Active Transportation to School Over 2 Years in Relation to Weight Status and Physical Activity

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Abstract

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Objective: To prospectively examine potential benefits of active commuting to school on measures of weight status and physical activity in a sample of youth.

Research Methods and Procedures: A cohort of students from seven elementary schools was measured four times—in the fall and spring of fourth grade ($N = 1083$) and fifth grade ($N = 924$). Participants were classified as active (walking, biking, or skateboarding to school almost every day for baseline analyses or at least 2 d/wk for analyses of consistent active commuting) or non-active commuters to school. Accelerometers were used to measure physical activity. Height, weight, and skinfolds were objectively assessed.

Results: Boys who actively commuted to school had lower BMI ($p < 0.01$) and skinfolds ($p < 0.05$) than non-active commuters to school in the fourth grade. Active commuting to school over 2 years was not associated with BMI change or overweight status.

Discussion: Walking and cycling to school may contribute to preventing excessive weight gain, or leaner children may walk or cycle to school.

Key words: children, adolescents, exercise, walking

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Introduction

Overweight prevalence among children and adolescents has more than tripled since the 1960s, from 5% to 15.5% among 12 to 19 year olds in 1999 (1). The obesity epidemic has highlighted the need to improve understanding of children's physical activity patterns that might suggest intervention approaches. Children's active commuting to school is of particular interest because it declined by 37% from 1977 to 1995 in the U.S. (2,3). A survey of U.S. families found that only 14% of school trips were made by biking and walking (4), but a study using direct observations found that only 5% of elementary school children used active modes of transportation to or from school (5). Children who actively commute to school engage in more total physical activity than those who travel by other means (6–11). Accordingly, an objective in Healthy People 2010 is to increase the percentage of active trips to school made by children who live within 1 mi of school (12).

Interventions are being conducted to increase the number of students who walk or bike to school. For example, Safe Routes to School Programs use a variety of educational and environmental change strategies to promote walking and biking to school. Evaluation data indicate that these programs can be effective (13,14).

Students attend school five days per week, providing an opportunity for the accumulation of health-promoting levels of activity if active modes are chosen (15). We located few studies that examined the association of walking to school in youth with health indicators. The findings for BMI are inconsistent. In a large study of adolescents, active commuters to work or school were more likely to be non-overweight (16). One study found no relationship between BMI of children in grades 4 to 12 and active commuting to school (17). The findings of one prospective study were the opposite of those expected, showing a positive association between commuting to and from school and BMI among overweight children (9).

The purpose of the present investigation was to examine potential health benefits of active modes of transportation to school in a prospective study of children. Lower BMI and skinfolds and higher physical activity among children who actively commute to school, compared with those who use non-active modes, were expected.

Research Methods and Procedures

Data were collected as part of a 2-year randomized controlled trial of school-based physical activity promotion titled Sports, Play, and Active Recreation for Kids. The study began in 1990, and 98% of two successive cohorts of fourth graders in seven suburban elementary schools in southern California participated. The study was approved by the Institutional Review Board, and passive consent procedures were used. Measurements were taken in both the fall and spring of fourth and fifth grades, for a total of four measurement points. Baseline and prospective, or consistent, active commuting data were analyzed separately. Baseline active commuting analyses were based on 1083 participants in the fall of fourth grade (53.2% boys and 46.8% girls). Consistent active commuting analyses were based on 924 (53.2% boys; 46.8% girls) participants who completed all four measures. The ethnic breakdown of the baseline cohort was 85% white, 7% Hispanic/Latino, 6% Asian/Pacific Islander, 1% African-American, and 1% other.

Mode of Transportation to School

Participants completed a supervised questionnaire in the classroom at each measurement point. To assess active commuting to school, one question asked, "How many days in the past week did you walk, bike, or skateboard to school?" Response choices were 0 days, 1 day, 2 or 3 days, almost every day, or every day. For baseline active commuting analyses, answers were recoded into two groups: active commuters (those reporting walking, biking, or skateboarding to school almost every day or every day; $N = 356$) and non-active commuters (those reporting walking, biking, or skateboarding to school ≤ 3 d/wk; $N = 727$). To create sufficient cell sizes for consistent active commuting analyses, respondents classified as active commuters ($N = 184$) had to report active commuting at least 2 or 3 d/wk at all four measurements; all other respondents were classified as non-active commuters ($N = 740$).

Physical Activity

Caltrac accelerometers (Hemokinetics, Madison, WI) were used to objectively measure physical activity (18). These devices have high inter-instrument reliability and have been shown to be valid for use with children (19). Accelerometers were worn for 1 weekday in the fall of fourth grade. The accelerometers were programmed and placed into a waist pouch with cushioning to reduce inadvertent motion; the pouches were sealed to prevent students from tampering with them (20). The children were shown the accelerometers to reduce curiosity and were instructed to wear the pouch at all times except when swimming, bathing, or sleeping. The pouches were attached to children at the end of the school day for them to wear that evening and to school the following day. Accelerometers were removed before school started the next day, and cumulative total activity counts were recorded. Complete data were obtained for ~74% of the sample. Most common reasons for missing data were child absence from school and forgetting the accelerometer (21). Accelerometer counts reflect "activity counts" per hour independently of weight, age, and sex (21,22).

BMI and Skinfolds

Weight, height, and skinfolds were measured by trained staff. Inter-observer agreement (computed by agreements/disagreements + agreements) for all measures was monitored throughout measurement and found to be high (height = 0.98; weight = 0.97; skinfolds = 0.85) (22). BMI was calculated from weight using calibrated digital scales (model 013089; Health-O-Meter, Bridgeview, IL) and height using a wooden ruler attached to the wall. Participants were classified as overweight if they were $\geq$85th percentile of BMI based on sex and age (23). Lange calipers were used for calf and triceps skinfolds. Three measurements were taken at midcalf and midupper arm, and means were summed for the total skinfolds score in millimeters.

Demographics

Parent surveys were sent home to parents in the fall of fourth grade, and ~75% were completed and returned. Parents reported the number of years spent in school for father, mother, or other adult in the household. The highest value was used as the highest level of parent education. Parents also reported their child's ethnicity. Because of the small number of participants categorized into non-white ethnic groups, data were collapsed, and participants were classified as white or non-white.

Analyses

For baseline analyses, a series of sex-specific one-way ANOVAs were conducted, with active commuting status as the predictor and BMI, skinfolds, or Caltrac counts as the outcome variables. For prospective analyses, change scores were created by subtracting the skinfold or BMI in the fall of fourth grade from the measurement in the spring of fifth grade. A series of sex-specific one-way ANOVAs were run using the change scores as the outcome variables. To interpret all ANOVAs, means were examined to determine the direction of significance.

Logistic regression was used to examine whether active commuting to school predicted overweight at baseline and

Table 1. Associations between commuting category and BMI, skinfold, and accelerometer data at baseline for 4th grade boys and girls

	n	Mean*	Standard error	F	*p*	Partial η^2
Skinfolds (total mm)						
Boys ($n = 450$)				6.71	0.01	0.015
Active†	162	24.62	0.84			
Non-active‡	288	27.33	0.63			
Girls ($n = 365$)				1.57	0.21	0.004
Active	113	31.17	0.98			
Non-active	252	29.69	0.66			
BMI						
Boys ($n = 450$)				7.42	0.007	0.02
Active	162	17.25	0.22			
Non-active	288	18.01	0.17			
Girls ($n = 365$)				1.10	0.30	0.003
Active	113	17.82	0.26			
Non-active	252	17.49	0.17			
Caltrac (counts per hour)						
Boys ($n = 320$)				3.31	0.07	0.01
Active	116	9.95	0.34			
Non-active	204	9.17	0.26			
Girls ($n = 274$)				1.24	0.27	0.005
Active	79	8.83	0.38			
Non-active	195	8.33	0.24			

* Means were adjusted for highest level of parent education and child's white/non-white ethnicity.
† Active commuters reported walking, biking, or skateboarding to school almost every day or every day.
‡ Non-active commuters reported walking, biking, or skateboarding to school 3 or fewer days per week.

at the end of 2 school years. The predictor variable was the binary variable active commuting status either at baseline or consistently over 2 school years. The outcome variable was classification as overweight (at or above the 85th percentile of BMI for age and sex) at baseline for the baseline analysis and in the spring of fifth grade for the prospective analysis. All analyses were conducted using SPSS version 12.0 (SPSS, Inc., Chicago, IL). All analyses were sex-specific and were adjusted for highest level of parent education and child ethnicity. Sports, Play, and Active Recreation for Kids was a randomized trial of improved physical education. However, there were no significant intervention effects on any of the variables reported in this study (21). Thus, intervention condition was not controlled for in the analyses.

Results

Approximately 36% of boys and 29% of girls were classified as active commuters at baseline based on those reporting walking, biking, or skateboarding to school almost every day or every day ($\chi^2 = 5.85$, $p = 0.02$).

Baseline Physical Activity, BMI, and Skinfolds

At baseline in fourth grade, boys classified as active commuters to school had significantly lower BMI and skinfold values than boys who did not actively commute to school (Table 1). There were no significant differences between active and non-active commuters for either BMI or skinfolds at baseline for girls. Boys who actively commuted to school had marginally higher Caltrac rates than boys who were not active commuters to school. Caltrac rates did not significantly differ between girls who actively and non-actively commuted to school.

Change in BMI and Skinfolds

Change in BMI and skinfolds from fall of fourth grade to spring of fifth grade was not significantly different for girls or boys classified as actively or non-actively commuting to school (Table 2).

Predicting Overweight

At baseline, ~27% of participants were at or above the 85th percentile of BMI for age and sex and were considered

Table 2. Associations between school commuting category and change in BMI and skinfold over two school years

	n	Mean*	Standard error	F	*p*	Partial η^2
Change in skinfolds (mm)						
Boys (n = 450)				0.67	0.41	0.001
Active†	92	0.36	0.79			
Non-active‡	358	1.08	0.40			
Girls (n = 365)				0.002	0.97	0.00
Active	66	−0.22	0.96			
Non-active	299	−0.18	0.45			
Change in BMI						
Boys (n = 450)				0.02	0.88	0.00
Active	92	1.01	0.15			
Non-active	358	1.04	0.08			
Girls (n = 365)				0.32	0.57	0.001
Active	66	1.21	0.19			
Non-active	299	1.09	0.09			

* Means were adjusted for highest level of parent education and child's white/non-white ethnicity.
† Active commuters reported walking, biking, or skateboarding to school at least 2 or 3 days per week at all 4 measurements.
‡ Non-active commuters reported walking, biking, or skateboarding to school 0 or 1 day per week on at least 1 of 4 measurements.

overweight. For both boys and girls, actively commuting to school was not associated with being classified as overweight at baseline (Table 3).

After 2 school years (spring of fifth grade), ~21% of participants were classified as overweight. Logistic regression analyses revealed that mode of transportation to school did not predict overweight for boys or girls (Table 3). Additional logistic regression analyses were run controlling for baseline overweight status to assess whether changes in overweight status were predicted by active commuting to school; again, the results were non-significant for both boys and girls.

Discussion

Results showed that, in baseline analyses, boys who actively commuted to school had lower skinfold and BMI measurements than non-active commuters to school. However, there seemed to be no health benefits of using active modes of transportation to school consistently over 2 years for both boys and girls. Additionally, overweight status was not predicted from use of active modes of transportation to school. The baseline findings do not allow any interpretation of direction of causation, so it could be that active commuting to school could help reduce BMI and skinfolds, particularly in boys, or that leaner boys are more likely to actively commute to school than heavier boys.

Reasons for the inconsistent results at baseline for boys and girls are not clear. Perhaps boys are allowed to walk, cycle, or skateboard longer distances to school than girls, producing greater energy expenditure for boys. The marginal association between active commuting and accelerometer scores for boys but not girls provides limited support for such an interpretation. Because distance to school was not available in this study, sex differences in this variable could not be examined. Investigators are encouraged to measure distance to school in future studies.

To our knowledge, only one other study has examined the prospective effects of active commuting to school on body composition, but relationships were not in the expected direction (9). The generalization of that study can be questioned, because the sample consisted only of overweight youth. Other studies examined relationships only cross-sectionally (16). Thus, a major strength of this study was the prospective nature of the data.

While these results support baseline associations, there may be several reasons for a lack of prospective findings. More stringent criteria were required for participants to be classified as active commuters at baseline than prospectively because of fewer participants regularly commuting actively to school over time. Thus, the lack of prospective findings for skinfolds and BMI could suggest that a low frequency of active commuting to school is not sufficient to impact weight status. Additionally, power was reduced because of the small sample of consistent active commuters. Prospective studies using larger sample sizes and measures

Table 3. Logistic regression analysis predicting overweight status (at or above the 85th percentile for sex and age) at baseline with active commuting to school at baseline and predicted overweight status two years later with consistent active commuting to school over two years*

	Overweight at baseline (fall 4th grade)†	Overweight two school years later (spring 5th grade)‡
Variable	**OR (95% CI)**	**OR (95% CI)**
Boys	(n = 450)	(n = 437)
Education	0.98 (0.90 to 1.07)	0.92 (0.84 to 1.01)
Ethnicity		
Ref: white		
Non-white	1.19 (0.75 to 1.89)	0.80 (0.49 to 1.30)
Transportation		
Ref: active commuters		
Non-active commuters	1.34 (0.84 to 2.10)	1.10 (0.64 to 1.92)
Girls	(n = 365)	(n = 378)
Education	0.90 (0.83 to 0.99)§	0.98 (0.89 to 1.09)
Ethnicity		
Ref: white		
Non-white	0.90 (0.57 to 1.44)	1.62 (0.96 to 2.73)
Transportation		
Ref: active commuters		
Non-active commuters	0.84 (0.52 to 1.36)	1.04 (0.52 to 2.07)

OR, odds ratio; CI, confidence interval.
* Measured on four occasions.
† Active commuters reported walking, biking, or skateboarding to school almost every day or every day at baseline. Non-active commuters reported walking, biking, or skateboarding to school 3 or fewer days per week at baseline.
‡ Active commuters reported walking, biking, or skateboarding to school at least 2 or 3 days per week at all 4 measurements. Non-active commuters reported walking, biking, or skateboarding to school 0 or 1 day per week on at least 1 of 4 measurements.
§ $p < 0.05$.

of commuting distance or time will be required to further study the amount of active commuting to school required to result in health benefits.

The effect sizes of current cross-sectional results were small according to Cohen's criteria (for η^2: small, 0.01 to 0.05; medium, 0.06 to 0.13; large > 0.13) (24). However, rather than dismissing findings based on cut-offs for small effects, it is useful to compare present effect sizes to those in related areas. For example, a recent meta-analysis found a small effect size for the correlation between television viewing and body fatness (r = 0.084) (25). However, television viewing has been a consistent correlate of overweight, and decreasing sedentary time has been shown to decrease BMI (26,27). It is also necessary to consider that the vast majority of students are exposed to the potential risk factor of being driven to school, because small effects across large populations create substantial public health impact. Therefore, small effects in this study do not necessarily negate the potentially important role that active commuting to school may have on health indicators.

Although several studies found that active commuting to school contributed to higher total physical activity (6–11), these findings did not support this conclusion. However, the number of days of accelerometer data was too small a sample to estimate habitual physical activity. In addition, the technology did not allow an assessment of the consistency with which children wore the monitors, so measurement errors are likely even with the objective measure.

The study had a large sample, a prospective design, and objective measures of physical activity, height, weight, and skinfolds. Key limitations were the single geographic study area, limited racial/ethnic diversity, insufficient sample of days of physical activity measurement, and inability to control for pubertal maturation. Measures of transportation to school were self-reported, and there was no information on the commuting mode used after school. Distance to school is an important barrier to active commuting, and this information was not available for this sample. The low percentage of students actively commuting to school limited statistical power. The inconsistent findings across girls and boys need to be followed up in future studies.

National efforts are underway to promote safe walking and biking to school, because of the potential effects on children's health and traffic congestion (1,2,4). It is important that an evidence base be established to assist in prioritizing resources that can be devoted to various recommended intervention approaches (15). The cross-sectional results of this study can be interpreted as either providing limited support that walking and cycling to school may assist in the prevention of overweight in children or that leaner children are more likely to walk or cycle to school. In the context of an epidemic of childhood obesity (1,15,28), the findings highlight the need for further studies on the effects that active commuting to school may have on the daily energy expenditure and weight status of millions of children.

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