Evaluation of a Walking School Bus for Promoting Physical Activity in Youth

Kate A. Heelan, Bryce M. Abbey, Joseph E. Donnelly, Matthew S. Mayo, and Gregory J. Welk

Background: Walking to and from school has potential to increase daily physical activity among children. Methods: A Walking School Bus (WSB) intervention was implemented for 2 years in 2 schools with a third school as a control. The primary aim evaluated schoolwide prevalence of walking to school by self-report 6 times (fall, winter, spring). The secondary aims compared objective physical activity levels among a subsample of research participants (intervention [INT] = 201, control [CON] = 123) and between frequency of walking to school groups. INT and CON participants wore an accelerometer during 4 time periods to assess daily physical activity and were measured for body mass index (BMI) and body fat each fall and spring. Results: Schoolwide prevalence of walking to school frequently (>50% of the time each week) was 27% higher in the WSB schools than in the control school. INT obtained significantly more daily physical activity than CON (78.0 [38.9] vs 60.6 [27.7] min/d, \( P < .05 \)). In addition, across all schools, frequent walkers obtained 25% more physical activity (\( P < .05 \)), gained 58% less body fat (\( P < .05 \)), and attenuated BMI by 50% (\( P < .05 \)) compared with passive commuters. Conclusion: This study suggests a WSB intervention may increase frequency of walking to school and establishes a link with increased daily physical activity.

Keywords: children, BMI, active commuting

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The purpose of this study was to evaluate the effectiveness of a school-based WSB program for increasing the frequency of walking to and from school among elementary school children. Emphasis was placed on school-level outcomes because the program is viewed as a school-based initiative. Additional analyses were conducted on a subsample of research participants to examine the effect of the WSB program (and walking in general) on physical activity patterns and body composition over the course of the 2-year intervention. Comparisons were made between intervention and control participants, but the nature of the design also allowed us to compare outcomes for frequent walkers and passive commuters across all schools. This allowed us to also report (more generically) on the effects of walking to school on physical activity and body composition.

Methods

Study Design and Description of Intervention

The study used a quasi-experimental design with 2 public schools selected to receive a WSB intervention and a third enrolled as a control school. The project was conducted over a 2-year time span to examine long-term effects. Outcome measures included school-wide prevalence of walking to and from school assessed 3 times each year (fall, winter, spring). A subsample of students from the WSB schools (INT) and the control school (CON) were assessed for total daily physical activity (using an ActiGraph LLC accelerometer) and several indicators of body composition (BMI, skinfold thickness, percent body fat) twice each year (September and May).

The WSB program was adapted from the Centers for Disease Control and Prevention (CDC) Nutrition and Physical Activity Program, “KidsWalk-To-School.”17 Neighborhood walk-stops were designated within a 1-mile radius of the WSB schools. An adult WSB leader (a paid college student) met the neighborhood children at these designated walk-stops at specified times each morning and walked the group of children to their school and back to the walk stop in the afternoon. Eight routes were created for the 2 WSB schools. On average, participants in the WSB intervention walked 0.65 miles each way to and from school. The WSB was conducted during the entire academic year in both the morning and afternoon and was only cancelled when temperatures were below 25°F or if it was raining or snowing at the scheduled walk time.

Schools and Subjects

Participants were elementary school children from 3 schools in a small Midwestern community of 30,000 people in Nebraska. When this study was initiated, there were no walk-to-school programs within the school district. Three participating schools were selected from 9 elementary schools in the town. Schools were in different parts of town but each one was located within an established neighborhood that was considered conducive to walking to school. Each elementary school had approximately 220 children in kindergarten through fifth grade, and all students in first through fifth grade in the 3 schools were invited to participate in the study. All schools agreed to allow school-wide prevalence of walking to school to be assessed as part of normal school activities to facilitate comparisons between treatment and control schools.

A subsample of youth was recruited to participate in a more detailed measurement protocol to evaluate outcomes. The sample included 201 children (106 girls, 95 boys) from the 2 WSB schools and 123 children (73 girls, 50 boys) from the control school. The descriptive characteristics of participants can be found in Table 1. These research participants were predominately white (90%) with 7% of Hispanic ethnicity. Participants’ socioeconomic status (judged by percentage of youth qualifying for free and reduced lunches) was equivalent across schools (approximately 30%). Parental consent and child assent were obtained for all research participants (INT and CON). This study was approved by the Institutional Review Board at the University of Nebraska at Kearney.

Measures and Assessment Procedures

Prevalence of Walking to and From School. School-wide prevalence of walking to and from school was determined 3 times a year (August, February, and May) using a previously validated self-report logging tool designed to capture mode of transport to and from school over a full week.18 Large posters were placed in each classroom at all 3 schools for the same week-long period. Every child simply circled a picture of a person walking, biking, or riding in a car or bus each morning and afternoon of the week. This checklist format has been shown to have good validity (97% concordance between child and parent, 91% concordance between child report and direct observation) and reliability (97.5% concordance for test–retest) for this population.18

Daily Physical Activity Levels. Physical activity levels were determined using accelerometers (ActiGraph LLC Model #AM7164, Fort Walton Beach, FL). The ActiGraph is the most widely used accelerometer and has been shown to provide a reliable indicator of movement19 and a valid indicator of physical activity in youth.20 Participants at each school wore physical activity monitors for 4 consecutive weekdays on 2 separate weeks throughout the academic year (another assessment of self-reported mode of transportation was collected on the same days to facilitate analyses and
BMI (kg/m²). Age-adjusted BMI percentiles were computed and used to calculate each research participant derived from the equation of Slaughter et al. The same child’s triceps and medial calf. Percent body fat was skinfold calipers in duplicate to the nearest 1 mm on the consequent body fat were taken by research staff via Lange Body Composition.

Table 1  Baseline Descriptive Characteristics of Participants, Mean ± SD

<table>
<thead>
<tr>
<th>Variable</th>
<th>INT</th>
<th>CON</th>
<th>Frequent walkers</th>
<th>Infrequent walkers</th>
<th>Passive commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>201</td>
<td>123</td>
<td>100</td>
<td>145</td>
<td>79</td>
</tr>
<tr>
<td>Age (y)</td>
<td>8.1 ± 1.7</td>
<td>8.4 ± 1.6</td>
<td>8.0 ± 1.4</td>
<td>8.1 ± 1.7</td>
<td>8.5 ± 1.8</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.31 ± 0.12</td>
<td>1.34 ± 0.10</td>
<td>1.31 ± 0.08</td>
<td>1.33 ± 0.10</td>
<td>1.36 ± 0.11</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>32.6 ± 10.7</td>
<td>32.5 ± 8.7</td>
<td>31.0 ± 8.2</td>
<td>32.3 ± 9.7</td>
<td>34.5 ± 10.3</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>18.95 ± 3.40</td>
<td>17.80 ± 2.97</td>
<td>17.86 ± 3.19</td>
<td>17.93 ± 3.06</td>
<td>18.38 ± 3.38</td>
</tr>
<tr>
<td>BMI percentile (%)</td>
<td>67.6 ± 22.3</td>
<td>61.6 ± 29.1</td>
<td>64.9 ± 28.2</td>
<td>51.1 ± 26.1</td>
<td>63.2 ± 28.4</td>
</tr>
</tbody>
</table>

Abbreviations: INT, intervention participants; CON, control participants; frequent walkers, actively commuted (AC) ≥ 50% throughout the study; infrequent walkers, AC < 50%; passive commuters, driven. No significant differences between INT and CON participants for any variables at baseline. No significant differences between frequency categories for any variables at baseline.

BMI percentile based on age- and gender-adjusted CDC growth chart.

interpretation). By sampling over 2 independent weeks, we obtained more representative data on youth activity patterns than if only 1 week’s data had been used.

The monitors were initialized to record data in 15-second epochs and were attached to an elastic belt that each participant wore around the waist (the monitor was worn over the right hip). After collection, stored activity counts were downloaded and then uploaded into SAS for data processing. Compliance was evaluated for each day the monitor was worn using procedures established in a previous study. If more than 3 periods of 20 consecutive minutes of zeros were detected during the day (7:30 AM to 8:00 PM), it was assumed the monitor had been removed and data from that day were considered “missing.” Participants with more than 2 days of missing data per testing period were considered to be noncompliant with the overall protocol, and the physical activity data from that week were removed from the overall analyses. Time spent in physical activity was determined on each day using the activity threshold of 1560 counts/min established by Welk using receiver operator characteristic curves. This cut point was established using free-living activity and was set to maximize classification accuracy for distinguishing between active versus nonactive behavior. The threshold is lower than other cut-point values designed to detect moderate to vigorous physical activity. Because walking is a relatively low-intensity activity it was important to use a threshold that was designed to capture walking behavior.

Body Composition. Body mass and stature were measured and used to calculate each research participant’s BMI (kg/m²). Age-adjusted BMI percentiles were computed for each participant using the CDC growth charts. Skinfold thickness measurements of subcutaneous body fat were taken by research staff via Lange skinfold calipers in duplicate to the nearest 1 mm on the child’s triceps and medial calf. Percent body fat was derived from the equation of Slaughter et al. The same research assistant conducted all skinfold measurements on all research participants over the course of the study. Changes in BMI, BMI percentile, skinfold thickness, and percent body fat were evaluated.

Data Analysis

Data analysis involved school-level comparisons, as well as comparisons of individual data obtained from INT and CON participants. Self-reported modes of transportation (walk, bike, bus, private car) used to get to and from school were tracked for both school and individual analyses. Of all trips made to and from school, only 3% were made on a bike. Because emphasis was on total activity, walking and biking were collapsed into a single category defined as active commuting. For school-level analyses, we compared the percentage of youth who achieved the HP2010 goal of actively commuting 50% of time (5 of the 10 possible trips per week). For individual-level analyses, participants were categorized into 3 groups based on the frequency of active commuting. Participants (both INT and CON) who actively commuted more than 50% of available trips (≥20 out of 40 trips over the 4 assessment periods), meeting HP2010 objective 22 to 14, were classified as frequent walkers. Participants who actively commuted occasionally but less than 50% of the time (1 to 20 trips) were classified as infrequent walkers. Participants who were driven every assessment period were classified as passive commuters. Baseline descriptive characteristics for frequency of walking groups can be found in Table 1.

Group effect was computed using an analysis of repeated measures via general mixed model using an autoregressive correlation structure over time for frequency of active commuting, adjusting individually for age and gender. An average amount of physical activity over the study was compared using analysis of variance between the 3 levels of active-commuting frequency. Change scores (post – preintervention) were also compared using analysis of variance. Relevant P values were calculated using SAS 9.1 software.
Results

School-Level Comparisons

An emphasis in the school-level analyses was placed on comparisons of school-wide prevalence of walking to and from school. At baseline, modes of transportation used by children attending the 2 WSB schools (n = 464) and the control school (n = 227) were similar. Approximately 26% of WSB school children and 28% of control school children actively commuted to school at least once a week, whereas 34% of WSB and 35% of control school children actively commuted home from school at least once a week. Differences in the prevalence of active commuting between the WSB schools and the control school over 2 years are shown in Figure 1. At each time period postbaseline, a significantly greater percentage of children actively commuted to and from the WSB schools compared with the control school (P < .05). Postbaseline results averaged across the 2 years (winter ’05, spring ’05, fall ’05, winter ’06, and spring ’06) revealed that 36.2% of youth from WSB schools actively commuted at least 50% of the time (meeting the HP2010 recommendation) compared with 26.2% of the control school. This data are representative of the entire school population.

Individual-Level Analyses

A subsample of youth participated in more detailed assessments of physical activity and body composition. Emphasis in the individual analyses was placed on students who were involved in the program across the entire 2 years. Some fifth-grade students who were involved in year 1 graduated and could not be assessed the following year. Other students moved, changed schools, or missed key data-collection periods during the 2-year study. To provide the most effective comparison of these data, the individual analyses were restricted to a subsample of participants who had data over the full 2-year period of the study. Characteristics of the participants for these analyses are provided in Table 2.

Prevalence of Active Commuting. Results from the active research participants reveal stronger effects.

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* Significant difference between WSB and Control schools for each time period (p < 0.05)

WSB = Walking School Bus Intervention Schools
Control = Control School

Figure 1 — School-wide prevalence of active commuting.
Results averaged across the 2 years postbaseline (winter '05, spring '05, fall '05, winter '06, spring '06), indicated that 70.5% of INT research participants met the HP2010 recommendations compared with 24.7% of CON participants with no intervention.

**Physical Activity.** The accelerometer data were evaluated to examine overall impact on physical activity levels of the INT and CON participants. Eighty-seven percent of participants met the compliance criteria and were included in the analyses. No imputation was done on the missing physical activity data. Statistically significant differences in total daily physical activity levels (physical activity levels were averaged over all time points) were found between the INT (78.01 [38.87] min/day) and CON (60.62 [27.70] min/day) participants (P < .05; Figure 2).

To assess active commuting frequency regardless of the intervention condition, all participants (INT and CON) were segmented into categories based on the frequency of active commuting to school. Frequent walkers had significantly higher activity levels (80.61 [37.55] min/d) than infrequent walkers (70.48 [34.90] min/d) and passive commuters (60.70 [31.72] min/d; P < .05; Figure 2). These differences remained significant when adjusting for age and gender.

**Body Composition.** There were no statistically significant differences in changes in BMI, BMI percentile, or percent body fat over 2 years between INT and CON participants. However, there was a significant difference in BMI change over 2 years between frequent walkers (ΔBMI = 0.80 [1.5] kg/m²) and passive commuters (ΔBMI = 1.57 [1.83] kg/m²; P < .05; Table 2). It is important to note that the BMI percentile change and BMI z-scores were negative for frequent walkers but positive for passive commuters. Pairwise comparisons also revealed that frequent walkers had a significantly lower increase in sum of skinfolds and percent body fat than those who walked infrequently and those classified as passive commuters (Table 2). These differences remained significant when adjusting for age and gender.

### Table 2 Changes in Body Mass, BMI, BMI Percentile Score, Body Fat, and Sum of Skinfolds Over 2 Years, Mean ± SD

<table>
<thead>
<tr>
<th>Change scores</th>
<th>INT</th>
<th>CON</th>
<th>Frequent walkers</th>
<th>Infrequent walkers</th>
<th>Passive commuters</th>
</tr>
</thead>
<tbody>
<tr>
<td>spring '06–fall '04</td>
<td>78</td>
<td>85</td>
<td>60</td>
<td>65</td>
<td>38</td>
</tr>
<tr>
<td>n</td>
<td>1.05 ± 1.52</td>
<td>1.24 ± 1.44</td>
<td>0.80 ± 1.52 A</td>
<td>1.23 ± 1.11 AB</td>
<td>1.57 ± 1.82 B</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>−2.08 ± 14.5</td>
<td>0.58 ± 13.23</td>
<td>−4.15 ± 15.10 A</td>
<td>0.01 ± 12.81 A</td>
<td>1.16 ± 14.39 A</td>
</tr>
<tr>
<td>BMI percentile (%)</td>
<td>−0.17 ± 1.25</td>
<td>0.03 ± 0.45</td>
<td>−0.16 ± 0.51 A</td>
<td>0.00 ± 0.51 B</td>
<td>0.00 ± 0.10 A</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>2.10 ± 3.78</td>
<td>2.99 ± 3.26</td>
<td>1.55 ± 3.84 A</td>
<td>2.82 ± 3.16 B</td>
<td>3.72 ± 3.31 BC</td>
</tr>
<tr>
<td>Sum skinfolds (mm)</td>
<td>3.16 ± 5.66</td>
<td>4.54 ± 4.92</td>
<td>2.40 ± 5.80 A</td>
<td>4.25 ± 4.90 B</td>
<td>5.55 ± 4.66 BC</td>
</tr>
</tbody>
</table>

Abbreviations: INT, intervention participants; CON, control participants; frequent walkers, actively commuted (AC) ≥ 50% throughout the study; infrequent walkers, AC < 50%; passive commuters, driven. Letters that are different imply significant difference (P < .05).

Discussion

Results of this study support the efficacy of walk-to-school promotions and campaigns for promoting physical activity in youth. The WSB intervention increased the school-wide prevalence of active commuting and also increased the frequency of active commuting. The study also provided important outcomes related to the importance of walking to school for youth. Children categorized as frequent walkers (irrespective of the intervention) were found to have significantly higher levels of physical activity than children categorized as infrequent walkers or passive commuters. The frequent walkers also had significantly smaller increases in BMI and percent body fat than other groups, suggesting that the increased activity may be sufficient to attenuate weight (fat) gain.

The WSB intervention tested in this study was effective in helping to promote walking in children. School-wide active commuting prevalence in the 3 participating schools was equivalent to national data at baseline with approximately 30% of children age 5 to 15 years living within 1 mile of school choosing to walk or bike to and from school. The 2 schools with the WSB program had significantly higher school prevalence at each of the 5 time points in the study. Overall, we found that approximately 70% of INT participants met the HP2010 recommendations (walking 50% of the time) compared with 25% of CON participants or 26% of the control school. Frequent walkers in both the INT and CON groups walked an average of 4 out of 5 days each week (8 out of 10 possible trips to and from school). However, it is noteworthy that INT participants walked more per day than frequent walkers in the CON group. The accelerometer data captured this difference as frequent walkers in the INT group had significantly higher activity levels (~8 minutes per day) than frequent walkers in the CON group. Collectively, this suggests that the WSB program may have reduced barriers to walking and allowed youth...
Walking School Bus

It has been estimated that walking to and from school can increase daily energy expenditure by ~40 to 80 kcal per day. Over 2 years, the WSB program escorted children to and from school 1050 times (~525 days · 2 trips per day: out of 608 school days over 2 years). Frequent walkers actively commuted 76% of the time, so frequent walkers may have expended an additional 16,000 kcal over 2 years (525 days · 76% of the time · ~40 kcal/d) compared with passive commuters. This is equivalent to a difference of approximately 2.1 kg of weight per participant over 2 years assuming all other variables were kept constant.

Although activity levels were significantly different we did not observe statistically significant differences in BMI or body fat between the INT and CON groups. This is not necessarily surprising considering the many factors that influence body weight and the fact that the intervention only affected 1 component of energy balance. Some sample calculations are provided to help quantify the potential impact of the intervention on energy expenditure and weight status in children. Using average walk-to-school distances, it has been estimated that walking to and from school can increase daily energy expenditure by ~40 to 80 kcal per day. Over 2 years, the WSB program escorted children to and from school 1050 times (~525 days · 2 trips per day: out of 608 school days over 2 years). Frequent walkers actively commuted 76% of the time, so frequent walkers may have expended an additional 16,000 kcal over 2 years (525 days · 76% of the time · ~40 kcal/d) compared with passive commuters. This is equivalent to a difference of approximately 2.1 kg of weight per participant over 2 years assuming all other variables were kept constant. While these estimates are crude, changes in weight and BMI in our sample are remarkably close to these estimates. Over 2 years, frequent walkers gained 6.1 (3.5) kg or 0.80 (1.5) kg/m² in BMI units, compared with passive commuters, who gained 7.9 (4.4) kg, or 1.6 (1.8) kg/m² BMI units, a difference of 1.8 kg (P > .05), or

Figure 2 — Daily physical activity levels of intervention and control participants, frequent walkers, infrequent walkers, and passive commuters.

### Figure 2

<table>
<thead>
<tr>
<th>CON</th>
<th>INT</th>
<th>Frequent Walkers</th>
<th>Infrequent Walkers</th>
<th>Passive Commuters</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
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</table>

§Significant difference between CON and INT (p <0.05)

* Significantly different than Frequent Walkers (p <0.05)

INT = Intervention Participants

CON = Control Participants

To walk a farther distance to school. Time and safety have been highlighted as common barriers, so it is likely that the structure and adult supervision provided by the WSB program helped address these barriers. The program was cancelled only when temperatures fell below 25°F or precipitation prohibited walking, so the program also may have helped promote active commuting during winter months or days with less than ideal weather.
0.77 kg/m² BMI units (P < .05). The elementary years are characterized by rapid growth, so changes in height and weight are expected. Using the CDC growth chart programs we determined that frequent walkers had decreases in BMI percentile and BMI z scores, whereas passive commuters had increases in these parameters that are commensurate with typical patterns of increasing pediatric overweight. Perhaps more important, frequent walkers had significantly lower body-fat changes than passive commuters over the 2-year study. The positive results in this walking intervention are in contrast to a comparable prospective walking study by Rosenberg et al.8 This study found no association between active commuting and overweight status over 2 years, but differences in the definition of active commuting may explain the discrepant results. In our study, frequent walking was defined as actively commuting at least 50% of the time (5 trips per week), whereas the comparison study classified active commuting as at least 2 trips per week. Over 2 years, this difference in frequency may account for the difference in results. The results of this study provide empirical support for continued efforts to promote walking to school in youth, but some limitations in our design should be noted. First, the study used a quasi-experimental design, so additional studies with a randomized design are needed. Self-selection is a possible bias but walking to and from school is not a behavior that can easily be randomized. It is possible that physically active children were more likely to enroll in the intervention, but we do not have data on the nonstudy participants to determine whether this is true. We obtained detailed measures of school-level (and individual) walk-to-school prevalence over 2 years in a large sample of elementary youth (and corroborated the findings with data from accelerometers). Overall, the strengths of the design outweigh the limitations.

Conclusions

Our data demonstrate that a WSB intervention increases the percentage of children who walk to and from school, as well as the frequency of walking. In addition, children who walk to and from school frequently accumulate more daily physical activity. Future studies should evaluate behavioral and academic outcomes associated with walking to and from school and determine if elementary active commuting tracks through adolescence and into adulthood. Interventions designed to increase active commuting to and from school are promising public health strategies to promote physical activity in youth.

Acknowledgment

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References


