‡ and David J. Richardson*†*

Abstract

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Objective: This study aimed to compare moderate-to-vigorous physical activity (MVPA) and vigorous physical activity (VPA) in normal-weight and overweight boys and girls during school recess.

Research Methods and Procedures: Four hundred twenty children, age 6 to 10 years, were randomly selected from 25 schools in England. Three hundred seventy-seven children completed the study. BMI was calculated from height and weight measurements, and heart rate reserve thresholds of 50% and 75% reflected children's engagement in MVPA and VPA, respectively.

Results: There was a significant main effect for sex and a significant interaction between BMI category and sex for the percent of recess time spent in MVPA and VPA. Normal-weight girls were the least active group, compared with overweight boys and girls who were equally active. Fifty-one boys and 24 girls of normal weight achieved the 40% threshold; of these, 30 boys and 10 girls exceeded 50% of recess time in MVPA. Eighteen overweight boys and 22 overweight girls exceeded the 40% threshold, whereas 8 boys and 8 girls exceeded the 50% threshold.

Discussion: Overweight boys were significantly less active than their normal-weight male counterparts; this difference did not hold true for girls. Even though nearly double the number of normal-weight children achieved the 40% of MVPA during recess compared with overweight children, physical activity promotion in school playgrounds needs to be targeted not only at overweight but at other health parameters, as 40 overweight children met the 40% MVPA target proposed for recess.

Key words: physical activity, heart rate, girls and boys, overweight, school recess

Introduction

The physical activity and adiposity of children is currently a major public health concern primarily because of the consistent upward trend in overweight in youngsters (1–3). Obese children have an increased acute risk of insulin resistance (4), type 2 diabetes (5), and dyslipidemia (6). Overweight youngsters are also more likely to experience clustered risk and have lower levels of physical activity (7) and to suffer poorer psychological health than their normal-weight peers (8). Furthermore, overweight youngsters are at increased risk for adult overweight and obesity (9). Being overweight has long-term consequences on all-cause mortality and cardiovascular disease, which suggests that the prevention and treatment of overweight at an early age could reduce the impact of future adult disease and promote health and well-being.

Physical activity and diet are the obvious bedrocks of combating overweight. Indeed, investigations into habitual physical activity patterns of youngsters mainly suggest that children who are overweight are less active (10,11) and have poorer fundamental movement skills than those who are normal weight (12). Moreover, there is consistent evidence that boys are more habitually active than girls (13–15). Most of these studies report habitual activity levels and do not account for variations in "opportunities" to be active. In habitual settings, overweight children favor sedentary behaviors more than their normal-weight peers (16). There are little, if any, data reported on normal-weight and over-

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*Research Into Exercise, Activity and Children's Health (REACH) Group, †Research Institute for Sports and Exercise Sciences, and ‡School of Physical Education, Sport and Dance, Liverpool John Moores University, Liverpool, United Kingdom.
Address correspondence to Gareth Stratton, Research Institute for Sports and Exercise Sciences, 15–21 Webster Street, Liverpool John Moores University, Liverpool, UK.
E-mail: G.Stratton@ljmu.ac.uk

weight children in a context where there is equal opportunity and the choice to be physically active is readily available. Environments that promote healthy behavior are required to combat overweight and obesity in youngsters (17). Schools that subscribe to a health promoting philosophy are essential in supporting healthy eating and positive physical activity.

Young children best accumulate physical activity in play environments (18). One context where physical activity is permissible on a daily basis is the primary school playground. The majority of primary school children have 15 recess periods per week. The duration of recess varies, with each day being made up of a 15- minute mid-morning play, 1 hour for lunch (of which over 30 minutes represents recess), and a 15-minute mid-afternoon break (19). Other than extracurricular sports and curriculum physical education, primary school recess time represents the largest block of school time for children to engage in physical activity. Primary school children spend about a fifth of their school life on the playground, equating to 600 recess periods per year [3/day, 5 days/week, 39 weeks/year (19)].

Data on physical activity levels during recess are emerging (20–24) with physical activity targets proposed for "health promoting playgrounds" of 50% (25) and 40% of recess time (26). Ridgers et al. (26) reported that children engaged in 34 minutes of moderate-to-vigorous physical activity (MVPA)[1] if they were active for 40% of recess time. Thirty-four minutes of physical activity exceeds the 30-minute minimum MVPA recommendation for children (27).

The fact that most children are exposed to school recess, which is largely peer controlled with no computer games, televisions, or mobile telephones to suppress physical activity, helps pose a relevant question: first, do boys and girls in normal-weight ($<$85th percentile for BMI) and overweight ($\geq$85th percentile BMI) categories (28) differ in the amount of time they spend in physical activity during recess? Second, how many children in each weight category achieve the target of 40% or 50% of MVPA during school recess?

Therefore, the aims of this investigation were 2-fold. The first aim was to investigate whether normal-weight children were more active than their overweight peers and to investigate whether boys were more active than girls. The second aim was to compare the proportion of normal-weight and overweight children that would meet the 40% and 50% activity thresholds for recess activity.

[1] Nonstandard abbreviations: MVPA, moderate-to-vigorous physical activity; HRR, heart rate reserve; HRR50, HRR values of 50%; HRR75, HRR values of 75%; VPA, vigorous physical activity; CI, confidence interval.

Research Methods and Procedures

Participants and Setting

A total of 420 children (210 boys and 210 girls; a maximum of 18 children per school), with a mean age of 8.1 ± 1.4 years, were randomly selected from 25 primary schools in the northwest of England. Measurements of body mass (to the nearest 0.1 kg) and stature (to the nearest 0.1 cm) were recorded using scales (Seca Ltd., Birmingham, UK) and the Leicester height measure (Seca Ltd.), respectively.

All of the children participating in the study followed their normal daily school routine. Physical activity was monitored during morning, lunch, and afternoon recess on the same day. The mean daily recess time available for the children to engage in physical activity in the playground was 86 (± 15.2) minutes. All schools were located in the same geographic urban area of northwest England. This study was conducted as part of the Liverpool Sporting Playgrounds Project, the outline having been detailed elsewhere (29). All participants returned signed parental informed consent to participate in the study. The research protocol received ethical approval from the University ethics committee.

Physical Activity Measurement

Heart rate telemetry. Heart rate telemetry has good test-retest reliability and has been validated for use with children (30). Moreover, heart rate monitoring correlates well with energy expenditure and with other methods for measuring activity such as motion sensors (31). However, there are factors that influence heart rate other than physical activity, including emotional stress, body temperature, and levels of fitness (32). Differences reported between overweight and normal-weight children may be dependent on the method used to measure physical activity (33). This study sought to overcome some of these problems by calculating heart rate reserve (HRR) for each individual involved in the project, thus correcting for differences in resting heart rate between girls and boys and normal-weight and overweight groups. The Polar Team System (Polar Electro Oy, Kempele, Finland) heart rate monitor was used to measure children's physical activity during recess. Heart rate was recorded every 5 seconds. Resting heart rate was determined by averaging the 5 lowest recorded heart rate values during the period of data collection (32). HRR values of 50% (HRR50) and 75% (HRR75) were used as threshold values to represent MVPA and vigorous physical activity (VPA), respectively. HRR50 equates to a brisk walk (34), and HRR75 equates to a measure of VPA as it is thought that this intensity increases cardiorespiratory fitness in children (35). Maximum heart rate was set at 200 beats/minute.

Procedure. Eighteen children from each of the 25 primary schools had their heart rates monitored on one school day between July 2003 and March 2004. Monitors were fitted to the children at the beginning of the school day.

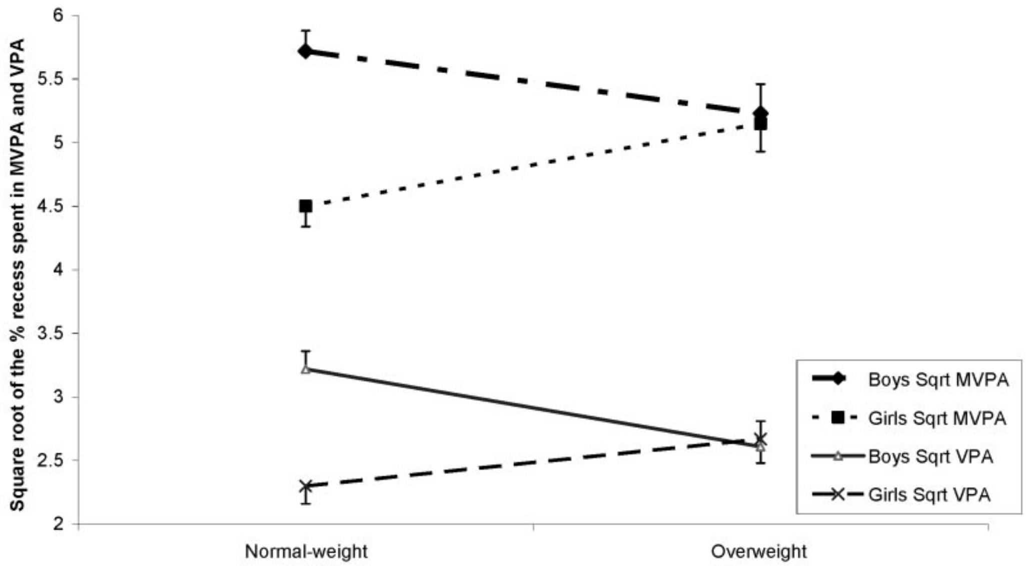

Figure 1: The MVPA and VPA of normal-weight and overweight boys and girls during school recess time. Sqrt, square root.

During this time, children were instructed to seek the researchers for refitting if the monitors became detached. Children were then asked to follow their normal daily routine. Children from 12 schools wore the monitors during morning and lunch recess, and children from 13 schools wore the monitors during morning, lunch, and afternoon recess. Monitors were removed at the end of the school day.

Data Transfer

Heart rate data were downloaded using the Polar Team System Interface and analyzed using the Polar Precision Performance 3.0 Software (Polar Electro Oy). All data were analyzed using the Statistical Package for the Social Sciences, version 11 (SPSS, Inc., Chicago, IL). The dependent variables were the percentage time spent in MVPA and VPA during recess over the whole school day. The independent variables used to group the data were gender and normal-weight or overweight group, according to the international BMI cut points proposed by Cole et al. (28).

Data Analysis

Of the initial 420 children who agreed to take part in the study, 203 boys and 207 girls had their heart rates monitored. After checking data, 375 children had valid heart rate time curves. Heart rate data were lost through electronic and manual interference. The percentage of recess time per day that each child spent at or above HRR50 and HRR75 were calculated and used in subsequent analyses. Sixty-one of 185 (33.0%) boys and 67 of 190 girls (35.3%) were overweight. These figures were slightly higher than the BMI reported in the general junior school population in Liverpool (32). Before analysis, data were checked for normality. Skewness and kurtosis were reduced by using square root scores for MVPA and VPA. Descriptive data were reported as means and standard deviations for BMI, and means and standard errors for MVPA and VPA. Univariate analyses of covariances were subsequently used to detect differences in square root scores of MVPA and VPA between girls and boys and normal-weight and overweight groups. Levene's test revealed no significant differences in homogeneity of data among independent variables. Play duration, children's calendar age, and school were used as covariates. No adjustment was made for season since previous work in this area reported no day-to-day or seasonal differences in physical activity during recess (36). Alpha was set at $p < 0.05$ for all analyses.

Results

MVPA and VPA of Normal-weight and Overweight Boys and Girls

The respective BMIs of the normal-weight boys and girls were 16.02 (±0.12) and 15.83 (±0.13) kg/m^2. The BMIs of overweight boys and girls were 21.33 (±0.27) and 21.04 (±0.31) kg/m^2, respectively.

The first aim of this investigation was to compare MVPA and VPA in normal-weight and overweight groups of boys and girls. Adjusted square root scores (mean ± standard error) for MVPA and VPA are illustrated in Figure 1. Normal-weight boys were the most active group, spending 5.72% [± 1.59; confidence interval (CI), 5.41 to 6.03] of recess time in MVPA, of which 3.22% was VPA (±0.14; CI, 2.95 to 3.50). Overweight boys spent 5.23% of recess time in MVPA (±0.23; CI, 4.78 to 5.67), of which 2.61% was VPA (±0.20; CI, 2.21 to 3.00). Of the four groups, normal-weight girls were the least active, engaging in

Table 1. The number of normal-weight and overweight girls and boys exceeding the 40% and 50% thresholds for MVPA during recess

% recess spent in MVPA	Boys		Girls	
	Normal-weight (n = 124)	Overweight (n = 61)	Normal-weight (n = 123)	Overweight (n = 67)
40	51 (43.5%)	18 (29.5%)	24 (21.5%)	22 (34.3%)
50	30 (24.2%)	8 (13.1%)	10 (8.3%)	8 (11.9%)

MVPA, moderate-to-vigorous physical activity.

MVPA for 4.50% (±0.16; CI, 4.18 to 4.81) and in VPA for 2.30% (±0.14; CI, 2.02 to 2.58) of recess time. Overweight girls took part in more MVPA (5.15 ± 0.22; CI, 4.73 to 5.58) and VPA (2.67 ± 0.19; CI, 2.29 to 3.04) than normal-weight girls. Significant effects for the percentage of recess spent in MVPA were found for sex ($F1,374 = 11.3$; $p < 0.001$) and BMI group-by-sex interaction ($F1,368 = 8.89$; $p < 0.003$) (Figure 1). Similar significant differences were found for the percentage of recess time spent in VPA between girls and boys ($F1,374 = 6.37$; $p < 0.01$) and BMI-by-sex interaction ($F1,368 = 8.17$; $p < 0.004$) (Figure 1). There were no significant main effects for the percentage of recess time spent in MVPA or VPA for BMI ($p > 0.05$).

The second aim of this investigation was to calculate the number of children who exceeded the 40% and 50% thresholds for MVPA during recess. These data are summarized in Table 1.

Heart rate data were also used to calculate the frequency and percentage of children exceeding the 40% and 50% thresholds for MVPA during recess time (Table 1). Fifty-one boys (of 124; 43.5%) and 24 girls (of 123; 21.5%) of normal weight exceeded 40% of recess time in MVPA. Of the normal-weight children, 30 boys (of 124; 24.2%) and 10 (of 121; 8.3%) girls exceeded 50% of recess in MVPA. Eighteen overweight boys (of 61; 29.5%) and 22 overweight girls (of 67; 34.3%) exceeded the 40% threshold, whereas 8 boys (of 61; 13.1%) and 8 girls (of 67; 11.9%) exceeded the 50% threshold.

Discussion

The first aim of this investigation was to assess whether normal-weight and overweight boys and girls differed in the percentage of recess time that they spent engaged in physical activity. The second aim was to calculate the frequency of normal-weight and overweight boys and girls who exceeded the 40% and 50% MVPA thresholds for physical activity during recess.

Results revealed that normal-weight boys and girls spent over a third and a fourth of recess time in MVPA, respectively. Both boys and girls who were overweight spent ~30% of recess in MVPA. The significant main effect for sex demonstrated that boys were more active than girls during recess. These data agree with other research on physical activity during recess in primary aged children (24–26,37). Furthermore, the results from this study support the extant literature in that normal-weight boys were more active than their overweight counterparts (38–40). However, the same did not hold true for overweight girls, who were more moderately and vigorously active than girls of normal weight. The phenomenon of similar levels of physical activity in normal-weight and overweight girls is difficult to explain. It could be attributed to the structure and organization of playgrounds, where girls and non-athletic boys are marginalized (41) and, thus, less active (42,43). For example, Swain (46) has reported that marginalized children tend to play in smaller areas and generally stay away from activity areas in playgrounds where games such as soccer dominate. As a consequence, girls and overweight boys take part in less active games, use smaller amounts of playground space, and engage in less vigorous and competitive activity. Girls also seem to prefer "walking and talking" (44–46), as well as dance and game activities that involve the upper body more than the lower body (47). Boys, on the other hand, engage in more physical activity regardless of the structure of the playground, as their games are generally vigorous and involve more high-intensity running-type activities than girls' games (45). However, in this study, overweight boys were less active than those of normal weight. Therefore, other factors, such as motor skill, may be related to participation in male dominated playground games in overweight boys. No literature is available on this issue in the context of school recess. It is possible that overweight boys had poorer motor skills compared with their normal-weight peer group and, consequently, were excluded from vigorously active games (such as soccer) that are popular for boys during school recess. Okley et al. (12) reported significant differences in fundamental movement skills between overweight and normal-weight boys and girls. Interestingly, for object control (games such as soccer), this difference only existed between normal-weight and overweight boys. The ability to participate in playground games may well be mediated by fundamental movement skills and, as such, overweight children are likely to be less active. Overweight boys are also less fit (47) and may find it difficult to participate in games that involve constant running.

Children generally tend to play in same-sex groups (48,49), suggesting that normal-weight boys play together, taking up more space through playing soccer (50), than girls (51). What is apparent from this study is that traditional playgrounds do not promote equal amounts of physical activity for overweight girls and boys. Thus, on average, playgrounds only succeed in promoting appropriate amounts of physical activity in normal-weight boys. These reports go some way to explaining why sex differences in physical activity exist during recess. While the differences between girls and boys activity has been reported elsewhere in the literature, few data exist on gender and weight differences in physical activity during recess.

While there may be social and behavioral explanations for differences in physical activity between groups, such as gender and overweight, methodological aspects may also affect interpretation of physical activity results. Even though an attempt to individualize heart rate was accomplished by using HRR to calculate physical activity thresholds, differences in fitness and fatness may affect heart rate response to exercise.

These differences may, in turn, confound results, in that heart rates would be higher for any given movement in overweight children. Consequently, this would result in a higher level of physical activity in overweight children compared with normal-weight, whose heart rates may be lower for a similar level of movement. The most effective way of accounting for this would be to bring children into laboratory conditions to undertake structured and controlled exercise, while at the same time recording heart rate responses. This was outside the remit of this study. On the other hand, by using the HRR method, the differences between overweight and normal-weight groups would be smaller than using generic heart rate thresholds. Thus, the differences in activity between groups reported in this study are likely to be conservative.

The second aim of this investigation was to quantify the frequency of normal-weight and overweight boys and girls who exceeded the 40% and 50% thresholds of MVPA during recess. Stratton and Mullan (25) proposed that children should be active for one half of recess time. In this study, a minority of children engaged in MVPA for 50% of recess time, intimating that this target may not be achievable by the majority of children. Moreover, in Stratton and Mullan's intervention study (25), only young children (4 to 6 years of age), in playgrounds painted with multicolored markings, were active for one half of recess time, whereas children in normal playgrounds and junior age children (7 to 11 years of age) failed to reach this threshold, similar to children in this study. In comparison, over 40% of normal-weight boys, 20% of normal-weight girls, and a third of overweight boys and girls met the 40% of recess threshold proposed by Ridgers et al. (26). In this study, 40% of recess equated to 34.5 minutes, indicating that these children achieved the minimum physical activity target of 30 minutes (27) through recess alone. It seems that the 40% of MVPA during recess is a more realistic and achievable activity target, particularly for children who are overweight. These data somewhat muddy the picture regarding physical activity intervention insofar as a significant number of overweight children met the 40% target for MVPA during recess, suggesting that factors other than BMI also have an impact on children's activity levels in this context. These factors may be psychosocial in nature, where youngsters in the same friendship group participate together and find active roles for each other. Such roles may be physically active roles. Whatever the case, these data suggest that plans to increase children's physical activity during recess should account for the complexity of the determinants of physical activity in this age group. Physical activity interventions during recess that simply target all overweight children may not be the answer.

In summary, this study aimed to assess differences in physical activity levels between overweight girls and boys during school recess. It also set out to calculate the number of children in each group who met the recently proposed physical activity targets of 40% and 50% of recess time in MVPA. Normal-weight boys were significantly more active than the overweight boys and girls and normal-weight girls for both MVPA and VPA. Even though twice as many normal-weight boys were active for 40% of recess, compared with normal-weight and overweight girls and overweight boys, over 20% of children in the normal-weight and overweight girls and overweight boys groups also attained this threshold. Finally, normal-weight boys use recess time as an opportunity to be significantly more active than normal-weight and overweight girls and overweight boys. Future studies that aim to increase physical activity in obese and overweight children should be cognizant of these findings when planning physical activity interventions.

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