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Assessing Children's Physical Activity Behaviors at Recess: A Multi-Method Approach

Pedro F. Saint-Maurice and Gregory J. Welk
Iowa State University

Pedro Silva
University of Porto

Mohammad Siahpush and Jennifer Huberty
University of Nebraska at Omaha

To better understand and promote youth physical activity (PA) it is important to determine settings and characteristics that promote or influence behavior. This study evaluated the utility of a multi-method approach (accelerometers plus direct observation) to better understand youth PA at recess. A total of 100 third through fifth grade children (52 males and 48 females) wore an Actigraph accelerometer during school recess for five consecutive days in both Fall and Spring. Trained observers coded PA behaviors at the same recess periods using the System for Observing Play and Leisure Activities (SOPLAY). Overall, gender comparisons based on both instruments indicated that boys were more active than girls. MVPA levels were higher during climbing/sliding activities (40–50%) and when the activity setting was supervised and equipped (30%). Both assessments indicated that boys were more active but the contextual data from the SOPLAY indicate that differences may vary according to the environmental context.

The study of youth physical activity (PA) behavior is often approached in a reductionist manner. Most studies have employed a single measurement approach and most report only the aggregated amounts of activity in different segments of the population (e.g., PA levels of boys and girls of different ages). Research on psychosocial correlates has identified factors that may influence individual behavior but less is known about the effects of social and physical environments on youth activity behavior.

Saint-Maurice and Welk are with the Dept. of Kinesiology, Iowa State University, Ames, IA. Silva is with the University of Porto, Porto, Portugal. Siahpush and Huberty are with the University of Nebraska at Omaha, Omaha, NE.

Schools are the most commonly targeted setting for youth physical activity promotion in activity-based research, and an increased emphasis has been placed on noncurricular approaches that can promote physical activity throughout the school day (13,15,19). Recess periods provide a particularly opportune setting to promote activity and studies have demonstrated effective ways to enhance activity at recess (1,21). A review of this literature has indicated that the contribution of recess to daily physical activity levels ranges from 5 to 40% (17,19,20). However, despite extensive work, little is known about the specific conditions or settings (e.g., supervision or/and availability of equipment) that may encourage youth to be more or less active at recess.

Most studies of youth activity behavior have used accelerometry-based activity monitors to quantify levels of activity in recess or other discrete periods of the day (10,17,20,21). A disadvantage of only using accelerometers is that they do not provide information about the context in which physical activity is performed. Some studies have provided insights about the environmental or social context of children's activity behaviors (5,16,30) but more work is needed in this area. Direct observation techniques provide considerable promise to enhance the effectiveness of youth activity studies since they can provide important contextual information that cannot be obtained when collecting data with accelerometry-based monitors. A particularly effective direct observation tool for recess-based studies is the System for Observing Play and Leisure Activities (SOPLAY). This instrument can evaluate physical activity behavior in groups of children as well as the social and environmental contexts in which those behaviors occurred (15). However, direct observation methods such as SOPLAY also have some disadvantages. The most significant limitation is that it does not provide insights into the individual variability in behavior within a group. A multi-method approach that incorporates the use of both accelerometry-based activity monitors and direct observation offers potential to advance research on youth activity behavior. To date, no study has examined the context of recess PA behavior or the potential of combining SOPLAY and accelerometer data to explain variability and differences in youth PA behavior.

The present study addresses this gap by providing unique multi-measure insights about the nature of children's physical activity and sedentary behavior during recess. Van Sluijs and colleagues (27) recently concluded that youth physical activity interventions should incorporate both cognitive and environmental strategies. The review emphasizes that we must understand (and target) individual factors as well as environmental factors to change physical activity behaviors (27). To develop more comprehensive and integrated interventions we first need to understand how social and physical environments influence PA behavior in children. The multi-method approach in the current study (i.e., combination of activity monitor data and direct observation data) provides new insights about youth PA behavior at recess.

Methods

Participants and Settings

Data were collected from two elementary schools involved in a pilot study for the Ready for Recess intervention project (12). The schools received training and support to improve the quality of recess programming but emphasis in the pilot phase was on refining the measurement protocols. Children in third through fifth grade were eligible to participate in the individual measurement protocol which involved collection of anthropometry data and wearing a physical activity monitor for five consecutive days at school. Informed consent documents approved by the Institutional Review Board at the University of Nebraska Medical Center were sent to the 136 children in these grades from the two schools and a total of 105 returned signed forms. Other site level data were collected using the SOPLAY direct observation tool and administrators provided approval for this data collection. Data were collected in both the Fall and Spring semester.

Instruments

GT1M Actigraph (Pensacola, FL). The Actigraph accelerometer (GT1M Actigraph, Pensacola, FL) was used to evaluate children's levels of physical activity during the recess periods. The Actigraph is a small, lightweight monitor that is widely used (and accepted) in pediatric physical activity research (6,7). In the current study, the monitors were initialized (set at 5-s epochs) and downloaded using Actigraph software (version 4.2.0, Actigraph, Pensacola, FL).

System for Observing Play and Leisure Activity (SOPLAY). The SOPLAY direct observation tool was used to obtain contextual information about settings and conditions that were associated with physical activity or sedentary behavior. The direct observation data were collected on three consecutive days (Tuesday through Thursday) during two data collection periods. As mentioned, SOPLAY uses momentary group time sampling (Placheck recording) and is suitable for assessing behavior in all areas where physical activity may occur.

Procedures

Data Collection Procedures. The data for the current study were collected during two independent measurement periods of the 2008/2009 school year (Fall and Spring of the same school year). Children's body mass and stature were collected by the school nurse using standardized procedures.

Children wore the Actigraph monitors from Monday through Friday during the entire school day for both measurement periods (baseline: trial 1 and post-intervention: trial 2). Participants were asked to wear the monitor on the right side of their hip (at waist level) during the entire school day. Children were fitted for the monitor each morning (7:30am) and the monitor was taken off at the end of the school day (3:50pm) by a research team member. This process was repeated for the five days and the same monitor was used for each day to minimize variability due to different monitors.

Direct observation data were collected during the primary recess period on three consecutive days (Tuesday through Thursday) at each school for each data collection period. To capture the diverse places where children can be active during recess, the school site was divided into different areas. One of the schools was divided into seven areas (playground—divided in A and B area, basketball—divided in A and B area, soccer field, and baseball—divided in A and B area) and the other school was divided into five areas (soccer field—divided in A and B area, playground, small green space, and blacktop). On a given day, the observer completed scans at a given location and coded the percentage of children observed to be engaged in the three distinct activity categories (sedentary, walking, and vigorous) in a separate record for boys and girls. The observer first coded activity participation for girls and repeated the scan in the same area for boys. After this scan was completed the observer repeated the process for each of the remaining areas. When scans were completed at all areas, they repeated the scans in the same order to obtain multiple observations at each site. A total of three scans were obtained from each area at each of the schools for each trial. Observation codes were also obtained to capture the context of the observations. For each scan, the observer coded the predominant activity and also coded the context in which it was performed using codes indicating whether it was accessible, usable, supervised, equipped, and organized. These SOPLAY codes are dichotomous, with yes or no coded for each of the five context variables.

Data Processing Procedures.

Processing of Accelerometer Data. The monitor data were processed using KineSoft version 3.3.28 (Kinesoft Software, New Brunswick, Canada). Data were first screened to remove children that were absent for one or more days in each measurement period. Compliance was determined based on minimum criteria of three complete school days of data (from 9:00am to 3:30pm). There were five children who did not meet the inclusion criteria and were excluded from data analysis.

Recess times (ranged from 20 to 50 min) were the specific time period of interest in the current study so the data for these periods were extracted based on the timing of recess periods at each school. The school environment was viewed as a controlled setting and therefore it was assumed that children at school were compliant in wearing the monitors during recess unless otherwise noted by the research team on the tracking logs. Age-specific cut points derived from the Freedson et al. (9) prediction equation were used to process the accelerometer data. Estimates of METs were computed for each minute using the equation (METS = 2.757 + (0.0015·counts·min-1)—(0.08957·age [yr])—(0.000038·counts·min-1·age [yr]; 9) and to allocate counts into light (1.5–3.0 METS), moderate (MPA; 3.0–6.0 METS) or vigorous (VPA; > 6.0 METS). Minutes with fewer than 200 counts were coded as sedentary to avoid misclassifying the amount of light activity in the day (28). Moderate-to-vigorous (MVPA) was calculated by summing moderate PA and vigorous PA.

Processing of SOPLAY Data. The SOPLAY data were compiled onto spreadsheets and were imported into SAS for statistical processing. The percentage of boys and girls participating in sedentary, walking, and vigorous were determined for each scan. The percentage of youth coded as "vigorous" was used to reflect participation in MVPA based on findings from a recent (in press) SOPLAY calibration study (22). The corresponding codes of "walking" and "sedentary" were used to reflect participation in Light activity and Sedentary, respectively. Data from repeated scans at the same area were aggregated across observations to obtain activity profiles for each observation area. The observations from each area were then averaged across days to create aggregated outcomes by school and trial.

Additional processing was done to facilitate evaluation of the contextual data (activity type and environmental setting) that were linked to the individual intensity distributions. There was not sufficient variability in coding for usability and accessibility so the contextual analyses focused on the other three variables. To further simplify the analyses, the possible combinations of supervised, organized, and equipped codes were categorized into four distinct activity contexts. The four combinations were categorized as "Unsupervised Games" (UG; meaning not supervised, not equipped, but organized PA), "Supervised Games" (SG; meaning not equipped, but supervised and organized PA), "Unsupervised Resourced Games" (URG; meaning not supervised, but equipped and organized PA), and "Supervised Resourced Games" (SRG; meaning supervised, equipped and organized PA).

Statistical Analysis

The outcome measures from the Actigraph and SOPLAY each provide different information about children's participation in physical activity during recess. Therefore, separate analyses were conducted for each set of data.

The outcome measure from the accelerometer data were the average percentage of time spent in MVPA. Although this study emphasizes findings related with MVPA, it was decided to include sedentary time as a second outcome in some of the analyses since this indicator has been of considerable public health interest. The analyses of these data focused on individual factors and therefore three-way (gender x school x trial) mixed-model ANOVAs were used to examine gender differences in levels of MVPA and sedentary behavior between the two schools and across trials. To facilitate interpretation, separate three-way mixed-model ANOVAs were used to test grade, race, and BMI group differences in MVPA for each gender. These analyses used data collapsed by school and trial to increase the available power.

The outcome measure from the direct observation data were the average percentage of children engaged in Sedentary and MVPA during the observed recess periods. The analyses of these data focused on the environmental contexts that explain differences in group-level-participation in physical activity. Similar to the accelerometer analyses, three-way ANOVAs (gender x school x trial) were used to examine differences in levels of MVPA and sedentary behavior between schools and trials. A series of supplemental two-way ANOVAs (gender x SOPLAY area; gender x SOPLAY activity codes; gender x SOPLAY setting codes) were then conducted to further explore gender differences by area, type of activity, and by clusters of environments.

Three-way interactions were not relevant for this study and therefore results regarding these effects were not presented. Post hoc analyses were adjusted to control for type I error using the Tukey-Kramer method. All statistical tests were computed using a 99% confidence interval with a respective alpha £ .01 to minimize experimentwise type I error inflation. Data were analyzed using SAS v9.2.

Results

Evaluation of (Individual-Level) Actigraph Data

Complete information on race, grade, BMI percentile (CDC) and age was available for more than 90% of the total sample. Accelerometer data were collected on 92 children during trial 1 and 100 children during trial 2 (52 males and 48 females). Participants were from third to fifth grade with an age range from approximately 8–12 years-old (mean = 9.8 ± 1.0y) with BMI percentile values according to CDC charts, ranging from the third to the 99th percentile (mean= 68th ± 28th percentile).

The overall three-way ANOVA for the accelerometer data were significant ($F(7,184) = 43.45, p < .001$) and significant main effects were found for each of the three factors. Gender main effects indicated that boys spent 40.9 ± 23.9% of their time in MVPA, compared with 31.3 ± 16.7% for girls ($F(1,184)=32.22, p < .001$). The school effect was significant ($F(1,184)=63.59, p < .001$) with percent time in MVPA being higher at school 2 when compared with school 1 (43.5 ± 17.0% vs 29.2 ± 22.9%). There was also a significant trial effect ($F(1,184)=63.59, p < .001$) with higher percent of time reported in the Spring (46.9± 14.3% active) compared with the Fall (25.1 ± 21.8% active). Significant interaction effects indicated that gender differences in MVPA were not consistent across schools ($F(1,184)=12.82$, $p < .001$). Boys spent more time in MVPA than girls at school 2 ($Mean_{diff}$ = 17.9 ± 2.7%, $p < .001$) but not at school 1 ($Mean_{diff}$= 4.1 ± 2.8%, $p = .454$). The gender x trial interaction was not significant ($F(1,184)=0.46, p = .459$) indicating that gender differences remained stable between trials (Figure 1—panel A).

Findings for sedentary time were opposite to MVPA results. Girls were more sedentary than boys, and sedentary levels were higher during the Fall and at school 2. All these findings were significant with $p < .01$.

The supplemental three-way ANOVA for boys revealed no significant differences in MVPA by grade, race and BMI group and no significant interaction effects. Results with girls were similar. Detailed gender comparisons for race, grade, and BMI group are provided in Table 1.

Evaluation of (Group-Level) SOPLAY Data

A total of 382 scans were conducted at both schools (School 1 had 268 scans and School 2 had 114 scans). There were 43 scans with no observations recorded and therefore those could not be included in the analysis. Of the remaining 339 scans, 170 were performed on boys and 169 were performed in girls. The total number of children per male/female observation ranged from 1 to 46 but, on average, there were approximately 15 children per scan (8.2 ± 5.9 boys and 7.8 ± 5.2 girls). Approximately 28% of the boy scans and 31% of the girl scans contained 10 or more children.

The three-way ANOVA results for activity intensity were similar to the results with the accelerometry-based activity monitors ($F(7,331) = 6.85, p < .001$) . There was a significant main effect for gender ($F(1,331)=16.79$, $p < .001$) with the proportion engaged in MVPA being greater in boys than girls (34.1± 27.5% vs. 22.4 ± 23.3%). The main effect for trial was also significant ($F(1,331)=22.75$, p

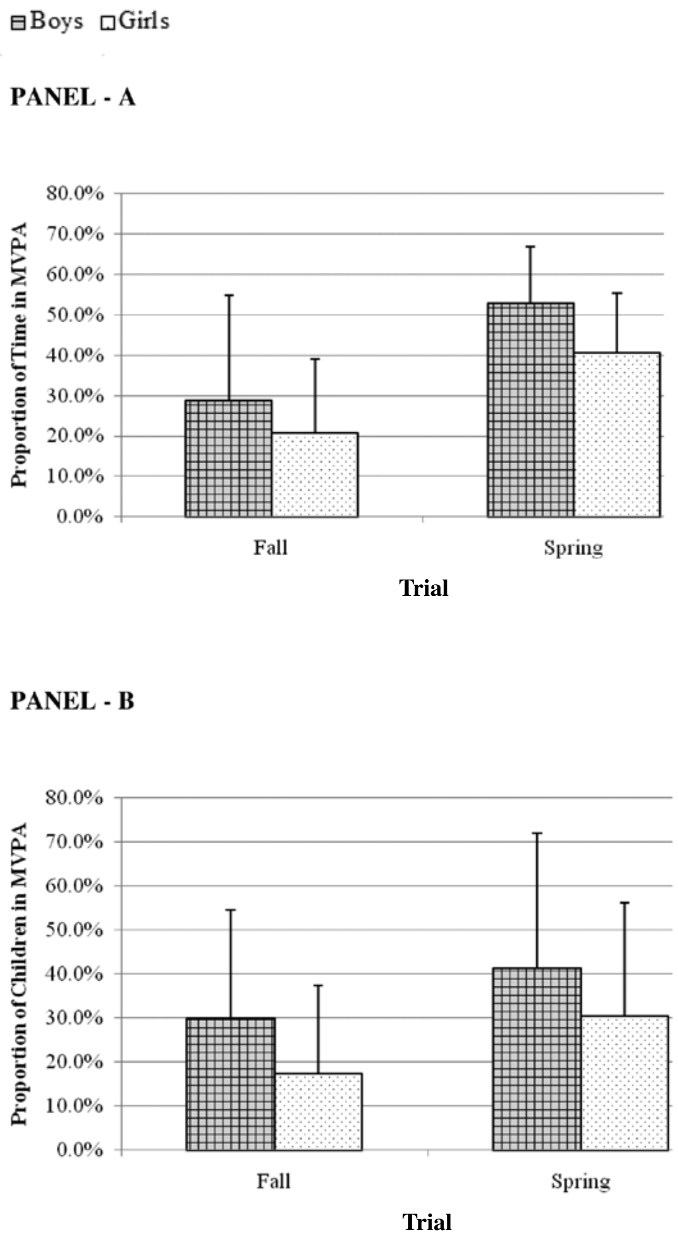

Figure 1 — Comparison of gender x trial effects for recess activity as assessed with the Actigraph (panel A) and SOPLAY (panel B).

Table 1 Comparison of Activity Level (% in MVPA) for Boys and Girls by Race, Grade, and BMI Group (Based on Accelerometer Data).

	Boys[1]	n[2]	Girls[1]	n[2]	Total
Race					
Caucasian	41.5 (23.2)	72	31.2 (16.0)	66	138
African-American	34.2 (24.9)	11	36.2 (20.5)	13	24
Hispanic			31.9 (19.8)	4	4
Asian	48.6 (28.7)	10			10
Other	40.6 (33.1)	2	17.4 (19.1)	2	4
Grade					
3	45.9 (22.3)	40	37.9 (15.1)	37	77
4	34.1 (23.9)	31	30.1 (16.2)	18	49
5	43.2 (25.4)	24	25.0 (17.1)	30	54
BMI group					
Underweight	38.6 (24.0)	6	19.0 (12.8)	6	12
Normal Weight	41.9 (24.2)	59	35.2 (16.6)	46	105
At risk	37.0 (26.9)	8	32.6 (18.3)	16	24
Overweight	42.2 (23.7)	22	25.9 (14.9)	17	39

[1]% time spent in MVPA: Mean (Standard Deviation)

[2] total data points recorded

$< .001$), with the proportion of active children being higher in the Spring than the Fall (46.9 ± 14.3% vs. 25.1 ± 21.9%). The school effect was borderline significant ($F(1,331)=5.35$, $p = .021$). Contrary to individual level analysis, the interaction between gender and school was nonsignificant ($F(1,331)=0.53$, $p = .467$) but post hoc comparison tests indicated that boys were significantly more active than girls at school 1($Mean_{diff}= 14.3 \pm 3.5\%$, $p < .001$) but not at school 2 ($Mean_{diff}= 10.0 \pm 4.8\%$, $p = .034$). However, similar to the individual level analysis, there was no significant interaction between gender and trial ($F(1,331)=0.43$, $p = .511$) indicating that main differences between boys and girls remained unchanged during both Fall and Spring data collection (Figure 1—panel B).

Similar to individual level analysis, the prevalence of sedentary behaviors was in direct opposition to the findings reported for participation in MVPA. The overall ANOVA regarding sedentary time was also significant ($F(7,331) = 3.26$, $p = .002$). There was a main effect for gender ($p < .001$), indicating that the percentage of girls engaged in sedentary behaviors (38.2 ± 31.0%) was greater than the percentage of boys (26.2 ± 25.6%). The main effect for school was nonsignificant ($p = .199$), and there was a borderline effect for trial ($p = .027$). There were no significant interaction effects ($p > .01$).

Evaluation of Contextual SOPLAY Data

Activity levels by recess area were analyzed for both schools but comparisons between sites are not appropriate due to differences in the nature of the environments at each school. The contextual analyses of activity levels by school area are provided for one school (school 1 = 233 scans) to provide insights about the type of information that can be obtained with these analyses. Main effects for gender were previously described so the focus here is on trying to identify the source or nature of the differences in activity patterns observed at this school during recess.

On average, the total number of observed children per area ranged from 7 to 16. The soccer field had the highest average number of observed boys per scan (n = 11) while the number of girls per scan was higher in the basketball B (9.5 ± 1.1) and Playground A (8.7 ± 1.1) areas.

Differences in the prevalence of children in MVPA between areas of observation were borderline significant (F(13,219)=2.83, p = .011) with no differences in sedentary behaviors by area (F(6,219)=1.59, p = .152). The playground area (zone A) had the highest percent of boys and girls engaged in MVPA (Boys= 41.9 ± 31.8%, Girls = 43.9 ± 27.0%). The MVPA gender x area interaction was not significant (F(6,219)=1.21, p = .303) but boys were more active than girls in five of the seven locations—the exceptions were for one playground area ($Mean_{diff}$= 2.0 ± 8.9%) and one area of the basketball court ($Mean_{diff}$ = 0.2 ± 9.3%). The sedentary gender x area interaction was also nonsignificant (F(6,219)=1.45, p = .198).

Additional analyses were conducted to examine the activity levels in specific types of games and settings. Since the types of activities and settings were similar between the two schools, data from both were used to increase sample size. There were four SOPLAY activities that had only two or three scans so these were not included in the analysis. The remaining activities had sufficient numbers for generalization (samples ranged from 18 to 98 scans). Six different groups of SOPLAY activities were examined in the remaining 327 (out of 339) scans. The average number of boys per activity was higher during soccer (12.6 ± 8.2) and the average number of girls was higher during jumping activities (13.3 ± 5.9).

The percentage of children in MVPA differed significantly depending on the coded activity (F(5,315)=10.01, p < .001). There were nonsignificant differences between activities in sedentary behaviors (F(5,315)=1.71, p = .131). Sliding/climbing activities were found to yield the highest percentage of youth in MVPA (40.6 ± 26.8%) while nonidentifiable activities (NA; 16.4 ± 21.7%) yielded the lowest percentage of youth in MVPA.

The gender x activity interaction had two activities with fewer than 10 scans per gender but the remaining scans ranged from 17 to 53 scans (total n = 252 scans). There were nonsignificant interactions for percentage of youth in MVPA and sedentary behavior for the gender matched activities (p > .01). Follow-up analyses confirmed that the percent of girls in MVPA were similar to the percent in boys for soccer/football activities ($Mean_{diff}$ = 11.4 ± 7.0%, p = .899), climbing/sliding activities ($Mean_{diff}$ = 12.7 ± 5.1%, p = .340) but boys were more active than girls during tag games (Mean difference = 23.4 ± 11.4%, p = .653). Difference between prevalence of sedentary boys and girls was higher during Basketball/Volleyball activities ($Mean_{diff}$ = 27.7 ± 8.3%, p = .045). Figure 2 provides detailed analysis regarding the gender comparisons for different activities that children engaged in.

The number of scans for the four designated settings varied with a total of 25 scans coded as UG, 23 scans coded as SG, 8 scans coded as URG and 283 scans coded as SRG (total of 339 scans). The ANOVA revealed significant differences in MVPA levels across these settings (F(3,331)=4.13, p = .007) but nonsignificant differences in sedentary (F(3,331)=0.46, p = .709). The SRG setting was associated with the highest participation in MVPA (30.3 ± 26.5%) while the SG had the

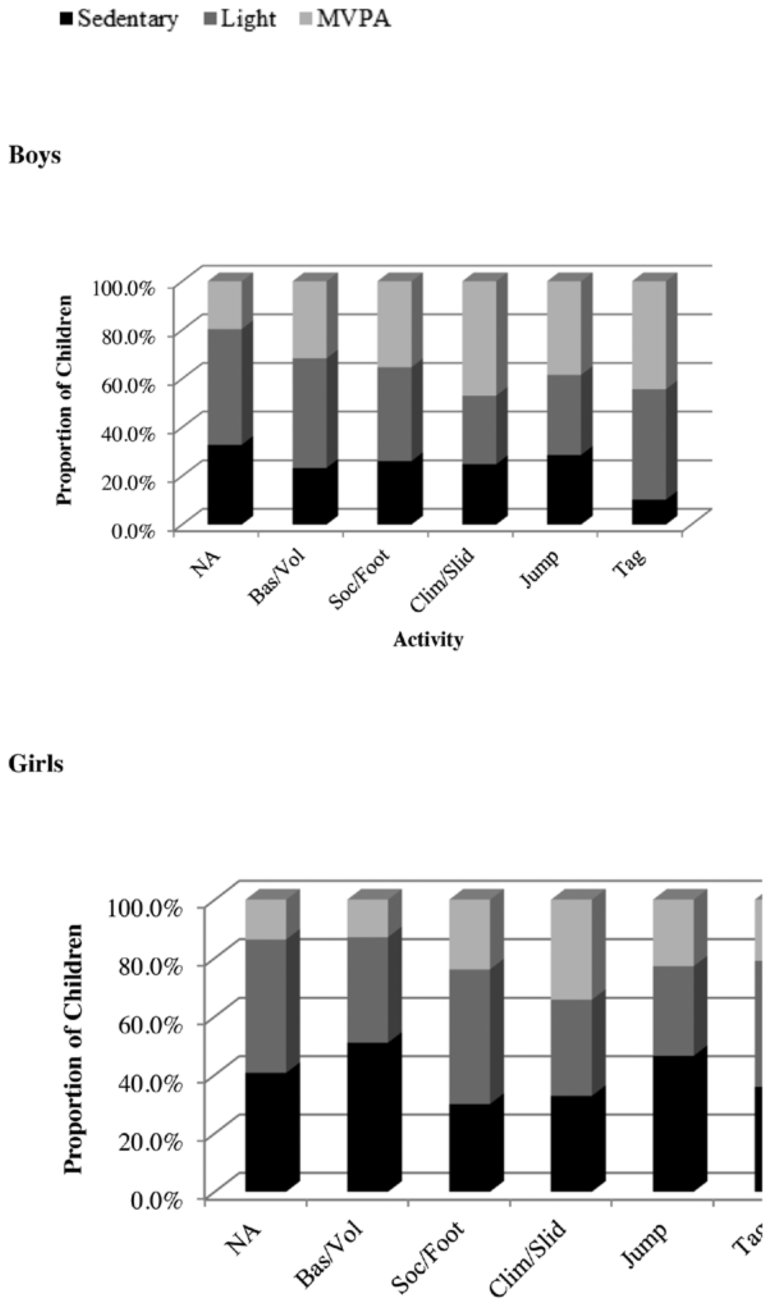

Figure 2 — Percent boys (top) and girls (bottom) engaged in sedentary and MVPA behaviors per different activities (averaged by school and trial) using SOPLAYcodes.

lowest estimates of MVPA (16.0 ± 16.6%). The gender x setting interaction was not significant for both MVPA and sedentary outcomes ($p > .01$) but examination of the individual activities revealed that boys were significantly more active in the SRG setting ($Mean_{diff}$= 12.0 ± 3.0%, $p = .002$).

Discussion

The development of accurate methods for assessing youth physical activity behavior is critical for advancing knowledge about youth activity behavior and promotion. Accelerometry-based activity monitors have become an accepted methodology and recent refinements in assessment practices (7,8,26,31) have helped to improve the quality of this type of data. Activity monitors provide an objective and quantifiable outcome for statistical comparisons; however, they are not able to provide information to explain any observed differences in regard to the context of PA. The present study used a multi-method approach for evaluating youth activity behaviors at recess. The advantage of this approach is that accelerometers and direct observation techniques provide unique information about youth involvement and participation in physical activity.

Data from the accelerometry-based activity monitors provided information on levels of activity in individual while direct observation data from SOPLAY provided information on group activity patterns and the context of behavior. While the methods differ in metric and outcome measure they provided consistent information about overall activity patterns. Similar main effects were observed for gender, school and trial and this helps to corroborate the findings obtained from either measure alone. More importantly, the combination of measures provided unique insights into factors that may influence youth activity behavior.

The SOPLAY data, for example, help to explain the commonly observed gender differences in physical activity at recess. We found that boys were more active than girls based on the accelerometer data and this is consistent with previous research (14,21). However, the results of this study demonstrated that the gender differences could be explained, in part, by the contextualized data obtained from SOPLAY. Gender differences were examined by area (e.g., soccer field), activity (e.g., jumping), and also by context or setting (e.g., supervised activity) and these comparisons helped to explain the source of the differences.

Observed measures of recess areas indicated that girls were able to match boys PA levels in specific play zones (playground A, and basketball B; within 2.0% difference). These areas had similar numbers of boys and girls. Boys tended to be more active in spaces where they tended to be more boys than girls and this is likely due to the more structured nature of game play (i.e., sports) among boys. Pellegrini and Smith (18) reported that girls tend to segregate from boys since they dislike more aggressive games. This segregation might explain the greater number of girls in specific playground areas. The fact that girls do not have to compete for a space with boys may also offer greater opportunities for girls to be active (4). Integrated play spaces that promote mixed sex play games and engage boys and girls equally are not common (4); however, this needs further exploration since results from this study indicated that activity levels were high in some areas despite similar number of boys and girls.

The comparisons by activity type also yielded some interesting findings. The average number of boys and girls observed in each activity provide some insights on their recreation preferences. The number of girls was highest for "jumping activities" (13.3 ± 5.9), while the number of boys was highest for "soccer/football activities" (12.6 ± 8.2). Play preferences in elementary children has been explored in the past and our results were consistent with this past work. Boys prefer to spend most of their play time in team sports activities as girls have more diverse interest, such as social conversations and turn-taking games (3,29).

The coded context or settings for activity sessions indicated that MVPA levels were higher when equipment was available and when activity was supervised (the proportion of children in MVPA was approximately 30%). These periods, characterized as SRG (Supervised Resourced Games), were distinguished by supervision (i.e., the presence of adult staff), organization (i.e., structured activity), and presence of equipment. Settings characterized as URG (Unsupervised Resourced Games) were associated with the second highest levels of MVPA. These results support the benefit of having equipment available for use during recess periods. Other studies have reported similar benefits associated with availability of equipment and/or adult supervision (11,23,30). However, the use of equipment by itself may not be enough to increase activity levels and children may actually need adult supervision to allow for its appropriate and coordinated use. Gender comparisons for the different contexts were examined to see if these variables influenced boys and girls differentially. However, these analyses were limited by the low number of observations in the UG, SG and URG settings. Overall, we observed that boys were more active than girls in supervised resourced environments.

The SOPLAY coding described above helps to explain differences in activity behaviors and it has similar utility for understanding sedentary behaviors. This area of study has become increasingly popular in the field (2,24,25) and our results suggest that some contexts were associated with higher (or lower) levels of sedentary behaviors at recess. Sedentary behaviors were more prevalent in girls and were most evident in the basketball and baseball fields (interestingly, the basketball court was actually associated with the highest proportion of both active and sedentary behaviors in girls). Girls were also found to be more sedentary in basketball activities (based on the analyses of activity type) and this, in addition to findings related to gender differences in active play, may reflect the tendency for boys to dominate the play space and the ball. The prevalence of active behaviors seems to be higher in boys when they dominate the space while sedentary behaviors are more prevalent in girls independent of boys/girls ratio. Despite the girl's preference for jumping activities, these were also linked to greater proportion of sedentary behaviors. Jumping activities, such as jump rope might not allow for simultaneous participation and therefore the opportunity to be active may be restricted to fewer children at one time. Supervised and equipped settings had the lowest prevalence of sedentary behaviors so this supports the use of this strategy to enhance activity at recess.

Guidelines have been developed to promote effective use of accelerometers and similar guidelines should be established to ensure effective use and interpretation of direct observation data. A key challenge with the use of SOPLAY data are determining whether data are representative of the population being observed. This threat to external validity can be the result of a low number of scans per activity or setting, and also the low number of participants observed in each scan. To ensure comparability across studies it is important for researchers to clearly describe the settings and contexts observed. It is important to provide detailed information on the scans (e.g., total number of scans, number of scans with zero observations, the average number of boys and girls per scan, the number of scans per area, activity and setting, and the average number of children per area, activity and setting). In the current study we restricted interpretations to periods with more than 10 children per scan (however, this is an arbitrary standard and may not be appropriate for all studies). To date, few studies have explored the utility of the SOPLAY to help explain the context of youth physical activity behavior. The results of this study demonstrate the unique contributions of the SOPLAY data in explaining differences in activity profiles between boys and girls.

The comprehensive nature of SOPLAY can present some challenges for reporting findings in research. In this study we restricted our contextual analyses to one school since our study focused on explaining the impact of social and physical environments on individual behavior. If analyses were conducted at multiple schools it might be possible to explain school level differences in activity patterns (including differences attributable to intervention). A challenge in this regard is creating comparable spaces at multiple schools (e.g., playgrounds vs fields) so that direct comparisons can be made.

This study illustrates how activity-monitors and direct observation can contribute to a more comprehensive evaluation of youth physical activity behavior. The individual data from activity monitors provide important information that cannot be obtained with direct observation (e.g., activity per grade, race, and BMI subgroups). This information is critical for characterizing individual differences. The SOPLAY data, in contrast, can help to explain some of the individual differences through the detailed contextual information. In the current study we reported a number of unique gender- related findings that could not be explained without the direct observation data. The present study reported findings for only a small sample and was intended primarily for descriptive purposes. Future research based on larger and more representative samples could help to explain age and gender-related differences in physical activity behavior as well as differences due to environmental characteristics or socioeconomic status. Appropriate tracking and reporting of SOPLAY data are critical to ensure effective comparisons.

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