Travel by Walking Before and After School and Physical Activity Among Adolescent Girls

Brit I. Saksvig, PhD; Diane J. Catellier, DrPH; Karin Pfeiffer, PhD; Kathryn H. Schmitz, PhD; Terry Conway, PhD; Scott Going, PhD; Dianne Ward, EdD; Patty Strikmiller, MS; Margarita S. Treuth, PhD

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

Design: Cross-sectional sample.

Setting: Thirty-six middle schools from Arizona, Maryland, Minnesota, Louisiana, California, and South Carolina participating in the Trial of Activity for Adolescent Girls (TAAG).

Participants: Seventeen hundred twenty-one sixth-grade girls consented to participate; adequate information was available for 1596 participants (93%).

Main Exposure: Travel by walking before school, after school, and before and after school combined assessed from the 3-Day Physical Activity Recall.

Main Outcome Measure: Mean minutes of physical activity measured by accelerometry were estimated for total physical activity (light, moderate, vigorous), moderate to vigorous physical activity (MVPA), and MVPA of 3 metabolic equivalents.

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

Conclusion: Our results provide evidence that walking to and from school increases weekday minutes of total physical activity and MVPA for middle-school girls.

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aged children, 5-year-olds, and 13- to 14-year-old adolescents. Two of the studies showed that physical activity between 8 AM and 9 AM was higher among children who walked to school. However, total weekly activity was not different between walkers and nonwalkers nor was total daily activity except among boys in 1 study. 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. The purpose of this article 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 sixth-grade girls enrolled in the Trial of Activity for Adolescent Girls (TAAG), a multicenter, group-randomized trial sponsored by the National Heart, Lung, and Blood Institute. More information on the TAAG study appears in an article by Pate et al published earlier in the ARCHIVES. Sixty healthy sixth-grade girls were randomly selected from 6 schools at each of the 6 TAAG field sites to undergo a series of measurements. Parental consent and participant assent were obtained from the participant by questionnaire. Ten questions were asked regarding the girls’ perceptions of their neighborhoods and included perceived safety (eg, safe to walk or jog in the neighborhood), aesthetics (eg, many interesting things to look at in the neighborhood), and access to facilities near home (eg, 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). Following a standardized protocol, 2 weight readings were recorded to the nearest 0.1 kg on an electronic scale (model 770; Seca, Hamburg, Germany), and 2 height measurements were recorded to the nearest 0.1 cm using a portable stadiometer (Shorr Height Measuring Board; Shorr Productions, Olney, Md). The height and weight values used in the analysis were the average of the 2 readings.

All Actigraph accelerometers (model 7164; Health One Technology, Fort Walton Beach, Fla) 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 (ie, partial data from the first and last day were not used to determine daily activity levels). Data were uploaded from the monitor to a personal computer 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 substudy demonstrated that to minimize the school-level intraclass correlation between girls within a school. Actigraph data should be collected over at least 2 different calendar weeks.

Actigraph counts (per 30 seconds) were summarized by quantifying the time (minutes) spent at different intensity levels. The TAAG thresholds for the activity intensities were less than 50 counts per 30 seconds for sedentary activity, 51 to 1499 counts per 30 seconds for light activity, and 1500 or more counts per 30 seconds for MVPA. The threshold of 1500 or more counts per 30 seconds for MVPA corresponds approximately to the lower bound for a 3.5-mph walk. We also operationally defined a slightly lower cut point, corresponding to the lower bound for a 2.5-mph walk and representing an activity intensity of 3 metabolic equivalents (METs). Including this lower bound provided the ability to compare with similar studies that used a 3-MET threshold. Occasional missing Actigraph data within a girl’s 6-day record were imputed using the expectation maximization algorithm. 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 physical activity and MVPA were accumulated before school, after school, and before and after school combined. “Before school” was defined as 6 AM to the school start-bell time and “after school” was defined as the school end-bell time to 5 PM 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, which was previously validated in youth. McMurray et al found that the 3DPAR was significantly correlated with Actigraph counts in adolescent girls for MVPA (r=0.28-0.31).

The 3DPAR form consists of 3 grids (1 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 2 ways. One modification was to include 2 contextual variables, where the activity was performed and who was with the participant while the activity was performed. Girls could choose between 5 options for where they were (home/neighborhood, school, community facility, other outdoor public area, or other) and 4 options for whom they were with (by yourself; with 1 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 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. Participants were classified as walkers if they reported travel by walking on 1 or more weekdays before or after school as this activity was found to demonstrate good agreement between reported walking status on consecutive days (κ=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 physical activi-
Of the 1721 girls who consented to be measured, 118 were excluded because they failed to wear the accelerometer for at least 1 day and 7 were excluded for missing data on the 3DPAR. The mean ± SD age for the 1596 girls included in the analysis sample was 12.0 ± 0.5 years; 47% were white, 23% African American, 15% Hispanic, and 10% multiracial, and 5% belonged to other race or ethnic groups. There was a wide range in body mass index, calculated as weight in kilograms divided by height in meters squared (12.7-44.8); however, the mean body mass index did not differ significantly between girls who reported travel by walking before and/or after school vs those who did not (P = .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 more minutes (95% confidence interval [CI], 1.2 to 26.3) of total physical activity and 4.7 more minutes (95% CI, 2.2 to 7.2) 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 more minutes (95% CI, −1.8 to 22.4) and 2.8 more minutes (95% CI, −7.0 to 12.7) of total physical activity than the nonwalkers, but these differences were not statistically significant. On the other hand,
these girls accumulated significantly more minutes of MVPA than nonwalkers with before-school and after-school walkers accumulating 2.5 more minutes (95% CI, 0.10 to 4.9) and 2.2 more minutes (95% CI, 0.24 to 4.2) of MVPA on an average weekday, respectively. Girls who reported travel by walking both before and after school had 8.4 more minutes (95% CI, 3.7 to 13.1), 4.7 more minutes (95% CI, 2.1 to 7.3), and 3.8 more minutes (95% CI, 0.33 to 7.3) of total physical activity during those periods (ie, 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 < .05). Using a regression equation developed in a similar population, activity counts accumulated before school were converted to energy expenditure. Before- and after-school walkers expended 194 kJ (95% CI, 92 to 295) more energy than nonwalkers. The longest bout of continuous MVPA (3 METs) before school was 8.5 to 11 minutes for walkers vs 5 minutes for nonwalkers. After school, the longest bout was about 20 minutes each for before- and after-school walkers, 15 minutes for girls who walked both before and after school, and 17 minutes for nonwalkers. 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 the Figure).

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 white girls.

There were significant differences between the number of neighborhoods (3.91 vs 3.55; P = .006), having sidewalks on most of the streets in their neighborhoods (3.94 vs 3.38; P = .001), and having many interesting things to look at while walking in their neighborhoods (3.81 vs 3.43; P = .004).

The prevalence of overweight children and adolescents has more than doubled since the 1960s while at the same time their participation in physical activity has declined dramatically, especially among girls, 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. Research has found that children who walk to school engage in more physical activity than those who travel by car, yet the number of children who walk to school has been in steady decline. 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.

This study found that middle-school girls who reported walking for transportation before and after school on at least 1 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 indicated 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 6 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 DP3AR that travel by walking is the most frequently reported activity, as indicated in Table 1. The 2 different measures of activity provide supporting information.

The only national data on school travel come from the Nationwide Personal Transportation Surveys, now called the National Household Travel Survey. Walking as a percentage of school trips among US children between the ages of 5 and 15 years declined from approximately 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 National Household Travel Survey (14%). Lower rates of walking were reported in studies involving 2 rural states. In West Virginia, 7.6% of students walked to school and the average ± SD time spent walking to school was 7.6 ± 4.4 minutes as estimated by principals from elementary, middle, and high schools. A similar number (7.5%) of middle-school girls reported walking to school on 1 or more days in a usual week in North Carolina based on the Youth Risk Behavior Surveillance Survey.

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 nonwalkers from 5 urban primary schools in Bristol, England, were compared before and after school. Significant
Sixth-grade girls whose home addresses could be geocoded by computer were included in this study.12 Using a different MVPA cut point (≥3.35 kcal/min) in adolescent girls,23 this would translate into 45 additional minutes of MVPA per week. 

By walking 2.5 mph expends approximately 14 kJ/min (3.35 kcal/min) in adolescent girls,23 this would translate into 45 additional minutes of MVPA per week. Among 1556 students who walked both to and from school accumulated 66 minutes more of MVPA for an entire week 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 METs) than the nonwalkers.

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.26 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 associates27 failed to find a significant association between BMI and a school travel index (times per week × 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. Sturm28 suggests that if an additional 25% of children were to walk to school, total active travel time could increase by 50% in the United States. 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 vs 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 kcal per day (232 kcal/wk). 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. Because walking 2.5 mph expends approximately 14 kcal/min (3.35 kcal/min) in adolescent girls,23 this would translate into approximately 151 kcal per week of additional energy expenditure and approximately 0.59 kg of weight-gain prevention over an average 30-week school year. Hill et al31 have estimated that an increase in energy expenditure of approximately 50 kcal per 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.22 Of the 1556 sixth-grade girls whose home addresses could be geocoded, 15.5% lived within a mile of their school, 28% lived within 1 to 2 miles, 23% lived 2 to 3 miles from school, and 33% lived 3 or more miles from school.22 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 with 2.4 miles for after-school walkers, 2.7 miles for before-school walkers, and 2.8 miles for nonwalkers (P<.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 nonwalkers, 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 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 postintervention measurement occasion will include this information. Therefore, use of the travel by walking item on the 3DPAR within the before- and after-school time frames may not necessarily represent walking to school. However, by examining the where variable associated with each 30-minute 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-minute 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, because 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 (ie, the percentage of girls who participated in physical education, 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 nonwalkers 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.

CONCLUSIONS

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 nonwalkers. 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. Although 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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Correspondence: Brit I. Saksvig, PhD, Department of Kinesiology, University of Maryland, Room 2316, Health and Human Performance Building, College Park, MD 20742 (bsaksvig@umd.edu).

Author Contributions: Study concept and design: Saksvig, Schmitz, Conway, and Treuth. Acquisition of data: Pfeiffer, Schmitz, Going, and Strikmiller. Analysis and interpretation of data: Saksvig, Catellier, Schmitz, Going, Ward, and Treuth. Drafting of the manuscript: Saksvig, Catellier, Pfeiffer, Ward, Strikmiller, and Treuth. Critical revision of the manuscript for important intellectual content: Saksvig, Pfeiffer, Schmitz, Conway, Going, Ward, and Treuth. Statistical analysis: Catellier, Conway, and Going. Obtained funding: Conway and Going. Administrative, technical, and material support: Pfeiffer, Going, and Strikmiller. Study supervision: Saksvig, Conway, and Treuth.

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REFERENCES