Physical Activity During School in Urban Minority Kindergarten and First-Grade Students

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KEY WORDS: physical activity, pedometers, urban youth, elementary school students, school day

ABBRVIATIONS
CDC—Centers for Disease Control and Prevention
NYSED—New York State Education Department
PA—physical activity
PE—physical education

All authors meet the criteria for authorship. Dr Reznik contributed to study conception and design, acquisition of data, supervision of research group, interpretation of data, drafting and revising the article critically for important intellectual content and incorporating co-author feedback into the final manuscript, and provided final approval of the version to be published. Dr Wylie-Rosett advised on study design, contributed to interpretation of data and revising the article critically for important intellectual content, and provided final approval of the version to be published; Dr Kim collaborated on statistical design, completed final statistical analyses, reviewed and revised the article for important intellectual content, and provided final approval of the version to be published; and Dr Ozuah contributed to study conception and design, supervision of research group, interpretation of data, revising the article critically for important intellectual content, and provided final approval of the version to be published.

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WHAT’S KNOWN ON THIS SUBJECT: Physical inactivity is one of the major modifiable factors contributing to the growing national epidemic of childhood obesity. There is lack of literature on pedometer-determined physical activity (PA) during the school day in US minority kindergarten and first-grade students.

WHAT THIS STUDY ADDS: This is the first study to assess school-day PA in US urban minority kindergarten and first-grade students. Higher grade level, participation in physical education class, and outdoor recess were found to be independent predictors of PA.

OBJECTIVES: To determine if physical activity (PA) during the school day varied by school, grade level, gender, weight status, and physical education (PE) and recess participation among urban kindergarten and first-grade students.

METHODS: Cross-sectional study at 4 Bronx, NY, schools. Student PA was measured by a Yamax Digi-Walker pedometer, an objective and validated measure of PA in children. Each student wore a sealed pedometer during school for 5 consecutive days. Hierarchical models were fit to identify variables predictive of PA.

RESULTS: A total of 916 had valid pedometer data (53% male, 70% Hispanic, mean age 5.98 years [SD 0.66], 45% overweight). PA varied by school (P < .0001). First-grade students took a significantly greater mean number of steps during school than kindergarten students. Overall, students took an average of 2479.7 (SD 961.8) steps/school day. PA did not differ by BMI status. Students took on average 724 more steps on PE days than on non-PE days and 490 more steps on days with outdoor recess than nonrecess days (P < .05 for both). Fewer than 1% of all students achieved lower cut points for previously published mean range of steps/school day for boys and girls. Multivariable analysis revealed higher grade level, participation in PE class, and outdoor recess as independent predictors of PA.

CONCLUSIONS: PA levels were low in kindergarten and first-grade students. Future interventions incorporating classroom-based PA and outdoor recess may increase PA in resource-poor urban schools with limited PE facilities. Pediatrics 2013;131:e81–e87

abstract

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The prevalence of overweight and obesity among children in the United States has tripled in the past 3 decades, and urban minority children have been disproportionately affected by this epidemic. In 2009–2010, 39.1% of US Hispanic and non-Hispanic black children and adolescents were overweight and obese with a BMI ≥ 85th percentile on the BMI-for-age growth charts. The prevalence of overweight and obesity is even higher, up to 47%, in some low-income minority communities, such as Bronx, NY. Additionally, minority children have lower levels of physical activity (PA), fitness, and sports participation than their white counterparts. Physical inactivity is one of the major modifiable factors contributing to the growing national epidemic of childhood obesity.

Schools are well positioned to address increasing PA among their students. The Centers for Disease Control and Prevention (CDC) recommends at least 60 minutes of daily PA for children. However, only 3.8% of US elementary, 7.9% of middle, and 2.1% of high schools provide daily physical education (PE) for the entire school year for students in all grades. Many schools in New York City low-income communities (eg, Bronx, NY) do not even have gymnasiums, school playgrounds, or PE teachers. Although there are few published studies of pedometer-determined PA during the school day in US children, current data suggest PA is low in resource-poor communities. In a review, Tudor-Loke et al used 3 studies to establish a range of average number of pedometer-determined steps for boys and girls during a school day: 6700 to 7600 steps for boys and 4900 to 6100 steps for girls. Only 1 of these studies was conducted in the United States, and it had a small sample size (n = 81) of predominantly Caucasian sixth-grade students. Our literature review found no US studies that evaluated pedometer-determined PA levels during the school day in kindergarten and first-grade minority students attending urban elementary schools. The objectives of this study were (1) to assess pedometer-determined PA levels during the school day in young mainly Hispanic students attending kindergarten and first grade in 4 Bronx, NY, elementary schools and (2) to examine if school-day PA levels varied by school, grade level, gender, BMI status, and PE class and outdoor recess participation.

METHODS

We conducted a cross-sectional study at 4 elementary schools in Bronx, NY. The study was approved by both the New York City Department of Education and Montefiore Medical Center Institutional Review Board Committees. Parental opt-out consents were sent home with students and student assents were signed before participation.

Participants

A total of 988 students attended kindergarten and first grade (aged 5–6 years) in 4 elementary schools. All participating schools had a full-day kindergarten. Thirteen parents opted-out of having their child participate in the study, leaving 975 students. Study schools had comparable student socio-economic and demographic factors: (1) 89% to 99% of students were eligible for free lunch, a marker of family poverty; (2) 48% to 53% were boys; and (3) 62% to 78% were Hispanic and 20% to 38% were African American. One school had no gymnasium or PE teacher. The other 3 schools had comparable existing PA initiatives, gymnasium square footage, playground, and PE teacher availability. The participating schools were selected to be representative of Bronx elementary schools with regard to the above sociodemographic characteristics and available resources.

Procedures

We measured each student’s height (inches) and weight (pounds) with a digital scale (Tanita electronic physician scale, WB-300, Tokyo, Japan). Height was measured to the nearest 0.25 inch and weight was measured to the nearest 0.1 pound. Students were asked to remove their shoes and outer clothing before obtaining these measurements.

PA was measured by using a pedometer (Yamax Digi-Walker SW-200, New Life-styles, Lee’s Summit, Missouri), an objective and previously validated measure of PA in children. Before the study, 10% of the pedometers were randomly selected to undergo a shake and walking test. We collected pedometer data in 4 schools over a 4-week period in late fall and winter terms during the 2007–2008 academic year. Each school had data collection for 5 consecutive school days. Four days of objective monitoring is sufficient to obtain reliable assessment of PA in children. Schools 1, 2, and 3 had data collected during 3 weeks in December of 2007 and school 4, during the last week of November of 2007. We recorded weather conditions (temperature and precipitation) during each day of data collection. Before the monitoring period, students were familiarized with the pedometers and explained the nature of their use in the study. To prevent the subjects’ tampering with the pedometer readings, each pedometer was sealed with cable tie/tape and placed on a Velcro belt around the student’s waist. The pedometers were worn level with the hip bone in line with the midpoint of the right knee, as recommended. The pedometers were distributed at the beginning of the school day (8:00 AM–8:15 AM) and collected before dismissal (2:25 PM–2:40 PM). Although the exact arrivals and departures were not recorded for each student, students wore the pedometer for ~6 hours.
during each day of data collection. Students received small gifts (ie, toy, pencil, stickers) on the last day of pedometer data collection.

We asked classroom teachers to record whether students had a PE class or outdoor recess on each day of PA monitoring. In general, depending on the schedule, students from different classrooms at the study schools with a gymnasium and PE teacher(s) have 0 to 2 PE classes per school week. During the 5 days of PA monitoring, students had 0 to 2 PE classes (only 62 students from 3 classrooms had PE class twice during the data-collection period).

Students had recess as part of their lunch period with 20 to 25 minutes available for indoor or outdoor recess. During indoor recess, students stayed in the auditorium and watched a movie. During outdoor recess, students went to a school’s playground; activity during this time was not organized. Only 2 schools (1 and 4) had outdoor recess during the monitoring period. These schools’ playground areas varied in size (15 000–40 000 square feet) and their surface was blacktop with no trees (Fig 1). Only 1 school had any outdoor play equipment (a small jungle gym). Generally, outdoor recess was not a daily occurrence and depended on the weather conditions, student behavior, playground equipment malfunctioning, and availability of adequate staff supervision. Classroom teachers supervised their students during outdoor recess and it was ultimately their decision if students had outdoor recess.

**Statistical Analysis**

**Definitions and Computations**

BMI percentile was calculated by using each child’s weight, height, age, and gender. In accordance with national guidelines, we defined normal weight as a BMI between the sex-specific 5th and <85th percentile on the CDC’s 2000 BMI-for-age growth charts, overweight was defined as a BMI ≥85th percentile but <95th percentile, and obese was defined as a BMI ≥95th percentile. We used the CDC’s BMI reference values because they are based on representative US national survey data. Number of days with PE was computed by counting the total number of PE days for each school across the 5 days of PA monitoring. Number of days with outdoor recess was computed similarly. We converted the mean number of steps per day to steps per minute by dividing the number of steps taken during the school day by the amount of time in minutes (6 hours = 360 minutes) that children wore the pedometer.

**Data Analysis**

Physical activity levels were compared by school, grade level, gender, and weight status. Mean number of steps was computed for days with and without PE class and outdoor recess. We determined the proportion of boys and girls meeting the lower cut points for pedometer-determined range of steps per school day for boys and girls established by Tudor-Locke et al (6700 steps/school day for boys and 4900 steps/school day for girls). Days with step count <500 and >10 000 were not included in data analysis.

To adjust for within-cluster correlations at 3 different levels (student, classroom, and school), generalized linear mixed models (also termed hierarchical or multilevel models) were fit to identify variables predictive of the number of steps during a school day. The model included random effects for classroom and school, and fixed effects for subject characteristics, such as age and gender, as well as PE class and outdoor recess. P < .05 was considered statistically significant. Data were analyzed by using SAS software (version 9.1; SAS Institute, Inc, Cary, NC).

**RESULTS**

**Sample Demographics**

A total of 975 kindergarten and first-grade students from 45 classrooms in 4 elementary schools were enrolled. The analysis was based on 916 (94%) students who had nonmissing and valid pedometer data. Of 916 participants,
53.0% were boys, 70.0% were Hispanic, mean age was 5.98 years (SD 0.66), and 45.5% were overweight or obese (19.7% overweight and 25.8% obese).

**Pedometer-Determined PA**

Table 1 shows pedometer-determined PA by school, grade, gender, BMI status, PE class, and outdoor recess participation. The mean number of steps per school day was significantly different among 4 schools. Students in the school without a gym facility (school 3) took significantly fewer steps per school day than those at schools 1 and 4. Similarly, students in school 2 took significantly fewer steps than those in schools 1 and 4. First-grade students took a significantly greater mean number of steps during the school day than those at schools 1 and 4. First-grade students; all girls, 4 of whom were obese) reached the established by Tudor-Locke et al lower cut-off points for pedometer-determined range for the average number of steps per school day.

**PE Class and Outdoor Recess Attendance**

Table 2 shows the PE class and outdoor recess attendance by school and grade level during 5 days of PA monitoring. School 2 had a significantly fewer proportion of days with PE class (8.8%) as compared with school 1 (14.8%), *P* < 0.0001, and school 4 (25.1%), *P* < 0.0001. Schools 2 and 3 did not have any outdoor recess during 5 days of monitoring because of inclement weather. School 4 had significantly greater proportion of outdoor recess days (80.4%) as compared with school 1 (19.8%), *P* < 0.0001. First-grade students had a higher proportion of days with PE class (15.1%) as compared with kindergarten students (10.4%, *P* = 0.0077; however, kindergarten students had a higher proportion of days with outdoor recess (24.8%) as compared with first-grade students (19.8%, *P* < 0.0001. Overall, only 0.7% of all students (6 students; all girls, 4 of whom were obese) reached the established by Tudor-Locke et al lower cut-off points for pedometer-determined range for the average number of steps per school day.

**Multivariable Analysis**

Multivariable analysis using a multi-level hierarchical model revealed the following variables as independent predictors of PA: higher grade level, participation in PE class, and outdoor recess (Table 3).

**DISCUSSION**

Our findings revealed that PA during the school day in urban minority kindergarten and first-grade students was low. Higher grade level (older age), participation in PE class, and outdoor recess were found to be independent predictors of PA. Boys tended to be more active than girls, although the difference did not reach significance (*P* = 0.08). Our literature review revealed 6 studies that examined PA in children during the school day. Four of these studies were conducted in the United States, 1 study used a convenience sample of preschool children, and the other studies included third to sixth graders in schools with a largely Caucasian student enrollment. We found no US studies that assessed school-day PA in urban, minority kindergarten and first-grade students.

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**TABLE 1** Pedometer-Determined PA of Kindergarten and First-Grade Students Classified by School, Grade, Gender, BMI Status, PE Class, and Outdoor Recess

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean No. Steps per School Day (SD)</th>
<th>Mean No. Steps per Minute (SD)</th>
<th>Range No. Steps per Minute</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1 (n = 248)</td>
<td>2786.5 (1045.3)</td>
<td>7.7 (2.9)</td>
<td>2.4–17.2</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>School 2 (n = 278)</td>
<td>2305.8 (915.9)</td>
<td>6.5 (2.5)</td>
<td>2.2–18.5</td>
<td></td>
</tr>
<tr>
<td>School 3 (n = 214)</td>
<td>2119.5 (775.6)</td>
<td>5.9 (2.2)</td>
<td>2.0–15.1</td>
<td></td>
</tr>
<tr>
<td>School 4 (n = 180)</td>
<td>2780.5 (906.7)</td>
<td>7.7 (2.5)</td>
<td>2.1–18.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kindergarten (n = 408)</td>
</tr>
<tr>
<td>First grade (n = 508)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n = 429)</td>
</tr>
<tr>
<td>Male (n = 487)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BMI*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (n = 481)</td>
</tr>
<tr>
<td>Overweight (n = 181)</td>
</tr>
<tr>
<td>Obese (n = 236)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PE class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (n² = 456 PE days)</td>
</tr>
<tr>
<td>No (n = 3428 non-PE days)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Outdoor recess</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (n² = 868 recess days)</td>
</tr>
<tr>
<td>No (n = 3018 nonrecess days)</td>
</tr>
</tbody>
</table>

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* Schools 1 and 4 are significantly different from schools 2 and 3.
* Normal weight: BMI ≥ 5th but < 85th percentile; overweight: BMI ≥ 85th percentile but < 95th percentile; obese: BMI ≥ 95th percentile.
* Number of days with PE and outdoor recess was computed by counting the total number of PE and outdoor recess days during the 5 days of PA monitoring.
TABLE 2 PE Class and Outdoor Recess Attendance by School and Grade Level During 5 Days of PA Monitoring

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>No. of Days With PE Class, n (%)</th>
<th>P Value</th>
<th>No. of Days With Outdoor Recess, n (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schools&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School 1 (r² = 0.86)</td>
<td>160 (14.8)</td>
<td>&lt;.0001</td>
<td>214 (19.8)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>School 2&lt;sup&gt;b&lt;/sup&gt; (n = 1268)</td>
<td>111 (6.8)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>School 3&lt;sup&gt;c&lt;/sup&gt; (n = 872)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>School 4 (n = 848)</td>
<td>212 (25.1)</td>
<td>680 (80.4)</td>
<td>680 (80.4)</td>
<td>680 (80.4)</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kindergarten (r² = 1.000)</td>
<td>187 (10.4)</td>
<td>247 (24.8)</td>
<td>247 (24.8)</td>
<td>247 (24.8)</td>
</tr>
<tr>
<td>First grade (n = 2262)</td>
<td>286 (13.1)</td>
<td>447 (19.8)</td>
<td>447 (19.8)</td>
<td>447 (19.8)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Size of the school outdoor playground: School 1 (~40 000 sq ft), School 2 (~20 400 sq ft), School 3 (no playground), School 4 (~15 000 sq ft).
<sup>b</sup> Total number of pedometer days (days on which students had valid pedometer data) across all students.
<sup>c</sup> Schools 2 and 3 had no outdoor recess; School 3 had no gymnasium and no PE class.
<sup>d</sup> School 2 significantly different from Schools 1 and 4.
<sup>e</sup> School 1 significantly different from School 4.

TABLE 3 The Multivariable Analysis of Predictors of Higher PA Levels in Kindergarten and First-Grade Urban Minority Students

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Estimate (SE)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender (boys versus girls)</td>
<td>98.3 (56.5)</td>
<td>.08</td>
</tr>
<tr>
<td>Grade (1st versus kindergarten)</td>
<td>404.6 (140.5)</td>
<td>.004</td>
</tr>
<tr>
<td>PE class (yes versus no)</td>
<td>442.6 (43.5)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Outdoor recess (yes versus no)</td>
<td>196.0 (49.8)</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

boys averaging 6700 to 7600 steps and girls averaging 4900 to 6100 steps.<sup>14</sup> In our study sample, fewer than 1% (n = 6) of all students reached the Tudor-Locke et al.<sup>14</sup> lower cut points for average number of steps taken during the school day for boys and girls. Although students in our study took more steps on days with PE and outdoor recess, this number was still substantially less than the lower cut point for PA during the school day established by Tudor-Locke et al.<sup>14</sup>

BMI-referenced standards for recommended pedometer-determined steps per day have been established in an international sample of children.<sup>26</sup> Based on the BMI-referenced standards, the overweight and obese 6-year-old children tended to take fewer steps per day than their normal-weight counterparts (P = .08).<sup>26</sup> Similarly, in our study, PA did not differ by BMI status.

In our study, kindergarten students were significantly less physically active during the school day than first-grade students. The primary reason for this observed difference appears to be that kindergarten students had a significantly smaller proportion of days with PE class than the first-grade students. Additionally, kindergarten classrooms are generally self-contained rooms where students are less likely to leave the classroom for other lessons or to use restrooms, which are located inside the kindergarten classrooms. On the other hand, kindergarten students had a higher proportion of days with outdoor recess as compared with first-grade students. It is possible that outdoor recess was used to compensate for the lack of PE classes for the kindergarten students; however, activity during outdoor recess in schools was not organized. It is also unknown if kindergarten students had less access to the playground equipment because of overcrowding or developmental immaturity. Although the teachers recorded whether the students had outdoor recess on each day of PA monitoring, they did not document the details of student activities that took place during the recess. Further research using direct observation of outdoor recess activities may provide explanation for these findings.

We found significant differences in PA levels among 4 schools. One school (school 3) did not have a gymnasium or PE teacher, which may explain the lower levels of PA at that school. Students attending school 2 also had lower levels of PA than schools 1 and 4. This could be because of the significantly lower proportion of days with PE class in school 2 as compared with schools 1 and 4. Students in school 2 had PE class on a 6-week rotation schedule in which some classes participated in PE once a week for 6 weeks and some did not. Additionally, schools 2 and 3 had no outdoor recess during the 5 days of monitoring because of poor weather conditions contributing to the lower levels of PA in these schools. Our findings confirm previous research that indicates that levels of outdoor PA are influenced by weather conditions.<sup>27</sup>

The role of the outdoors in promoting PA in preschool children has been evaluated in studies from Sweden and the United States.<sup>28,29</sup> In our study, although the schools had playgrounds, these areas lacked greenery and adequate play equipment and were not used in inclement weather. Recognizing the importance of outdoor PA as a way to combat childhood obesity, programs such as Play Streets<sup>30</sup> and Open Streets<sup>31</sup> provide opportunities for children from urban low-income communities to be physically active by closing streets to cars. These programs occur at regularly scheduled times over the summer but their use is limited by inclement weather.

A 2011 audit from the City of New York Office of the Comptroller, which evaluated whether New York City School Districts were in compliance with the New York State Education Department’s (NYSED) Physical Education Regulations...
for students in elementary schools, found "limited evidence that any of the sampled schools were in compliance with the NYSED physical education requirements for all of its students." The NYSED requirements are that students in kindergarten through grade 3 must participate in PE on a daily basis and the minimum time devoted to such programs should be at least 120 minutes each week. Many Bronx, NY, public schools struggle with meeting these requirements because of overcrowding, lack of resources, and physical space for PE.

Our study had several limitations. First, this is a cross-sectional study and conclusions about causality are therefore limited. Second, the study was conducted in urban low-income public elementary schools in the Bronx, NY; thus, the conclusions may not be generalizable to other schools in different communities. Third, the pedometers are not designed to capture the intensity of PA or upper body motion. Therefore, we cannot make conclusions about students’ time spent in moderate to vigorous PA or upper body activity during the school day. However, pedometers have previously been shown to be valid, reliable, and objective measures suitable for assessing children’s PA in large population-based studies. Although we did not record individual exact arrival and departure times, pedometers were distributed and collected within 15 minutes of arrival and dismissal for all students. Finally, we measured PA only during the school day, which was the objective of the study. Having the control over placing and removing the pedometers during 5 days of PA monitoring allowed limited loss of data because of incorrect pedometer placement or students’ forgetting to bring the pedometer to school the next day.

The low levels of PA in kindergarten and first-grade students in our study are striking. Fewer than 1% of students in our study sample achieved lower cut points for previously determined range of steps for boys and girls during the school day. Our study is the first to determine PA levels and predictors of PA in a large sample of urban, minority kindergarten and first-grade students.

CONCLUSIONS

With the rising levels of obesity in minority children and low levels of PA in this population, our findings may partially explain disparities in obesity rates observed in urban schools. Promoting classroom-based PA and improving the school outdoor environment may be important components of future intervention programs for increasing PA in resource-poor schools with limited PE facilities.

ACKNOWLEDGMENTS

We are grateful to all the students and schools for their participation in the study.

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