A Walking School Bus Program
Impact on Physical Activity in Elementary School Children in Columbia, Missouri

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Background: The Robert Wood Johnson Foundation (RWJF) provided Columbia MO with an Active Living by Design (ALbD) grant in 2003 to promote active living in the community. A separate project was funded in 2006 through RWJF's Active Living Research program.

Purpose: To evaluate whether participation in a Walking School Bus (WSB) program increased or decreased active living in elementary school children residing in Columbia, in association with ALbD funding.

Methods: Objective measures of physical activity obtained using accelerometers were collected over 7 days in children participating in a WSB program and children in a nonparticipating comparison group. Differences in the percentage of time spent in moderate- to vigorous-intensity exercise (%MVPA) were compared between groups.

Results: Children in WSB programs showed no differences in %MVPA compared to children not participating in the WSB; however, when comparing the relationship of %MVPA and age, the slope of the regression line was steeper for those children not participating in the WSB.

Conclusions: The ALbD intervention in Columbia did not result in measurable changes in physical activity in children participating in the Walking School Bus program, but there was a negative association between age and physical activity, and the slope of that regression line was affected by participation in the program.
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Introduction

Active Living by Design (ALbD) was a program developed by the Robert Wood Johnson Foundation (RWJF) to promote active living through community-based approaches, and in 2003 Columbia MO received one of RWJF's 25 national ALbD grants. In 2006, RWJF funded a separate project to evaluate the extent to which the Columbia ALbD intervention "Bike, Walk, and Wheel: A Way of Life in Columbia Missouri (BW&W)" increased active living. One aspect of this project has been described previously.[1] The second aspect of this project was to evaluate physical activity levels in children participating in a specific schoolwide Walking School Bus (WSB) program at three participating elementary schools.

Walking to school has been shown to account for almost 25% of the moderate- to vigorous-intensity daily physical activity recommended by health experts.[2] However, the real or perceived dangers in allowing children to travel unattended to school likely have limited the widespread adoption of walking to school as a solution to physical activity concerns in children.[3] The WSB, however, an adult-supervised walking group, enables children to walk to school safely and add more physical activity into their day. The WSB is widely practiced in England and New Zealand (with more than 230 WSB routes in 100 Auckland schools),[4] and in a growing number of U.S. cities. Several studies have shown that WSB programs are successful at increasing moderate- to vigorous-intensity physical activity, overall physical activity, and active commuting behavior in children.[5,6] The purpose of the present study was to evaluate whether there were differences

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in physical activity in WSB participants compared to nonparticipants following the implementation of ALbD intervention in Columbia.

Methods

Setting and Population

Columbia is a Midwest college town with a population of ~100,000 residents. Additional demographic information can be found elsewhere.[1] The project area from the ALbD intervention included four elementary schools from the Columbia Public School district. This project was a 7-day cross-sectional evaluation of physical activity levels of children from three of the four ALbD project-area elementary schools who either participated or did not participate in the WBS from September 2007 to November 2007. The project was approved by the Columbia Public Schools and the University of Missouri IRB.

Recruitment

In August 2007, a total of 1000 children at three elementary schools within the ALbD project area were given a recruitment flyer to take home to their parents. Volunteers were not assigned randomly but self-selected as either a WSB participant or nonparticipant. In all, 118 signed recruitment flyers indicating parent/guardian and child interest were returned with the child to school and collected by homeroom teachers the following week.

Next, a detailed explanation of the study, informed consent document, and two surveys were provided to potential participants. Surveys contained questions regarding demographic information (e.g., child's age, gender, race) for the parent/guardian to complete and questions for both parent/guardian and child regarding the child's physical activity levels, neighborhood environment, leisure-time activity choices, parent income and education level and other variables that could affect physical activity. Once consent forms and surveys were returned, children were scheduled to receive accelerometers.

Overall, 118 parents and children consented to participate in the study. Complete data (7-day physical activity monitoring and physical activity surveys) were obtained from 77 children: 38 WSB participants and 39 nonparticipants). For participating, families received one adult and two child passes to the Activity and Recreation Center, a local recreation facility featuring exercise equipment, indoor track, and pool for adults and indoor water park facilities (e.g., lazy river, vortex, water play structure, water slides) for children.

Walking School Bus

In Columbia's WSB program, community volunteers meet and walk with children to school along scheduled routes five mornings per week before the beginning of the school day. This program has become the signature project of the ALbD intervention and is one of the most successful in the country. At the time of data collection in 2007, the WSB program in Columbia consisted of approximately 100–150 children and 40 volunteers in seven elementary schools, but it was expanded to more than 400 children and 120 trained volunteers in 14 elementary schools by 2010. The three participating schools in the present study were part of the original seven schools in Columbia with established WSB programs. The three schools provided 33, 28, and 16 children, respectively, for this study.

Accelerometers

Objective measures of physical activity were obtained using the Actigraph GT1M biaxial accelerometer. The GT1M is valid and reliable in children[7] and is the most widely used accelerometer in physical activity research.[8–10] Accelerometers were placed on belts provided by the manufacturer, secured snugly on the right hip and worn in this position for 7 consecutive days. Participants were instructed to keep the accelerometer on during all waking hours of the day and to remove only when bathing, showering, or sleeping. Participants were provided logs to record times the unit was removed during the 7-day period. After the 7-day assessment, data from the accelerometers were downloaded using ActiLife software 3.2.2.

Physical activity was defined as activity counts per 30-second epoch. To ensure comparability to other studies, counts were converted to METs using a widely used algorithm, derived from an energy-expenditure prediction equation: METs=2.757 + (0.0015 counts/minute) – (0.08957 X age [in years]) – (0.000038 X counts/minute X age [in years]).[11] Any minute with ≥3 METs intensity was categorized as moderate- to vigorous-intensity physical activity (MVPA). The number of minutes for each measurement session was summed, and a calculation was made of the percentage of time expended in MVPA (%MVPA) as the proportion of this sum divided by total minutes available for activity.[2,12]

Children were fitted with accelerometers in October 2007. The initial accelerometer fitting was performed at each school during the child's homeroom period by trained study personnel. Full instructions on how and when to wear the accelerometers (both verbal and written) were provided to children and parents/guardians at the time of the fitting.

Statistical Analysis

Predictors of physical activity behavior were collected via survey and examined before evaluation of objective measures of physical activity. These consisted of BMI percentile (obtained through parental report of height and weight); age; gender; days child was physically active for a total of at least 60 minutes during the past 7 days; time spent watching TV on a usual day during the week and weekend; family income; highest level of parental education; parent physical activity level; and neighborhood environment evaluated with an abbreviated version of the Neighborhood Environment Walkability Scale (NEWS).[13]

Summary statistics were calculated for potential predictors. Frequency was used to summarize categoric predictors such as gender and race. Mean and SD were used to summarize the numerical predictors such as age. Wilcoxon rank-sum tests were conducted to compare groups on numeric predictors. Chi-square or exact test was used to compare groups on categoric predictors. The Wilcoxon rank-sum test or Spearman correlation was used to assess the association between predictors and physical activity. Multiple regression was employed to compare groups on physical activity.

Results

Descriptive statistics are presented in Table 1. Comparing WSB participants to nonparticipants, there was no difference in age, gender, BMI, neighborhood walkability, parent education and physical activity level, family income, time spent watching TV during the week (WSB: 45.2±39.8 minutes; nonparticipants: 46.3±44.6 minutes) or weekend (WSB: 96.8±54.2 minutes; nonparticipants: 102.8±78.9 minutes), and days the child was physically active for at least 60 minutes during the past 7 days (WSB: 4.9±1.6 days; nonparticipants: 4.3±2.0 days; all $p>0.05$).

Percentage of time spent in MVPA is shown in Table 1. There were no observed differences in %MVPA between the WSB and nonparticipants. There were no differences between groups in %MVPA during the 7-day period ($p=0.17$); during the weekday ($p=0.33$); or during the weekend ($p=0.21$). There were no differences observed between groups in weekday %MVPA before school ($p=0.41$); during school ($p=0.59$); or after school ($p=0.42$).

Table 1. Demographic variables and percentage of time spent in MVPA, *n* (M±SD) or *n* (%)

Variable	WSB (*n*=38)	Comparison (*n*=39)	*p*-value
Age (years)	38 (8.6±1.6)	39 (8.1±1.4)	0.18
BMI percentile	28 (54.4±29.7)	30 (53.7±34.5)	0.81
Neighborhood walkability	37 (19.0±2.4)	35 (18.7±2.8)	0.58
%MVPA (week)	38 (20.9±6.9)	39 (23.4±8.8)	0.17
%MVPA (weekdays)			
Total	38 (20.9±6.9)	39 (22.6±8.5)	0.33
Before school	38 (25.3±12.2)	39 (22.9±12.6)	0.41
During school	38 (18.3±8.4)	39 (19.2±7.2)	0.59
After school	38 (26.7±9.2)	38 (28.7±12.0)	0.42
%MVPA (weekend)	35 (22.7±11.3)	36 (26.0±10.8)	0.21
Gender, female	22 (59)	15 (38)	0.09
Race	38	39	0.07
Caucasian	28 (74)	25 (64)	
Black/African-American	4 (10)	0 (0)	
Asian American	3 (8)	5 (13)	
American Indian/Alaskan Native	0 (0)	2 (5)	
Other	3 (8)	7 (18)	
Parent income ($)	33	34	0.82
<20,000	2 (6)	5 (15)	
20,000–39,999	3 (9)	2 (6)	
40,000–59,999	7 (21)	6 (18)	
60,000–89,999	10 (30)	9 (26)	
≥90,000	11 (33)	12 (35)	
Parent education	38	38	0.38
Completed high school	3 (8)	2 (5)	
Some college	2 (5)	7 (18)	
Completed college	15 (40)	13 (34)	
Graduate or professional degree	18 (47)	16 (42)	

Note: %MVPA= MVPA/minutes worn × 100.
MVPA, moderate- to vigorous-intensity physical activity; WSB, Walking School Bus

Because of the potential influence of age, race, and gender on child physical activity, strength of the associations of these variables with %MVPA was examined. Gender was not associated with %MVPA during the week (W=1243.0, $p=0.09$); during weekdays (W=1237.0, $p=0.07$); during the weekend (W=995.0, $p=0.25$); before school (W=1223.5, $p=0.09$); or after school (W=1288.0, $p=0.34$), but it was associated with %MVPA during school (W=1237.0, $p=0.05$). Race demonstrated associations with %MVPA during the week (W=705.0, $p=0.05$); before school (W=693.0; $p=0.01$); and during school (W=700.5, $p=0.01$) but not after school (W=669.0, $p=0.16$) or on the weekend (W=484.0, $p=0.20$).

Age had a strong negative relationship with %MVPA during the week ($n=75$, $r=-0.79$, $p<0.001$); weekdays ($n=75$, $r=-0.77$, $p<0.001$); weekend ($n=62$, $r=-0.75$, $p<0.001$); and before school ($n=76$, $r=-0.44$, $p<0.001$); during school ($n=76$, $r=-0.75$, $p<0.001$); and after school ($n=70$, $r=-0.67$, $p<0.001$). Initially age, race, and gender were entered in the regression model for two-group comparison. However, only age or its corresponding interaction with group was significant in the model; thus, age was the only covariate included in the final regression model.

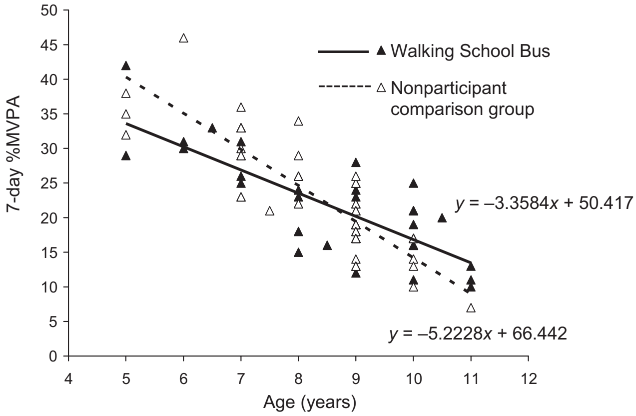

Figure 1. Negative association between age and physical activity in children participating in the Walking School Bus and nonparticipant comparison group

For %MVPA during the week, regression modeling demonstrated that age ($p<0.001$) and the interaction of age and group ($p=0.009$) were significant. Using an adjusted age of 8.4 years as the intercept (the sample mean age), regression results indicated that in the nonparticipant comparison group, there was a mean 5.2% difference in %MVPA with each additional year of life. In the WSB group, the mean difference in %MVPA with each additional year of life was 3.4% (Figure 1).

Additional regression analyses were run using the remaining %MVPA outcomes. For %MVPA during the weekdays, age ($p<0.001$) and the interaction of age and group were significant ($p=0.02$). In the nonparticipant comparison group, there was a mean 4.8% difference with each additional year of life. In the WSB group, the mean difference was 3.1% per year. Similarly, for after school, age ($p<0.001$) and the interaction of age and group ($p=0.01$) were significant. In the nonparticipant comparison group, there was a mean 6.4% difference with each additional year of life whereas in the WSB group the mean difference was 3.2% per year. For before-school, during school, and weekends, the interaction of age and group were not significant (all $p>0.05$).

Discussion

There were no differences in objective 7-day physical activity measures between WSB participants and nonparticipants (Table 1). The most interesting finding from the present study, however, was that there was a negative association between age and physical activity, and the slope of that regression line was affected by participation in the Walking School Bus (Figure 1).

The decline in physical activity throughout adolescence is well documented.[14] In both cross-sectional and longitudinal studies, the greatest declines in physical activity occur between the ages of 12 and 18 years.[15–17] Fewer studies have analyzed this trend in children. Taylor and colleagues reported that objective measures of physical activity declined longitudinally from ages 3 to 5 years.[18] However, a second study found no difference in physical activity obtained at ages 3–4 years and again at ages 6–7 years.[19]

The present study's cross-sectional design does not permit the evaluation of physical activity decline. However, a comparison of %MVPA and age (in children aged 5–11 years) showed a negative association, and the slope of that regression line was affected by participation in the WSB. It appeared that differences in the slopes of the regression line for 7-day %MVPA were driven by differences in weekday activity, specifically activity occurring after school.

It is tempting to speculate that the WSB potentially could affect afterschool physical activity. Of course, a selection bias may have existed, with children in the WSB program inherently more active than children not participating in this program, which could explain the different slopes of regression lines. However, there were no differences in children's self-reported physical activity or other predictors of childhood physical activity (e.g., BMI percentile, family income levels, parent education levels, or parent physical activity levels between groups). Future studies should examine longitudinal changes in physical activity in children regularly participating in WSB programs to determine if these programs do indeed mitigate the decline in physical activity with age.

Sirard et al.[2] reported no difference in %MVPA either during or after school in a walking group compared to control. Given the limitations of the present study's cross-sectional design and the small sample size of Sirard et al. (six subjects per group), both studies suggest that increased physical activity associated with the WSB does not augment physical activity at other times during the day (e.g., during school or after school). However, some studies suggest that daily walking and participation in WSB programs increase daily physical activity. Cooper et al.[20] reported in a cross-sectional evaluation that children who walked to school had higher levels of objectively measured physical activity than children who were driven. But because children were not randomized into particular groups, it is unknown whether children who walked to school were more naturally active compared to children who did not. Heelan et al.[21] also reported that children participating in the WSB over 2 years had higher levels of daily physical activity than nonparticipating children. It may be that longer periods of participation are needed to observe increases in daily physical activity beyond the period used in the current study.

In contrast to the present study, Sirard et al.[2] reported that %MVPA in the WSB group was significantly higher before school compared to control, which makes intuitive sense. In the present study, however, children self-selected into WSB or the nonparticipant group. Children in the comparison group who lived close to school may have walked to school or engaged in more self-directed morning physical activity compared to WSB participants.

In the comparison group, children who lived less than 1 mile from school (n=17) reported that they walked or biked to school 2.5 (±2.3) days in a usual week. Although this was fewer than the 5 days the WSB was in operation, additional physical activity among nearly 50% of the comparison group (n=39) was not controlled for in the current analysis and may have contributed to the lack of differences in before-school physical activity. Moreover, the present data showed that children in the WSB and control group reported that they were active for at least 60 minutes 4.9 and 4.3 days each week, respectively. These relatively high self-reported activity levels and lack of difference between groups may indicate a very active cohort of children and a potential ceiling effect.

Limitations

Limitations of the study include a low participation rate (~12%). Because of the methodology used in targeting potential children in the three schools, an accurate participation rate was difficult to determine. Flyers were sent home in each child's "Friday folder," which also included corrected homework and the following week's homework assignments, announcements, and other school-related information. The volume of information in each Friday folder can result in many forms not being given due attention by parents; thus, it is not known how many parents read the flyer, given that it did not specifically pertain to the academic performance of their child. Thus, potential participants may have been missed.

Given that it is not known how many parents received and read the flyers brought home by their children, comparatively few of those intended to receive flyers had children in the WSB program. Thus, participation in the nonparticipant group was likely lower than in the WSB group and could have affected how representative this group was. Still, the groups of children proved to be remarkably similar.

A second limitation was the sample size (n=77; 38 WSB participants; 39 control), which would necessitate large effect sizes to detect differences between the groups. In addition, a small sample increases the difficulty of examining associations within subgroups that may exist by age, ethnicity, or gender, as was done in the present study. Given the small, nonsignificant differences between groups, it would have been interesting to evaluate whether the WSB program was effective at getting more children involved in walking to school irrespective of physical activity changes; however, changes in attendance during the program data were not available.

Third, nonparticipants at each of the schools had exposure to WSB promotional information. Despite attempts to initially limit this exposure by including control schools outside the project area, the exponential increase in WSB programs outside the project area from study design to implementation made this impractical. Unfortunately, some schools outside the ALbD project area that could have served as controls did not participate because of the large time commitment required of teachers and staff. Finally, the cohort of WSB participants and nonparticipants consisted of children of wealthier, educated parents at three well-performing schools. Thus, these findings might not generalize to children in more-diverse areas or low-income communities.

Overall, WSB programs have been successful in increasing children's physical activity and active commuting to school.[5,6,21] However, challenges exist in setting up these programs, and finding an affordable model to keep them operating is critical.[1] Because children's physical activity increases with greater exposure to the WSB,[21] it is important to identify individuals within a community who will champion these programs and ensure their successful implementation from year to year. The authors believe that continuity in these programs within the schools and consistent participation by children over time may be one method to increase their impact on physical activity and health.

Conclusion

Results indicate that the ALbD intervention did not have a measurable effect on objectively measured physical activity in elementary school children in Columbia. However, there was a negative association between age and physical activity and the slope of that regression line was affected by participation in the WSB. Given these cross-sectional data, future studies should explore the longitudinal impact of programs such as the WSB on physical activity levels in this population.

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