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Children's In-School and Out-of-School Physical Activity During Two Seasons

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Physical activity (PA) promotion for youth has long been thought of as a public health issue (Sallis & McKenzie, 1991). However, with increases in diseases associated with a sedentary lifestyle and the known benefits of PA, increasing the PA levels of children and adolescents has become a major public health concern (Strong et al., 2005). To this end, numerous organizations are calling on schools to take a leadership role in youth PA promotion (National Assocation for Sport and Physical Education, 2008; Pate et al., 2006). The Institutes of Medicine (Koplan, Liverman, & Kraak, 2005) suggested that decreased opportunity for PA during school is one of five environmental factors preventing children from meeting PA recommendations of 60+ min/day. In addition, nearly all children attend school and spend as much as 30% of their waking hours in that setting (Hofferth & Sandberg, 2001; Snyder, Dillow, & Hoffman, 2009). For these reasons, schools are a logical setting to influence youth PA.

Prior to developing and evaluating interventions, it is important to understand the amount of PA children accumulate during the school day and across the school year. Although increasing students' activity levels during school hours is important, examining the impact of school-day interventions on students' activity levels outside of school is also crucial. A comprehensive approach that promotes PA both in school and out of school activities is necessary to maximize daily PA (Pate et al., 2006). Previous studies examining PA levels during specific times of the school day suggest that children can accumulate meaningful amounts of activity (Beighle, Morgan, Le Masurier, & Pangrazi, 2006; Morgan, Beighle, & Pangrazi, 2007; Ridgers, Stratton, & Fairclough, 2006; Tudor-Locke, Lee, Morgan, Beighle, & Pangrazi, 2006). Others have reported children's activity levels during school and outside of school. Gidlow and colleagues (2008) used accelerometry and found that for British children ages 3–16 years, school activity represented 30% of their daily activity. These interventions also found that children do not compensate for low school activity by being more active outside of school. In New Zealand, the number of steps taken during school accounted for approximately 47% of total daily steps for elementary-age students (Cox, Schofield, Greasley, & Kolt, 2006). Similarly, in a sample of U.S. students, steps taken during school represented 40% of daily steps (Morgan, Pangrazi, & Beighle, 2003).

It is also important to understand the role of season on children's PA, including school-day PA (Beighle, Alderman, Morgan, & Le Masurier, 2008). Several factors, such as temperature, weather conditions, and daylight may have an impact on children's PA. While some argued that seasonality has a limited role in children's PA levels (Fisher et al., 2005) others found children are more active when the weather is more conducive to outdoor activity (Goran et al., 1998; Rowlands & Hughes, 2006; Tremblay, Barnes, Esliger, & Copelane, 2005). These studies examined PA levels throughout the day. However, little is known about the impact of seasonality on children's school PA. A better understanding of how children's PA levels vary, including school-day PA, during different times of the year may help prioritize or reallocate resources to increase PA during particularly low activity seasons.

The purpose of this study was to examine the steps taken by children both during school and out-of-school

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during two seasons, fall and winter. We also examined the differences between daily steps, school steps, and out-of-school steps during fall and winter.

Method

Participants

Participants were recruited from one elementary school in the southeastern United States. In total, 186 students were enrolled in third-to-fifth grades at the time of baseline data collection. A total of 112 participants (60%) provided written informed assent, and their parent/guardian provided written informed consent at baseline and follow-up. The research and evaluation department at the local school district, the school's principals, and the university's institutional review board also gave approval to conduct research on human participants. Ethnic distribution included 60% Anglo American, 23% African American, 5% Mexican American, 3% Mixed, 1% Pacific Islander, and 9% Other,.

Instruments and Anthropometrics

The MLS 2505 pedometer (Walk4Life, Inc., Plainfield, IL) was used to assess student steps. This pedometer has been validated for measuring PA levels as steps (Beets, Patton, & Edwards, 2005; Schneider, Crouter, Lukajic, & Bassett, 2003). A stadiometer (Invicta, Leicester, UK) was used to measure each child's height without shoes. Weight was measured using a mechanical balance beam scale (HealthoMeter, Inc., Beijing, China). The scale was calibrated according to the manufacturer's recommended protocol prior to each use. We obtained students' age from school records based on informed consent.

Procedures

Prior to the study, all participants were familiarized with the pedometers, taught how to put them on and take them off, and allowed to wear the pedometers during physical education. Students were instructed to wear the pedometer on the waist above the right knee. The accuracy of this placement was examined by having students count and take 50 steps. Those whose pedometer read more than 52 or less than 48 ($n = 5$) were assisted in finding a more accurate pedometer placement, typically on the iliac crest or above the back pocket at the waist.

At the beginning of school on the first day of the study, students received a "school" pedometer to wear at school throughout the study, including during physical education class and recess. At the end of each school day, students returned the pedometer and received an "out-of-school" pedometer, which they wore in the evenings and in the morning before entering the classroom. Before going to bed, the children were to remove the pedometer and put it back on when getting dressed in the morning. On arriving at school, they returned the out-of-school pedometer and fastened the school pedometer to their waist. During the school day, out-of-school pedometer data were recorded and pedometers resealed and prepared for the afternoon. Each evening, school pedometer data were recorded, and pedometers were prepared for the morning. This process was performed for four consecutive weekdays. A similar protocol was implemented in previous studies (Beighle et al., 2008; Beighle & Pangrazi, 2006; Vincent & Pangrazi, 2002).

Data were collected in October 2007 and February 2008 using the same pedometers. During the 4-day fall data collection, the mean temperature was 77° F (25° C) with a mean of 11.8 hr of daylight per day and no precipitation. During the 4-day winter data collection, the mean temperature was 34° F (1° C) with a mean 10.7 hr of daylight. During winter data collection there was a total of 0.14 inches [.35 cm] of snow that occurred overnight and resulted in no accumulation.

Data Treatment and Analysis

All data analyses were performed using SPSS, version 14.0. Of the 112 participants, 105 (93%; M age = 8.9 years, SD = .67; M body mass index = 19.1 kg, SD = 3.8) were included in the final analysis. Seven participants were excluded from analysis because of excessive absenteeism (more than 2 days of the 4-day monitoring period during winter and fall data collection).

Consistent with other research examining similar topics, mean daily steps were computed using 2–4 days of pedometer steps in the fall and at follow-up in the winter (Morgan et al., 2007). An alpha level of .05 was used for all statistical tests, and appropriate alpha level adjustments were made for post hoc analyses.

Seasonal Differences Between Steps. A 2 x 2 x 2 mixed-design analysis of variance (ANOVA) was conducted to determine differences between steps with school (fall, winter) and out-of-school (fall, winter) mean steps as the within-participants factors. Sex was used as the between-participants factor to determine if steps were different between boys and girls by season.

Results

Seasonal Differences Between Steps

There were no significant School x Gender, Wilks' $\Lambda = 1.0$, $F(1, 103) = .01$, $p = .93$, Out-of-School x Gender, Wilks' $\Lambda = .99$, $F(1, 103) = 1.15$, $p = .29$, or School x Out-of-School x Gender interactions, Wilks' $\Lambda = .99$, $F(1, 103) = .63$, $p = .43$, suggesting the seasonal differences between boys and girls were similar. There were significant differences for the School x Out-of-School interaction, Wilks' $\Lambda = .88$, $F(1, 103) = 14.02$, $p < .001$, partial $\eta^2 = .12$. Follow-up paired sample *t* tests using the Bonferroni correction method revealed no significant difference in mean school steps between fall and winter seasons, $t(104) = .49$, $p = .62$. However, there were significant differences between mean out-of-school steps between fall and winter seasons, $t(104) = 4.06$, $p < .001$. Boys and girls accumulated 1,153 more out-of-school steps during fall relative to winter (95% CI = 589 – 1,716 steps).

Seasonal Gender Differences

Girls accumulated ~2,246 (21%) fewer mean daily steps than boys during fall, $F(1, 104) = 9.87$, $p < .01$, and 1,450 (17%) fewer daily steps in winter, $F(1, 104) = 3.98$, $p < .05$. Comparing seasonality for mean school steps, girls accumulated 1,020 (26%) fewer steps during fall, $F(1, 104) = 13.51$, $p < .001$, and 860 (23%) fewer steps during winter than boys, $F(1, 104) = 7.22$, $p < .01$. Comparing seasonality for mean out-of-school steps, girls accumulated ~1,220 (19%) fewer steps during fall than boys, $F(1, 104) = 6.6$, $p < .01$; however, there were no significant differences during winter, $F(1, 104) = 1.19$, $p = .28$. Means and standard deviations for daily, school, and out-of-school steps for fall and winter seasons by sex are displayed in Table 1.

Discussion

The purpose of this study was to examine children's number of steps during school and out-of-school in fall and winter. We also examined the differences between steps while at school (school steps) and total daily steps on school days (daily steps) during the two seasons. A better understanding of these differences may help better prioritize intervention or school resources to locations and seasons identified as low active. This study was the first to examine differences between school and out-of-school steps. Our findings are consistent with previous seasonality research, with children having higher daily activity in fall, when the weather was suitable for outside PA, than in winter when temperatures were much lower (Fisher et al., 2005; Rowlands & Hughes, 2006; Tremblay, Barnes, Esliger, & Copelane, 2005).

An increase in daily steps in fall appears to be a function of more out-of school steps (see Table 1). In fall, 35% of girls' steps and 38% of boys' steps occurred during school. In winter, 40% of girls' steps and 42% of boys' steps occurred during school. Thus, school activity in winter contributed 4–5% more steps than in fall. During winter, children from our sample did not compensate for limited school-day activity by increasing activity levels outside of school. Thus, we suggest that promoting PA during school is even more important in winter months. Students should have more PA opportunities during the school day. An extra 15 min of outdoor recess can provide students with 1,250 steps (Beighle, Morgan, Le Masurier, & Pangrazi, 2006), while a 15-min indoor recess (e.g., PA video) can provide approximately 600 steps (Erwin, Koufoudakis, Beighle, & Schwartz, 2001). Other research has suggested that simple classroom PA breaks of 5–10 min using teaching cards that describe simple activities can provide students with 900–1,200 more steps per day (Erwin, Abel, Beighle, & Beets, 2009; Erwin, Beighle, Morgan, & Noland, 2011). Coincidentally, in the present study, 1,300 steps would account for the difference between fall and winter daily steps. Thus, these types of PA opportunities, especially during the winter months, are warranted.

Although the influence of seasonality tends to focus on weather conditions, daylight hours may play a key role as well. In the current study, based on sunrise and

Table 1. Daily, school, and out-of-school steps for fall and winter by gender

	Girls (n = 65)		Boys (n = 40)		Total (N = 105)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Age	8.8	0.7	8.9	0.7	8.9	0.7
BMI	19.1	3.6	19.1	3.9	19.1	3.8
Fall						
Daily	8,411	2,689	10,657	3,863	9,267	3,354
In	2,976	1,195	3,995	1,640	3,365	1,461
Out	5,435	2,098	6,662	2,762	5,902	2,434
Winter						
Daily	7,480	3,555	8,930	3,719	8,033	3,669
In	2,956	1,567	3,816	1,636	3,284	1,640
Out	4,524	2,677	5,114	2,725	4,749	2,698

Note. *M* = mean; *SD* = standard deviation; BMI = body mass index' In = during school; out = out of school.

Table 2. A three-study comparison of students' in-school and out-of-school physical activity

Location	Steps (in)		In (%)	Steps (out)		Out (%)
Arizona[a]						
Girls	4,200		38	6,800		62
Boys	5,400		41	7,600		59
	M	*SD*		*M*	*SD*	
Kentucky						
Girls	2,976	1,195	35	5,435	2,098	65
Boys	3,995	1,640	38	6,662	2,762	62
New Zealand[b]						
Girls	6,070	1,586	46	7,021	2,865	54
Boys	7,594	2,137	49	8,013	3,274	51

Note. In = in school; out = out of school; *M* = mean; *SD* = standard deviation.
[a]From Morgan, Pangrazi, & Beighle, 2003.
[b]From Cox, Schofield, Greasley, & Kolt, 2006.

sunset data during data collection, children had a full hour more of daylight in fall compared to winter. This may partially explain higher out-of-school activity levels in fall. School PA levels were similar during both seasons, suggesting that a mean daily temperature of 34° F does not impede school PA (i.e., outdoor recess is not eliminated). This also supports the contention that daylight hours are more influential than weather conditions for out-of-school PA. Future studies conducted before and after changing to or from daylight savings time may help determine if seasonality is more influenced by weather or daylight hours.

It is important to note students' low activity levels both in and out of school. These findings are comparable to data from previous research on children in the same region of the United States (Beighle et al., 2008). When compared to two other studies using pedometers to examine in- and out-of-school steps, the children in the current study were far less active than their peers in other studies (Cox et al., 2006; Tudor-Locke et al., 2006). The other studies did not examine seasonal effect, but when compared to fall data from the current study (see Table 2) it appears the children in the other studies accumulated more steps in and out of school. Interestingly, although children in the New Zealand study (Cox et al., 2006) accumulated more steps during school, the difference in percentage is not great. This suggests that both school and out-of-school contexts offer meaningful amounts of PA.

The findings from this study are limited by the sample size. A larger sample size could strengthen future studies examining these differences. Also, we collected no contextual data, such as frequency, intensity, or type of activity during school and out-of-school. Similarly, we collected only data from the entire school day rather than segmented sections of the school day as in previous research (Tudor-Locke et al., 2006). The geographic location of data collection is a potential limitation as well. Environmental factors (i.e., daylight hours, seasonal temperature change) associated with different regions may influence findings.

In the selected school, PA levels remained constant during fall and winter; however, out-of-school PA levels were greater in fall. Because out-of-school activity levels drop during the winter, both in-school and out-of-school PA promotion is recommended during months of adverse weather and less daylight. An increase in school PA during winter months may counterbalance the seasonality effect on PA levels. These data support the need for PA promotion for youth in all settings.

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