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Travel by Walking Before and After School Increases Physical Activity among Adolescent Girls

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Abstract

Objective—To examine how travel by walking before and after school contributes to total physical activity of adolescent girls.

Design—Cross-sectional sample.

Setting—36 middle schools from Arizona, Maryland, Minnesota, New Orleans, San Diego and South Carolina participating in the Trial of Activity for Adolescent Girls (TAAG).

Participants—1721 6th grade girls consented to participate; adequate information was available for 1596 (93%) of participants.

Main outcome measure—Travel by walking before school, after school, and before and after school combined, assessed from the 3-Day Physical Activity Recall (3DPAR). Mean minutes of physical activity, measured by accelerometry, were estimated for total physical activity (light, moderate, vigorous), moderate to vigorous activity (MVPA), and MVPA (3 MET).

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Results—Travel by walking was reported by 14% of participants before and 18% after school. Girls who reported “travel by walking” before and after school (combined) had 13.7 (95% confidence interval [CI], 1.2 – 26.3) more minutes of total PA and 4.7 (95% CI, 2.2 – 7.2) more minutes of MVPA than girls who did not report this activity. Before school and after school walkers (but not both) accumulated 2.5 (95% CI, 0.10 – 4.9) and 2.2 (95% CI, 0.24 – 4.2) more minutes of MVPA on an average weekday, respectively, than non-walkers.

Conclusions—Our results provide evidence that walking for transportation before and after school increases weekday minutes of total physical activity and MVPA for middle school girls.

There has been an age-related decline in the participation in physical activity among U.S. youth, especially among girls.[1] The importance of reversing the decline in activity among adolescents is acknowledged in the *Healthy People 2010* objectives 22-6 and 22-7.[2] A more recent recommendation is for children to accumulate a minimum of 60 minutes of moderate-to-vigorous physical activity (MVPA) each day.[3] Along with the decline in physical activity, the prevalence of overweight children and adolescents has more than doubled since the 1960s[4]. Increasing the number of children and adolescents participating in physical activity may be an important way to reduce overweight in children and adolescents.

Opportunities for increasing participation in MVPA among adolescents could occur at different times of day, such as before, during, and after school.[5, 6] During and after school hours have been targeted as opportunities for increasing physical activity among adolescents through physical education class and after-school programming. There is little information describing what physical activities adolescents are participating in before school and the use of active transport before and after school. One study documented leisure time physical activity patterns in 24 California middle schools.[7] Only 4% of all students visited the school-based activity areas before school, 51% of whom were engaged in unstructured MVPA.[7] Active commuting to school (i.e., walking or biking) has been identified as a source of continuous moderate physical activity for school-aged children.[8] According to the National Household Travel Survey (NHTS), however, less than 15% of students 5–15 years of age walked to or from school in 2001 and only 1% reported riding a bike compared to 1968 when 48% of students reported walking or biking to school.[9]

Three studies have used objective measures of physical activity to examine the contribution of walking to school to overall physical activity among elementary aged children, 5 y olds, and 13–14 y old adolescents.[10–12] Two of the studies [11, 12] showed that physical activity between 8AM and 9AM was higher among children who walked to school. However, total weekly activity was not different between walkers and non-walkers, nor was total daily activity except among boys in one study.[11, 12] Adolescents who walked to and from school accumulated more minutes of MVPA for the entire weekday than those who took a car, bus, or train to school.[10]

The purpose of this paper is to examine the contribution of before and after school travel by walking to total physical activity in middle school girls. We hypothesize that total daily physical activity will be higher in girls who reported travel by walking before and after school compared with those who did not.

METHODS

Participants

The study sample consists of 6th grade girls enrolled in the Trial of Activity for Adolescent Girls (TAAG), a multi-center, group-randomized trial sponsored by the National Heart, Lung, and Blood Institute (NHLBI). See Pate et. al.[13] in this issue for more information on the TAAG study. Sixty healthy 6th grade girls were randomly selected from six schools at each of the six

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TAAG field sites to undergo a series of measurements. Parental consent and participant assent was obtained from 1721 girls (80% of random sample). The protocol was approved by each participating institution's Human Subjects Review Board. Further details of the TAAG study design and analysis plan are described elsewhere.[14]

Measurements

Age, ethnicity, socioeconomic status, and neighborhood factors were obtained from the participant by questionnaire. Ten questions were asked regarding the girls' perceptions of their neighborhoods and included perceived safety (e.g., safe to walk or jog in the neighborhood), aesthetics (e.g., many interesting things to look at in the neighborhood) and access to facilities near home (e.g., places to walk to from home). Participants rated each item on a 5-point Likert scale, ranging from disagree a lot (1) to agree a lot (5).[15]

Following a standardized protocol, two weight readings were recorded to the nearest 0.1 kg on an electronic scale (Seca, Model 770, Hamburg, Germany) and two height measurements were recorded to the nearest 0.1 cm using a portable stadiometer (Shorr Height Measuring Board, Olney, MD). The height and weight values used in the analysis were the average of the two readings.

All Actigraph (Health One Technology, Model 7164, Fort Walton Beach, FL) accelerometers were checked at the Coordinating Center for similarity of basic functional condition using a standard laboratory shaker prior to being sent to each field site for subsequent use in this study. Each monitor was initialized prior to placing it on a belt to be worn on the girls' waist. Monitors were distributed to the girls and returned on the same day of the week, resulting in 6 complete days of data (i.e., partial data from the first and last day were not used to determine daily activity levels). Data were uploaded from the monitor to a PC and then sent to the Coordinating Center. Activity counts were stored in 30-second time intervals. The 30 second epoch was chosen because children tend to do activities in short bursts and are more sporadically active than adults. A previous sub-study demonstrated that to minimize the school level intraclass correlation between girls within a school, Actigraph data should be collected over at least two different calendar weeks.[16]

Actigraph counts (per 30-sec) were summarized by quantifying the time (minutes) spent at different intensity levels. TAAG thresholds for the activity intensities were <50 counts/30s for sedentary activity, 51–1499 counts/30s for light activity, and 1500 counts/30s for moderate-to-vigorous activity.[17] The ≥1500 counts/30s threshold for MVPA corresponds approximately to the lower bound for a 3.5 mile per hour (mph) walk. We also operationally defined a slightly lower cut point, corresponding to the lower bound for 2.5 mph walk representing an activity intensity of 3 METs (metabolic equivalent). Including this lower bound provided the ability to compare to similar studies that use a 3 MET threshold. Occasional missing actigraph data within a girl's six-day record were imputed using the Expectation Maximization (EM) algorithm.[18] On average, approximately 12 hours of data per person were imputed. Girls who provided too little data to accurately impute missing data were excluded from this analysis. For this analysis, minutes of total PA and MVPA were accumulated before school, after school, and before and after school combined. "Before school" was defined as 6AM to the school start bell time and "after school" was defined as the school end bell time to 5PM for each TAAG middle school.

A modified version of the 3-Day Physical Activity Recall (3DPAR) was used to augment the accelerometer data and provide contextual information regarding the physical activities that the participants performed. The 3DPAR itself is a modification of the Previous Day's Physical Activity Recall (PDPAR), which was previously validated in youth.[19,20] McMurray et al.

found that the 3DPAR was significantly correlated with MTI Actigraph counts in adolescent girls for MVPA (r = 0.28–0.31).[21]

The 3DPAR form consists of three grids (one for each day) divided into 30-minute segments/blocks. Participants chose and recorded the code number of the predominant activity that they performed during each block of time. The codes corresponded to a list of activities arranged in categories (eating, sleeping, personal care, transportation, work/school, spare time, play/recreation and exercise/workout). Participants then chose an intensity level (light, moderate, hard or very hard) at which they performed the activity.

For the TAAG study the 3DPAR was modified in two ways. One modification was to include two contextual variables, where the activity was performed and who was with the participant while the activity was performed. Girls could choose between five options for where they were (home/neighborhood, school, community facility, other outdoor public area, or other) and four options for whom they were with (by yourself, with one other person, with several people, or with an organized program, class or team). The other modification was to add extra activities to the list of codes provided in order to reflect the different activities that can be performed in various climates all across the country. All surveys were taken in a classroom or gymnasium setting in which girls were given instructions from a standardized script used across all sites.

Statistical Analysis

"Travel by walking", the code for walking for transportation as opposed to exercise, was the primary activity students reported before and after school on the 3DPAR (Table 1). Participants were classified as walkers if they reported "travel by walking" on one or more weekdays before or after school, as this activity was found to demonstrate good agreement between reported walking status on consecutive days (kappa = 0.7). "Travel by walking" before and after school from the 3DPAR was used because specific questions about transportation modes to school were not asked. Total activity is defined in this paper as the sum of light, moderate and vigorous activity.

To properly account for the hierarchical nature of the data, with girls nested within schools and schools nested within field centers, we performed a series of linear mixed models analyses. In these models, we treated "travel by walking" (categorized as none, before school, after school, before and after school) as fixed, and girl and school as random. These analyses were implemented by Proc Mixed in SAS 8.02 for Windows.[22]

RESULTS

Of the 1721 girls who consented to be measured, 118 were excluded because they failed to wear the accelerometer for at least one day, and 7 were excluded for missing data on the 3DPAR. The mean age for the 1596 girls included in the analysis sample was 12.0 (± 0.5) years; 47% were Caucasian, 23% African-American, 15% Hispanic, 10% multi-racial, and 5% belonged to other race or ethnic groups. There was a wide range in BMI (12.7 – 44.8 kg.m^2); however, the mean BMI did not differ significantly between girls who reported "travel by walking" before and/or after school vs. those who did not (p=0.14).

Table 1 lists the most frequently reported before and after school physical activities. "Travel by walking" was the most frequently reported before (14%) and after school (18%) activity; less than 1% of girls reported bicycling before or after school.

Table 2 presents the average levels of weekday activity accumulated before school, after school, before and after school, and throughout the day in girls who reported and did not report "travel by walking". On an average weekday, girls who reported "travel by walking" before and after school had 13.7 (95% confidence interval [CI], 1.2 – 26.3) more minutes of total physical activity and 4.7 (95% CI, 2.2 – 7.2) more minutes of MVPA than girls who did not report this activity. Girls who reported walking before school and after school (but not both) had 10.3 (95% CI, −1.8 – 22.4) and 2.8 (95% CI, −7.0 – 12.7) more minutes of total physical activity than the non-walkers, but these differences were not statistically significant. On the other hand, these girls accumulated significantly more minutes of MVPA than non-walkers, with before school and after school walkers accumulating 2.5 (95% CI, 0.10 – 4.9) and 2.2 (95% CI, 0.24 – 4.2) additional of minutes of MVPA on an average weekday, respectively. Girls who reported "travel by walking" both before and after school had 8.4 (95% CI, 3.7 – 13.1), 4.7 (95% CI, 2.1 – 7.3), and 3.8 (95% CI, 0.33 – 7.3) more minutes of total physical activity during those periods (i.e., before/after school) than girls who reported no walking, walking after school, and walking before school, respectively. Overall, girls who reported "travel by walking" before and after school had significantly higher levels of total physical activity and MVPA before school, before and after school, and for an entire day than did girls who reported none ($p < 0.05$). Using a regression equation developed in a similar population[23,] activity counts accumulated before school were converted to energy expenditure (EE). Before and after school walkers expended 194 kJ (95% CI, 92–295) more energy than non-walkers. The longest bout of continuous MVPA (3-METs) before school was 8.5 to 11 min for walkers vs. 5 min. for non-walkers. After school, the longest bout was about 20 min each for before and after school walkers, 15 min for girls who walked both before and after school, and 17 min for non-walkers. A similar trend in favor of greater activity for before and after school walkers was noted when we examined the time spent engaged in MVPA (3 METS) averaged over the entire day (Table 2 and Figure 1).

There were no significant differences in walking status by race/ethnicity (data not shown). For each race separately, "travel by walking" both before and after school was reported in 29% of the African-American girls, 32% of the Hispanic girls, and 23% of the Caucasian girls.

There were significant differences between walkers and non-walkers on three of the neighborhood perception items. Compared to girls who did not report walking, girls who walked both before and after school perceived their neighborhoods as having significantly more places they could go in walking distance from home (3.91 vs. 3.55; $p=0.006$), having sidewalks on most of the streets in their neighborhoods (3.94 vs. 3.38; $p=0.001$), and having many interesting things to look at while walking in their neighborhoods (3.81 vs 3.43; $p=0.0035$).

DISCUSSION

The prevalence of overweight children and adolescents has more than doubled since the 1960s[4] while at the same time their participation in physical activity has declined dramatically, especially among girls,[1] indicating the need to improve the understanding of children's physical activity patterns.

An area of particular concern has been the dramatic decline in children's active commuting.[24] Research has found that children who walk to school engage in more physical activity than those who travel by car, yet the numbers of children who walk to school has been in steady decline.[11] These findings underscore the importance of the *Healthy People 2010* objective to increase the number of active trips to school made by children who live within a mile of school.[2]

This study found that middle school girls who reported walking for transportation before and after school on at least one day of a 3-day self-report had significantly higher levels of total physical activity and MVPA before school, before and after school, and for an entire day than did girls who reported none. The highest total physical activity as shown in Table 2 is seen with girls who report travel by walking before and after school combined, followed by before school walking and then by after school walking. The number of girls reporting after school walking for transportation was 18% and the number of girls reporting before school walking was 14%. These data include girls from six different states and mostly suburban settings (San Diego, Tucson, New Orleans, Baltimore, and Minneapolis). South Carolina schools were located in relatively small cities and towns. Thus, our objective evidence of increased activity in girls who travel by walking before and after school as measured by accelerometry is confirmed by the contextual evidence from the modified 3DPAR that travel by walking is the most frequently reported activity, as shown in Table 1. The two different measures of activity provide supporting information.

The only national data on school travel comes from the Nationwide Personal Transportation Surveys (NPRS), now called the National Household Travel Survey (NHTS).[25] Walking as a percent of school trips among US children between the ages of 5 and 15 y declined from ~ 20% in 1977 to less than 15% in 2001. Girls in the current study had before school walking rates similar to what was observed in the NHTS study (14%). Lower rates of walking were reported in studies involving two rural states.[26,27] In West Virginia, 7.6% of students walked to school and the average time spent walking to school was 7.6 min (SD=4.4), as estimated by principals from elementary, middle, and high schools.[26] A similar number (7.5%) of middle school girls reported walking to school on one or more days in a usual week in North Carolina based on the Youth Risk Behavior Surveillance Survey (YRBS).[27]

Few studies have attempted to compare the physical activity levels of active travelers to those who use inactive travel modes. Physical activity of walkers and non-walkers from five urban primary schools in Bristol, England were compared before and after school.[11] Significant differences in 8AM to 9AM (before school) physical activity were observed between walkers and non-walkers. However, only the boys who walked to school showed higher total daily physical activity when compared to non-walkers.[11] Another English study found that school travel had little or no impact on the weekly physical activity of 5 y olds in their first year in school.[12] Using a different MVPA cut-point (≥1399 and ≤1547 counts per minute) a study of 13–14 y old boys and girls in Edinburgh, England, showed that students who walked both to and from school accumulated 26 minutes more of MVPA for an entire weekday than those who traveled by car, bus, or train. In our study, adolescent girls who walked before and after school accumulated 4.7 minutes more of MVPA and 13.8 more minutes of MVPA (3 MET) than the non-walkers.

Adolescents who use active means of transport to school may be less likely to be overweight or obese, according to data from the National Longitudinal Study of Adolescent Health (ADD Health) study.[28] Although this speculation holds promise, only a few studies have attempted to link travel mode to this health outcome. In a recent study of Nebraska youth, Heelan and associates[29] failed to find a significant association between BMI and a school travel index (times per week X distance). There was, however, a significant and positive association between self-reported physical activity and travel index. The impact of active school travel may be more important at the population level. Sturm[30] suggests that if an additional 25% of children were to walk to school, total active travel time could increase by 50% in the US. In our study, there was no difference in BMI between girls who reported "travel by walking" before and after school and those who did not. However, the difference in daily minutes of MVPA for TAAG girls who reported travel by walking before and after school versus those who did not was approximately 4.7 to 13.8 minutes, depending on the definition for the MVPA threshold. The mean difference in energy expended before school between those who walked and those who did not was 194 kJ or 46 kcals/day (232 kcals/week). Alternatively, if we use 9 minutes of additional MVPA as a midpoint for this 4.7 to 13.8 minute range, this would translate into 45 additional minutes of MVPA per week. Since walking 2.5 mph expends approximately 14 kJ/min (3.35 kcal/min) in adolescent girls[23], this would translate into approximately 151 kcal/week of additional energy expenditure and approximately 0.59 kg of weight gain prevention over an average 30-week school year. Hill and Peters[31] have estimated that an increase in energy expenditure of approximately 50 kcals/day would halt the increase in obesity occurring among at least 90% of adults. To our knowledge, similar estimates are not available for youth. Before and after school walking has the potential to contribute to a comprehensive plan for overall increased activity and consequently increased energy expenditure and prevent excessive weight gain.

An ancillary study of TAAG, using the same baseline data from this same sample, explored whether proximity to school was associated with physical activity by mapping the addresses and calculating the shortest distance from their home to their school along the street network.[32] Of the 1,556 6th grade girls whose home addresses could be geocoded, 15.5% lived within a mile of their school; 28% lived within 1–2 miles, 23% lived 2–3 miles from school, and 33% lived 3 or more miles from school.[32] In our study the mean distance to school (along a street network) for girls who walked both before and after school was 1.9 miles, compared to 2.4 miles for after school walkers, 2.7 miles for before school walkers, and 2.8 miles for non-walkers (p<0.001). Additionally, 34% of before and after school walkers lived within a mile of their school, while 23%, 20%, and 12% of the after school walkers, before school walkers and non-walkers respectively lived within a mile of school. Girls who walked before and after school also had a slightly more positive perception of their neighborhoods. The closer proximity to school as well as their perceived positive perceptions of their neighborhoods might be factors related to increased walking.

Several potential limitations of this study merit comment. First, specific questions about transportation modes to school were not included in the data collected at baseline. The post-intervention measurement occasion will include this information. Therefore, use of the “travel by walking” item on the 3DPAR within the before and after school time frame may not necessarily represent walking to school. However, by examining the “where” variable associated with each 30-min block of activity on the 3DPAR, we were able to determine that 60% of the participants who reported “travel by walking” before school identified “school” as their destination during the activity. Therefore, it is likely that girls who reported travel by walking but whose destination was not school, were simply walking to a bus stop or walking after already having arrived on the school grounds. Second, the 3DPAR asks respondents to report the activity performed for the majority of a 30-min “block” of time, not specific minutes of time. Thus, the duration of the reported activity during a block could be much less than 30 minutes. Nevertheless, a recent study found the 3DPAR to be slightly more accurate than asking middle school girls to recall exact minutes of time.[21] In addition, since walkers accumulated a mean of 43.8 minutes of total physical activity and 13.3 minutes of MVPA (3 METS) before school, for example, it appears reasonable that walking may indeed have been their main activity during that time period. Another potential problem may be confounding variables (other sources of activity during the day) when testing for differences in activity. We examined group differences for potential confounding variables (i.e. the percentage of girls who participated in PE, participation in sports teams in or out of school, participation in classes or lessons taken in and out of school as recorded by the girls). After controlling for these variables, there remained a difference between those girls who travel by walking before and after school and those who did not. Also, we did not consider the economic factors that might prohibit these adolescent girls from walking before and after school. Lastly, the finding that girls who reported before and after school travel by walking also had correspondingly higher accelerometer counts before and after school than non-walkers provides strong evidence that the contextual question on the 3DPAR yielded valid scores.

Studies like this one that focus on unexplored targets for intervention among adolescent youth are important. With the continued escalation in obesity rates especially among adolescents, opportunities to alter the energy balance toward caloric expenditure must be found. Walking to and from school is a low cost and attainable physical activity. Although most efforts to promote walking occur at the elementary school level, public health and education officials should search for promotion strategies that appeal to youth in middle schools.

Conclusion

In this study of middle school girls, 14% reported travel by walking before school and 18% reported travel by walking after school. We found that girls who reported "travel by walking" before and after school had 4.7 more minutes of MVPA and 13.7 more minutes of total physical activity than girls who did not report this activity. Before and after school walkers also expended 194 kJ more than non-walkers. This reveals an opportunity for increasing the activity level of adolescent girls through interventions to increase the percentage of girls who use active travel to school. Though the amount of activity added may not prevent obesity, the potential for this activity to contribute to a comprehensive plan for overall increased activity and increased energy expenditure is evident.

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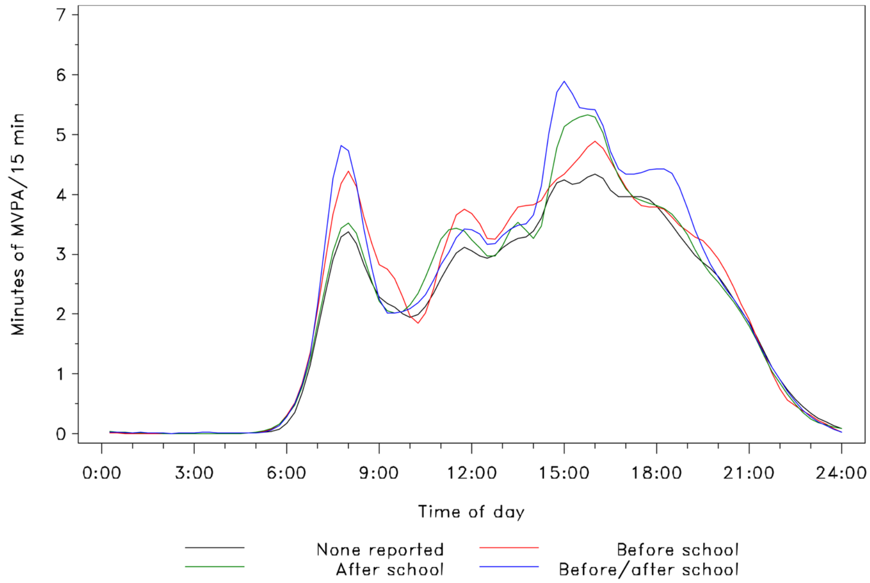

Figure 1.
Average weekday activity (3 MET) by hour in girls who reported and did 2 not report “travel by walking” before school (6AM to school start bell) and after 3 school (school end bell to 5PM)

Table 1

Most frequently reported before and after school physical activities among 1,596 girls in the TAAG study

Physical Activities	Before School	After School
	***N* (%)**	***N* (%)**
Travel by walking	232 (13.6)	302 (17.7)
Walking for exercise	23 (1.3)	81 (4.8)
Running/Jogging	17 (1.0)	74 (4.3)
Doing household chores	6 (0.4)	195 (11.4)
Dance	—	115 (6.7)
Basketball	6 (0.4)	134 (7.9)
Playing with younger children	9 (0.5)	94 (5.5)

Table 2

Mean daily physical activity in girls who did and did not report “travel by walking” before and after school[1]

	None reported (n = 1162)	Travel by walking: Before School (n = 120)	Travel by walking: After School (n = 190)	Travel by walking: Before and after School (n = 112)	P-value for difference in means[2]
Before school					
Total PA	40.3 (1.26)[3]	43.8 (1.73)*	40.1 (1.55)	45.0 (1.76)*	<.001
MVPA (3 METs)	10.1 (0.51)	13.3 (0.68)*	10.1 (0.62)	14.6 (0.69)*	<.001
MVPA	2.0 (0.21)	3.3 (0.28)*	2.0 (0.25)	4.0 (0.28)*	<.001
Total EE (kJ)	691 (23)	765 (33)*	700 (29)	791 (33)*	<.001
Duration of longest bout of MVPA (3 METs)	5.0 (0.43)	8.5 (0.66)*	5.3 (0.58)	11.0 (0.67)*	<.001
After school					
Total PA	63.9 (2.92)	65.9 (3.30)	68.3 (3.15)*	67.7 (3.33)*	.004
MVPA (3 METs)	19.2 (1.14)	20.5 (1.44)	23.9 (1.32)*	24.4 (1.46)*	<.001
MVPA	5.3 (0.52)	5.5 (0.68)	7.4 (0.62)*	6.8 (0.69)*	<.001
Total EE (kJ)	1126 (53)	1186 (60)	1222 (57)*	1207 (60)*	<.001
Duration of longest bout of MVPA (3 METs)	17.0 (2.3)	20.2 (2.37)	20.7 (2.10)*	14.8 (1.72)*	<.001
Before and after school					
Total PA	104.2 (3.13)	109.5 (3.77)*	108.4 (3.52)*	112.6 (3.81)*	<.001
MVPA (3 METs)	29.4 (1.43)	33.8 (1.80)*	33.9 (1.65)*	38.9 (1.82)*	<.001
MVPA	7.2 (0.67)	8.9 (0.84)*	9.4 (0.78)*	10.8 (0.86)*	<.001
Total EE (kJ)	1800 (56)	1937 (72)*	1900 (66)*	1994 (73)*	<.001
Average Weekday					
Total PA	379.4 (5.63)	389.7 (7.90)	382.0 (7.04)	393.1 (8.06)*	.091
MVPA (3 METs)	99.2 (2.93)	107.2 (3.86)*	104.8 (3.50)*	113.0 (3.93)*	<.001
MVPA	25.1 (1.65)	27.6 (1.98)*	27.3 (1.85)*	29.8 (2.00)*	<.001

EE=energy expenditure; MET=Metabolic equivalent; MVPA=moderate to vigorous physical activity, Total PA=light + moderate + vigorous physical activity

[1]”Before school” is defined as 6AM to school bell start time; “After school” refers to the school end bell time to 5PM

[2]p value for Analysis of Variance test of equality of means

[3]Data are given as mean (SE) minutes unless otherwise indicated

*Significantly different from non-walkers at $p<0.05$