

Seasonal variation of American Indian children's school-day physical activity

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Summary

Study aim: To examine the pedometer steps taken during the school-day by American Indian children during all four seasons.

Material and methods: Participants included third-sixth grade children (n = 157) aged 9.6±1.07 (boys) and 9.7±1.2 (girls) attending school from one Southwestern US American Indian community. Children had a mean BMI of 23.9±7.7 with 70% being classified as overweight or obese. Children wore a pedometer (Yamax Digiwalker SW-200) for 20 days (5 days per season).

Results: Children accumulated 4762±1544 (boys) and 4408±1194 (girls) steps/day across the four seasons with the highest totals occurring during the Fall (4899, males; 4796, females) and the lowest totals during the Winter (4463, males; 4043, females). Repeated measures ANOVA showed no significant differences in daily school-day steps across seasons. Children classified as normal weight averaged 5146±1688 steps/day, overweight children averaged 5020±1333 steps/day, and obese children accumulated 4275±1123 steps/day.

Conclusions: PA stayed relatively consistent across seasons in this sample of children. However, children were the least active during Winter months. With 70% of the current sample being classified as overweight and with American Indian children at greater risk for numerous hypokinetic diseases there is a clear need for additional school-day PA opportunities.

Key words: Indigenous populations – Pedometer – Step Counts – Youth – Health

Introduction

Schools have been identified as an essential component of physical activity (PA) promotion in youth [33] and have been called upon to take on more leadership in this endeavor [31]. Most children regularly attend school [21] and with this understanding, many researchers have developed and implemented PA interventions and/or programming while youth are at school [13,39]. PA surveillance has been identified as an important component of global action against physical inactivity; if physical activity is important it must be measured [23]. When evaluating school-based intervention programs it is essential to have baseline or expected PA values for youth while at school.

Studies have begun to describe typical school-day PA in youth [1,22,27] and the contributions of the school-day to overall daily PA levels [3,6,7,11,30,42]. Children appear to accumulate between 2900-7600 steps/day at school accounting for 35-47% of their total daily steps. Table 1 shows school-day steps and daily contributions of school-day PA to overall PA from previous pedometer research. Additionally, two accelerometer based studies have suggested that children accumulate 30-44% of their total daily activity throughout the school-day [16,18].

Numerous researchers have suggested that it is important to understand the role that seasons play on youth PA as temperature and weather patterns can influence PA levels [2,8,17,19,25,35,45]. Furthermore, it has been suggested that a better understanding of seasonal differences may help prioritize intervention programs or school resources to meet the needs of the low active students [3]. Previous examinations of seasonal impact on youth PA have primarily found that children are more active when the weather is warmer and allows for outdoor activity and have mostly examined total daily physical activity [2,4,19,25,35,45]. Most recently, research findings suggested that seasons (Fall and Winter) played a role in out of school PA but had no impact on school-day PA [3]. Only one previous study has examined seasonal impact on school-day PA [3] and included PA during the Fall and Winter months in Southeastern US elementary aged children. With most children attending school and a growing number of school-based PA interventions, it is imperative for the researchers and practitioners developing the interventions/ programming to have a more complete understanding of seasonal influences on school-day PA to ensure appropriate allocation of resources during the low activity seasons.

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Table 1. School day step counts and contributions to overall daily physical activity (PA)

Author	Male Steps	Female Steps	Contribution to Daily PA	Location	Season	Sample (n)
Loucaides and Jago [27]	6979	5078	N/A	Cyprus	Winter	5-6 th Grade (104)
Cox <i>et al.</i> [11]	7594	6070	47%	New Zealand	Spring	5-11 Years (91)
Barfield <i>et al.</i> [1]	4464	3796	N/A	USA	N/A	2 nd -5 th Grade (71)
Brusseau <i>et al.</i> [6]	4779	4027	35-38%	USA-American Indian Community	Fall	5-6 th Grade (77)
Johnson <i>et al.</i> [22]	4237	4042	N/A	USA-American Indian Community	N/A	8-12 Years (176)
Beighle <i>et al.</i> [3]	3925 3816	2976 2956	35-38% 40-42%	USA-Southeast	Fall Winter	3 rd -5 th Grade (112)
Brusseau <i>et al.</i> [7]	5042	4124	36-37%	USA-Southwest	Fall	4-5 th Grade (829)
Morgan <i>et al.</i> [30]	3800	2900	40%	USA-Southwest	N/A	8-11 Years (389)
Tudor-Locke <i>et al.</i> [42]	6832	4895	40%	USA-Southwest	Spring	6 th Grade (81)

This information is of utmost importance for American Indian youth who are at a greater risk for hypokinetic diseases and obesity when compared to other US youth [5,24,36,40,47]. For example, a recent study found that 67% of American Indian children were classified as overweight or obese [6]. Therefore the purpose of this study was to examine the pedometer steps taken by American Indian children during all four seasons; Summer, Fall, Winter, and Spring throughout the school-day.

Material and Methods

Participants: Participants included 157 American Indian children (77 males and 80 females) in grades 3-6 at one elementary school in a Southwestern US American Indian Community. The only requirement for inclusion was that children had to be ambulatory. Children were aged 9.64±1.1 (9.6±1.07 boys; 9.7±1.2 girls) years and had a BMI of 23.9±7.7 with 70% being classified [32] as overweight (>85% BMI) or obese (>95% BMI) and 96% of parents reported that their children were of American Indian descent. University Review Board, Tribal Council, school principals, and teachers approved the research design. Parental consent and informed assent were provided by all participants.

Instruments: The Yamax Digiwalker SW-200 pedometer (Yamax, Tokyo, Japan) was used to measure PA. This pedometer has been validated for measuring PA in pediatric populations [20,29,38]. Prior to data collection, batteries were changed and both shake tests [46] and step

tests [44] were completed to ensure the instrument accurately measured steps. Anthropometrics were measured without shoes and with light clothing on a calibrated digital scale (Seca 882 Digital BMI Scale; Hanover, MD) and stadiometer (Seca 214 Portable Stadiometer; Hanover, MD). BMI was calculated using the formula kg/m². A demographic form completed by parents provided the child's grade, gender, and ethnic background.

Procedures: All children had previous experience wearing a pedometer before participating in this study. Prior to data collection, students were reminded how the pedometer worked, the appropriate location to wear (on the waist above the right knee) the monitor, and all children completed a step test to ensure accuracy. The students wore their pedometer from Monday to Friday during school hours for four separate weeks (aligning with the four seasons). Research team members and classroom teachers reminded the youth to put their pedometer on each morning when they arrived at school. At the end of each school day, research team members and the classroom teacher reminded youth to leave their pedometers on their desks. When students left school for the day, research team members recorded step counts for each student and reset the pedometer to "zero." This process was repeated for each of the 20 days of data collection. This protocol is consistent with previous studies using pedometers [3,22].

Data were collected four times during the school year to align with the four traditional seasons (August, November, February and April). Table 2 illustrates the weather differences across the four data points.

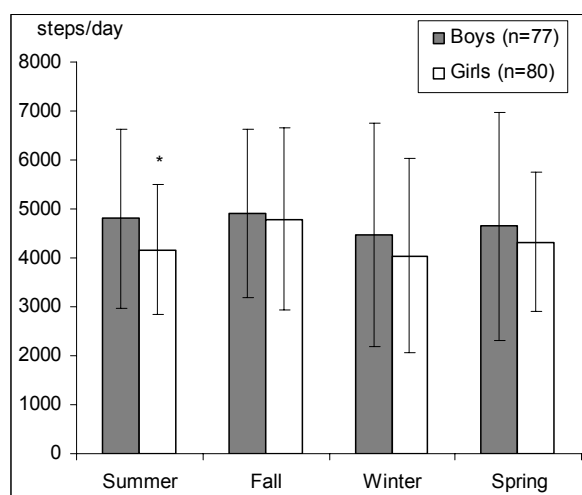
Table 2. Average temperature and precipitation during each season in the Southwest US

Season	Temperature (°F)		Precipitation (Inches)
	High	Low	
Summer (August)	104	76	1.14
Fall (November)	75	47	0.77
Winter (February)	71	41	1.03
Spring (April)	85	54	0.33

Data Treatment and Analysis: Following established procedures [34] a minimum of two days of data were required to be included in analyses. A valid day was defined as a day where the children wore the pedometer the entire school-day. Means for steps/day were computed for each season as well as an overall steps/day average. Repeated Measures ANOVA was utilized to compare differences across seasons. *T*-tests and ANOVA's (followed by Bonferroni tests) were used to examine differences across gender and BMI; the level of significance was set at $\alpha = 0.05$

Results

Repeated measures ANOVA showed no significant differences ($p = 0.07$) in daily school-day steps across seasons, across seasons by gender ($p = 0.44$), or across seasons by BMI category ($p = 0.54$), suggesting that seasonal differences were similar. Figures 1 and 2 shows the steps/day across each season by gender and by BMI category, respectively.

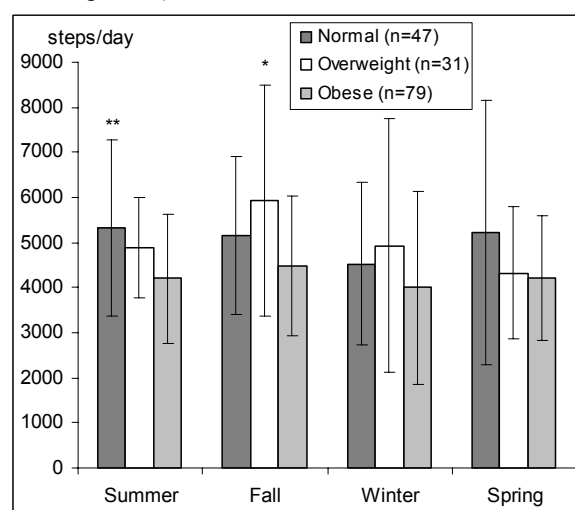
**Fig. 1.** Steps/day by season and gender (mean±SD)

* Significantly ($p < 0.05$) different from respective value in boys

Children accumulated 4762 ± 1544 (boys) and 4408 ± 1194 (girls) steps/day across the four seasons with *t*-test results indicating that boys and girls took a statistically similar

number of in-school steps ($p = 0.11$). Individual *t*-tests indicated that the only season that boys were significantly more active than girls was during the Summer ($p < 0.05$).

Children classified [32] as normal weight averaged 5146 ± 1688 steps/day, overweight children averaged 5020 ± 1333 steps/day, and obese children accumulated 4275 ± 1123 steps/day. Normal weight children accumulated the greatest steps/day in the Summer and Spring. Overweight children were the most active during the Fall and Winter. ANOVA results ($F_{2,128} = 6.19$; $p < 0.01$) suggested significant differences in daily steps by BMI. Bonferroni *post hoc* tests indicated that the significant differences ($p < 0.01$) were between the normal and obese groups. Individual season ANOVA's by BMI indicated that there were only differences during the Summer (Normal and Obese; $p < 0.01$) and Fall (Overweight and Obese; $p < 0.05$).

**Fig. 2.** Steps/day by season and BMI category (mean±SD)

Significantly different from respective value in obese children: * $p < 0.05$; ** $p < 0.01$

Discussion

This is the first known study designed to examine the seasonal differences in school day PA (across all 4 seasons). This study supports previous findings [3] suggesting that school-day PA (Fall and Winter) is not influenced by the seasons. These findings, however, are not supported by studies examining total daily activity throughout the different seasons [4,14,17,19,25,35,45]. Although not significant, children did accumulate their greatest step totals during the Fall (4899, males; 4796, females) and their lowest totals during the Winter (4463, males; 4043, females), suggesting a 9% and 16% decrease in steps/day for boys and girls, respectively in the Winter. Beighle *et al.* [3] found that activity performed outside of school-day dropped significantly during the Winter months, making

school-day PA even more essential. The current finding is especially interesting because temperatures during the Fall and Winter seasons were not drastically different (Table 2), precipitation is typically a non-issue, and both would be considered mild when compared to other regions of the country/world.

Children in the current study had physical education twice per week (30 minutes each) and had a daily lunch-time recess that typically led to about 15-20 minutes of free play opportunities. By simply adding an extra 15 minute recess during the Winter months (or during any season), previous research suggests there would be opportunities for an extra 900-1250 steps/school-day [7]. Similarly, research examining the impact of classroom based PA has suggested that activity breaks can add over 900 steps/day [15]. It would appear that by adding a second recess opportunity and classroom activity breaks, there is potential to add an additional 1800-2100 steps/day.

The daily step averages in the current sample are consistent (or greater) with most other US school day studies [3,12] and these students were also generally more active than other American Indian children [6,22]. The current sample, however, lags behind ($\Delta=-1200-1800$ steps/day, boys; $\Delta=-600-1600$ steps/day, girls) international studies of children's school-day PA levels [11,27]. By adding an extra recess and classroom based physical activity breaks, it seems reasonable that the current sample of children could accumulate similar steps to the international children throughout the school-day. Importantly, research has suggested that the short-term cognitive benefits of physical activity during the school-day adequately compensates for time spent away from other academic areas [41].

Approximately 50% of the current sample was classified as obese. These children accumulated nearly 1000 less steps/day during the school-day compared to non-obese children during the warmer seasons (Summer/Spring). When the weather cooled down (Fall/Winter), however, the differences dropped to only 300-400 steps/day. Similarly, overweight children were less active than normal weight children during the Summer and Spring and more active during the Fall and Winter. These findings suggest that overweight and obese children may be less inclined to participate in PA when the temperatures are warmer. Perhaps, if possible, allowing these children to choose indoor and/or temperature controlled activities may encourage greater participation in PA.

A recent study examined the efficacy of four interventions to increase both school and total day PA [26]. The schools targeted PA through structured recess, classroom activity breaks, and daily physical education, and found that school designed programming was able to increase school day step counts from 900-1700 steps when the teachers and administrators committed to increasing PA opportunities.

Although, seasonal differences appear to be minimal when children are in school, there is a continued need to develop programming and PA opportunities at school. Studies have begun to accumulate demonstrating the positive relationship that school PA can have on behavior, attentiveness, and performance at school [9,10,37]. For example, teachers from the Southwest US reported that physical activity in the classroom gave students something to be excited about, and students who didn't always participate in class activities enjoyed it. Furthermore, many teachers saw a distinct increase in attentiveness after physical activity, and used it to wake students up or take a break to refresh the students for more reading and math [10].

There are some notable limitations to this study. First, the study was conducted with only one group of children living in an American Indian community. Similar work with a more diverse sample of children is warranted for more generalizable findings. This study was also conducted in the Southwest US and in a desert community. Temperatures were regularly over 100°F in the Summer and almost never dropped below freezing in the Winter. A sample with more traditional seasons may be more representative of US children. For example, August is often considered a high outdoor activity month in much of the country and in this community the warmest month of the year (temperatures regularly over 100°F, therefore, perhaps limiting PA opportunities. Lastly, spring levered pedometers, although the most widely used pedometer in the pediatric literature [43] have been shown to underestimate steps in overweight and obese adults [12], something that is important to consider when 70% of the current sample are classified as overweight or obese (perhaps future studies could use piezoelectric pedometers of accelerometers to confirm findings).

In conclusion, PA stayed relatively consistent across seasons in this sample of American Indian children. However, children were the least active during Winter months and this sample had fewer steps than children living internationally accumulated within the school-day. With 70% of the current sample being classified as overweight and at a greater risk for numerous hypokinetic diseases, there is a clear need for additional school day physical activity opportunities.

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Received 27.09.2012

Accepted 15.10.2012

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