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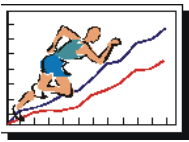
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Children's Step Counts on Weekend, Physical Education, and Non-Physical Education Days

by

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There have been well-documented increases in overweight and obese children, sedentary lifestyles, and increased prevalence of a hypokinetic disease over the past 20 years. Thus understanding the physical activity patterns of children is essential for developing effective interventions. Little evidence exists that illustrates the contribution of weekend, physical education, and non-physical education days to overall physical activity patterns of children. The purpose of the study was to examine differences in pedometer-determined physical activity patterns of fourth and fifth grade children during weekend, physical education and non-physical education days. Three hundred and sixty-three children (8-11 years old) from six Southwestern USA elementary schools participated by wearing pedometers (Yamax Digiwalker SW-200) for seven consecutive days. Children recorded their steps at arrival to school and when they woke up and went to bed on weekend days. During weekdays, the fourth and fifth grade children averaged $13,196 \pm 3,334$ and $11,295 \pm 3,168$ steps/day for boys and girls, respectively. This is compared to a weekend average of $7,660 \pm 4,647$ steps/day (boys) and $7,317 \pm 4,062$ steps/day (girls). Children were significantly more active on physical education days, averaging 12,979 steps/day ($14,197 \pm 4,697$ steps/day for boys and $12,058 \pm 3,772$ steps/day for girls), compared to non-physical education school days, when they accumulated 11,809 steps/day ($12,788 \pm 3,600$ steps/day for boys and $11,047 \pm 3,382$ steps/day for girls). Based on the findings in this study, children and youth are more active during school days than on weekend days. Furthermore, children are more active on physical education days than non-physical education days. These findings suggest that increased physical activity programming and interventions during weekend days may be needed to increase physical activity. The expansion of school-based physical education across more school days may also serve to increase children's physical activity during the school week.

Key words: Physical Activity, Pedometer, School Health, Youth

Introduction

An accurate understanding of the physical activity (PA) patterns of children and adolescents

is essential for designing effective interventions. Sallis, Prochaska, and Taylor (2000) stated that in order to develop effective PA interventions in children, influences on, and determinants of,

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activity levels need to be well understood. Data from cross-sectional studies can help identify potential mediators of PA that can be targeted for change through interventions. This need has coincided with the increased use and international acceptance of step-counting pedometers as a measure for the assessment of free-living PA levels in children (Rowland sea al., 1997; Tudor-Locke at al., 2002). This is even more important with young children, as this population often has difficulty in accurately recalling their activity through questionnaires and interviews (Sallis et al., 1993). Pedometers provide an inexpensive, objective method of assessing PA that can easily be transferred across time, groups of people and locations (Sirard & Pate, 2001).

Numerous recent descriptive studies have explored pedometer-determined PA patterns of children on weekdays (i.e. Tudor-Locke, et al., 2004; Tudor-Locke et al., 2006; Vincent & Pangrazi, 2002; Vincent et al, 2003), from which various steps/day recommendations have been established. These recommendations suggest that girls should accumulate 11,000-12,000 steps/day and boys should accumulate 12,000-15,000 steps/day.

Gavarry et al. (2003) suggest that it is important to compare children's PA patterns on school days to non-school days. There have been a limited number of studies addressing the weekday (or school week) PA of children compared to weekend days and the literature offers conflicting findings. Furthermore, only one study could be found that discussed the PA of

children on physical education (PE) days (compared to weekend and health days; Flohr, Todd, & Tudor-Locke, 2006).

A recent review article (Tudor-Locke et al., 2009) explored 31 studies published over the last decade that focused on the habitual pedometer-determined PA patterns of youth. This review found four (two from the USA, one from Belgium, one from New Zealand) studies (Cardon & De Bourdeauhuij, 2004; Duncan et al., 2006; Rowe et al., 2004; Flohr et al., 2006) reporting weekend day steps relative to weekday steps. The four studies had mixed findings relative to significance, but suggested that boys across these studies accumulated approximately 12,000-16,000 steps/weekday and 12,000-13,000 steps/weekend day. Furthermore, girls accumulated 10,000-14,000 steps/weekday and 10,000-12,000 steps/weekend day. These studies reported anywhere from 500-3,000 steps/day more during the week vs. the weekend.

Flohr, Todd and Tudor-Locke (2006) separated weekdays into PE (days on which they had structured PE class) and health days (days on which they did not have structured PE but had a health class). Boys accumulated an average of 11,980 steps on PE days and 13,159 steps/day on health days and the girls accumulated an average of 9,978 steps on health days and 10,660 steps/day on PE days. The differences between health and PE days may be attributed to varying after-school activities in which the children participated (i.e., after school sports/intramurals were more common on health days).

Variations across studies may be due to local differences and sample sizes. Further examination of PA patterns during weekdays as compared to weekend days is needed to make more confident generalizations about PA patterns during children's weekdays and weekend days. The current study is the first to compare weekend and weekday pedometer-determined physical activity of USA elementary age children (the two previous USA studies included middle school youth). It is also important to further examine the PA contributions of PE to the PA patterns of children. Therefore, the purpose of this study was to examine differences in pedometer-determined PA patterns of fourth and fifth grade elementary school children during weekdays (PE and non-PE days) and weekend days (Saturday and Sunday) by sex, ethnicity, and BMI.

Material and Methods

Participants

Fourth and fifth grade children from six elementary schools across one Southwest USA state were invited to participate in this study ($N=829$). Children who did not have the required minimum number of days or who reported taking off their pedometer for more than an hour (other than during water activities, bathing, or sleeping), lost, or broke their pedometer, were not included in the sample. A minimum of four days has been shown to be adequate time to accurately measure elementary children's PA patterns (Troost et al., 2000). A minimum of six days (four weekdays

and two weekend days); however, were required to be included in this data set as well as at least one PE day.

A total of 363 children (160 male and 203 female) provided complete data, approximately 60 children per school. The ethnic makeup of this sample were 161 (44%) Caucasian, 139 (38%) Hispanic, 22 (6%) African American, 14 (4%) Native American, 13 (4%) Asian/Pacific Islander, and 14 (4%) Other/did not report. Children ranged in age from 8-11 years (Mean = $9.7 \pm .6$ and $9.6 \pm .6$ for boys and girls, respectively) and had an average BMI (kg/m^2) of 19.7 ± 4.0 and 19.2 ± 4.2 for boys and girls, respectively. Socioeconomic status was determined at the school level, using the percentage of children who received free or reduced lunch reported by each individual school. Free and reduced lunch eligibility was determined by federal income guidelines according to a family size and therefore can be used as an indicator of poverty status (Food Research and ActionCenter, 2008). On average 49% of children at the participating schools received free or reduced lunch.

Procedures

Institutional Review Board approval was provided by the University as well as the Research Board/District Administration at all schools. Parental consent was obtained and children provided written assent. A brief demographic questionnaire was also completed by children's parents that provided sex, age, grade and ethnicity/race.

Instrument

The Yamax Digiwalker SW-200 (Yamax Corporation, Tokyo, Japan) pedometer was used to monitor the children's daily PA. This model of pedometer has produced valid and reliable scores in measuring children's PA (Barfield, Rowe, & Michael, 2004; McKee, Boreham, Murphy, & Nevill, 2005).

Pedometer Procedures

Each pedometer was individually checked for accuracy prior to use in data collection. All existing batteries were replaced and shake tests were conducted to ensure that instrumental error did not exceed 5% (see Vincent & Sidman, 2003 for complete details on the shake test). Prior to data collection a pedometer training session was conducted for participating schools' PE teachers. This training session provided the PE teachers with various pedometers lessons and protocols in order to familiarize their students with the protocol/procedures prior to data collection.

Researchers briefly reviewed these protocols with the children on the first day of data collection. The protocols included the children going about their normal routine, wearing the pedometer at all times except during sleeping or water-based activities, and not tampering with the pedometer at any time. To maintain consistency all children were asked to wear their pedometer on their waist in line with the right knee. Children then completed a walking test (they walked at a moderate pace for a minimum of 30 steps) to ensure that the placement was

appropriate for them (i.e., less than 5% measurement error). Placements were adjusted when needed.

Data Collection

Children were asked to wear their pedometer for one week. Each morning, a researcher interfaced with homeroom/first period classes to prompt the children to record their step values. Weekend recording was left to the children to remember to record on a provided form, although they were given both verbal and written reminders prior to the weekend. The children completed Previous Day's Activity Surveys (previously used by Tudor-Locke et al., 2006) daily to check for accuracy of values and compliance with wearing the instrument. These surveys asked questions related to how long they took their pedometer off, how they got to school, what types of activities they did at home, if they had PE the previous day, etc. Data were immediately examined and entered into a data spreadsheet; any unusual or non-normal (i.e. numbers much different than their average or extreme, i.e. >30,000 steps/day) numbers were clarified with the child. The children clarified their extreme step values by answering questions related to their participation in physical activity and sport the previous day, whether they complied with wearing the instrument, or if they forgot to reset their pedometer. If unusual data did not match the child's response, data was not used for that day (<1%). Height was measured without shoes to the nearest 0.5cm using a

portable stadiometer (Seca; Hanover, MD, USA). Weight was measured (also without shoes) to the nearest 0.1kg on a Seca 882 digital scale (Seca, Hanover, MD, USA).

Data Analysis

BMI was calculated using the formula kg/m^2 . Based on BMI, children were categorized using the CDC's (2000) age and sex-specific cut points as being normal range ($\leq 85\%$), overweight ($> 85\%$) and obese ($\geq 95\%$). Mean steps/day were calculated for the entire week (6 or 7 days), weekend days, weekdays, PE days and non-PE weekdays. *t*-tests were utilized to examine differences across weekday/ weekend days, Saturday vs. Sunday, sex, grade (4th vs. 5th), and PE vs. non-PE days. ANOVA was utilized to examine differences related to ethnicity and BMI.

Results

PE Days vs. Non-PE Days

The weekday steps/day average included data from both PE and non-PE days. Results indicated that children were significantly more active on PE days ($t(590)=6.83, p<.01$). The current sample averaged 12,979 steps/day (14,197 \pm 4,697 steps/day for boys and 12,058 \pm 3,772 steps/day for girls) on PE days compared to non-PE school days, the participating children accumulated 11,809 steps/day (12,788 \pm 3,600 steps/day for boys and 11,047 \pm 3,382 steps/day for girls).

Four schools ($n=229$) had multiple days of PE for their students and two schools ($n= 34$) had one day of PE. Results indicated significant

differences across weekdays for children with multiple days of PE ($t(361)=-2.24, p< .05$) compared to one day of PE. The children with multiple days of PE averaged 12,454 \pm 4,432 steps/weekday compared to 11,586 \pm 4,205 ($\Delta=868$) for children that had a single day of PE.

Weekdays vs. Weekend Days

During weekdays, the fourth and fifth grade children averaged 13,196 \pm 3,334 and 11,295 \pm 3,168 steps/day for boys and girls, respectively. This is compared to a weekend average steps/day of 7,660 \pm 4,647 (boys) and 7,317 \pm 4,062 (girls). When an all days (weekend and weekdays) average is calculated, the current sample of children accumulated 10,713 \pm 2,980 (boys=11,514 steps/day \pm 3,032, as compared to girls=10,081 steps/day \pm 2,787) steps/day. Significant sex differences (boys more active than girls) were present on PE days ($t(321)=4.48, p<.01, \Delta=2,139$), non-PE weekdays ($t(350)=4.74, p<.01, \Delta=1,741$), and all days ($t(361)=4.68, p<.01, \Delta=1,433$). The weekend steps were not significantly different for sex ($t(361)=.77, p=.44, \Delta=343$). Children were also significantly more active on Saturday's (7,920 \pm 5,228) than Sunday's (7,169 \pm 5,025); $t(383)=2.657, p<.01$.

BMI Differences

There were significant differences by BMI group on PE days ($F(2, 314)=7.46, p<.01, \eta^2=.05$), non-PE days ($F(2, 341) =3.77, p<.05, \eta^2=.02$) and for all days ($F(2, 352)=5.25, p<.01, \eta^2=.03$). In each of these cases, follow-up tests indicated that the significant differences were

present between the normal weight and the obese group ($p < .05$) rather than the overweight group. Table 1 shows the mean steps/day for each day according to BMI cut points and sex. No significant differences were found for weekend day ($p = .12$) PA by BMI classification.

Ethnic Differences

Results showed no significant differences across ethnic groups on PE days ($F(5,309) = 2.24$, $p = .05$, $\eta^2 = .04$), non-PE days ($F(5,334) = 1.22$, $p = .30$, $\eta^2 = .02$), weekend days ($F(5,345) = .10$, $p = .99$, $\eta^2 < .01$) or all days ($F(5,345) = 1.85$, $p = .10$, $\eta^2 = .03$).

Discussion

Average Weekday Steps

The children in this sample averaged 13,196 and 11,295 steps/day on weekdays for boys and girls, respectively, which was similar to a small, previous study reporting that USA elementary school boys accumulated an average of 13,162 steps/day, and girls an average of 10,923 steps/day on weekdays (Vincent & Pangrazi, 2002). These sex differences are supported by a recent review of the physical activity patterns of European youth which found that boys were also more active than girls (Armstrong & Welsman, 2006). The children accumulated fewer steps/day when compared to their Swedish (15,891 = boys; 13,143 = girls; Raustorp et al., 2004) and New Zealand (15,606 = boys; 13,031 = girls; Cox, Schofield, Greasley, & Kolt, 2006) counterparts.

The findings are consistent with a recent review article (Beets et al., 2010) that found USA

children to accumulate fewer steps/day than European and Western Pacific children.

Comparing Average Weekend Day with Weekday Steps

In this study, the only days where boys (7,660) and girls (7,317) accumulated similar step counts were during the weekend days. The significant differences found in this current sample between weekdays and weekend days were consistent with the differences reported in a similar pedometer-based study that included elementary school children that also reported more active weekdays.

Duncan et al., (2006) in their sample of 1,115 children (aged 5-13) from New Zealand, found that boys and girls averaged 16,132 and 14,124 steps/weekday, respectively as opposed to 12,702 (boys) and 11,158 (girls) on weekend days.

To our knowledge, the current study is the first to examine the weekend pedometer-determined PA patterns of USA elementary school children (and only the second internationally).

This significant drop in weekend steps was mirrored by a study examining the weekday and weekend steps of Polish adolescents (Groffik et al., 2008). This group of young people averaged approximately 3,200-4,300 and 3000-3,200 steps/day less on weekend days for boys and girls, respectively.

Table 1*Mean Steps/Day by BMI Cut Point and Sex*

	PE Day* (SD)		Non-PE Day* (SD)		Weekend Day (SD)		All Days* (SD)	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Obese (N = 87)	12712 (4010)	10567 (3180)	12106 (3522)	9794 (3193)	6554 (3688)	6874 (3922)	10711 (2719)	9058 (2687)
Overweight (N = 64)	13824 (4286)	11633 (3414)	13468 (4564)	10652 (3056)	8134 (4127)	7340 (4609)	11750 (3342)	9773 (2626)
Normal (N = 204)	15185 (4930)	12804 (4139)	12852 (3261)	11617 (3264)	8102 (4722)	7585 (3448)	11838 (3022)	10579 (2757)

* $p < .05$ between boys and girls (for BMI cut point) found between Normal and Obese.

Note that 8 children did not have their BMI calculated.

PE day included a structured PE class taught by a specialist.

BMI cut points were determined by CDC growth charts (CDC, 2000).

School physical activity opportunity.

In a sample of USA children, Morgan et al., (2003) found that elementary school (ages 8-11 years) children averaged 3,800 (males) and 2,900 (females) steps while they were at school. Tudor-Locke, et al. (2006) found that a sample of sixth grade elementary school children averaged 6,832 (males) and 4,895 (females) steps while they were at school. If the average accumulated steps taken while children were at school (from the above samples) were subtracted from the weekday mean steps/day of their samples, it would suggest that children from these studies accumulated between

6,364-9,396 (males) and 6,400-8,395 (females) steps/day outside of school. The average weekend steps of this current sample fall within these ranges (boys = 7,660 and girls = 7,317 steps/day). This may suggest that children in the current study did not compensate for the steps that they typically accumulate during school on the weekends.

Socioeconomic status.

A potential explanation for the large difference between weekday and weekend day PA may also be related to parental income or

socioeconomic status. Gordon-Larsen et al. (2000) found that family income was associated with PA patterns of adolescents. They stated that the higher the family income, the more likely the children to be categorized in the highest activity groups; while the lower the family income the greater the likelihood of children being in the lowest activity group.

Furthermore, Duncan et al. (2008) in their secondary examination of the physical activity patterns of 5-16 year old youth found that the low socioeconomic females were similarly active to their medium and high income counterparts during the week, but were 1,047-1,686 steps less active on weekend days. This relationship may partially explain the large decrease in steps/weekend day in the current sample, where the fourth- and fifth-grade children accumulated 3,978-5,536 fewer steps on weekend days. Nearly half (49%) of all children participating in this project were receiving free or reduced lunch (reported at the school level only).

PE vs. Non-PE Days

PE days may contribute an additional 1,409 and 1,011 steps/day for boys and girls, respectively. Utilizing Graser et al. (2011) estimate of 122 steps/minute for boys and 102 steps/minute for girls, a 30 minute PE (which includes quality instruction and activity) class has the potential to contribute an additional 12 and 10 minutes of PA each day for boys and girls, respectively. Using this line of reasoning, daily PE has the potential to contribute nearly 60 (males) and 50 (females)

additional minutes of PA per week. Previously, Flohr et al. (2006) did not find a difference between PE and non PE day activity patterns. Their sample of 44 seventh grade students had a consistent number of steps across days (PE, health education, and weekend), which is different from our own finding. They also reported that the students who participated in organized after-school activities (50% of their sample) accumulated more steps/day than students who did not participate in after-school activities (i.e., 3,108 more steps). The authors acknowledged that this participation in after-school activities may have negated any apparent difference in steps/day on PE and non-PE days.

Limitations

A number of limitations a worth noting. First, as Crouter et al. (2005) noted, spring levered pedometers may underestimate steps in overweight and obese individuals. Second, this study took place in six schools; however, they were in only one USA state, making it difficult to generalize these results beyond this locale.

Conclusions

Based on the findings in this study, elementary school children are generally more active on school days than weekend days. This supports the previous literature suggesting that children are less active on weekend days compared to school days (e.g. Gavarry et al., 2003) as well as the large scale pedometer study (that included elementary children) that examined

weekday and weekend PA (Duncan et al., 2006). Furthermore, few children are meeting the daily recommended steps/day (13,000 and 11,000 for boys and girls, respectively) on weekend days set forth by the President's Challenge Physical Activity and Fitness Awards Program (President's Council on Physical Fitness and Sports, 2001). This suggests that increased PA programming and interventions during weekend (and possible other types of non-school days, e.g., summer

time) may be needed to address the PA patterns of children. The highest steps/day values were attained on PE days, and those children who had multiple days of PE accumulated a statistically significant higher average daily step count compared to children with a single day of PE. Findings suggest that increased PA programming and interventions on weekend days may be needed along with an increased frequency of PE programming during the school week.

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