

Sociodemographic, Family, and Environmental Factors Associated with Active Commuting to School among US Adolescents

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ABSTRACT

Active commuting (non-motorized transport) to school can be an important source of physical activity for children and adolescents. This research examined socio-demographic, family, and environmental characteristics associated with active commuting to or from school among 3,451 US adolescents aged 12–17 years, who responded to the 2005 California Health Interview Survey. Logistic regression results indicated that those more likely to actively commute were males, Latinos, from lower-income families, attending public school, living in urban areas, and living closer to school. Adolescents without an adult present after school and those whose parents know little about their whereabouts after school were also more likely to actively commute. Parental walking for transportation and perceptions of neighborhood safety were not associated with adolescent active commuting. Important family and individual correlates of walking or biking to school among adolescents were identified, even after adjusting for distance to school and urbanicity.

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BACKGROUND

Active commuting to school is associated with higher levels of physical activity and energy expenditure among youth (1–4). However, the prevalence of walking or bicycling (“biking”) to school has declined significantly in the past 30 years (5). Increasing the prevalence of walking and biking to school is a Healthy People

2010 goal (6). Healthy People 2010 is a statement of US national health objectives to be achieved by the year 2010.

According to social ecological models, individual, family, and environmental characteristics are all likely to influence active commuting (non-motorized transport) (7,8). Although several previous studies examined a range of correlates of active commuting in children, few focused on adolescents. Correlates of walking and biking to school, the most common modes of non-motorized transport in the United States, are likely to differ for children and adolescents (9,10).

Studies conducted in the United States and Australia have examined the association of sociodemographic characteristics such as age, race/ethnicity, and income with active commuting and have found mixed results (11,12). Several studies found older children were more likely to actively commute (5,13–16). Three of these studies included children aged 5–18 years (5,13,14), and two included children aged 5–12 years (15,16). However, McDonald(9) found that age was associated among younger children but not among adolescents; Kerr *et al.* (17) found that adolescents did not have higher rates than younger children; and Evenson *et al.* (10) found no association for age among middle school or high school students. Past research examining race/ethnicity has produced mixed results, with some studies finding African-Americans and Latinos were more likely to actively commute, and others finding no race/ethnicity differences after adjusting for other factors (10,13,14,18,19). Results were also mixed for income. Some studies found that as household income increased, likelihood of active commuting decreased (5,20). However, several studies found no consistent association after adjusting for other factors (9,13,14,19). Other indicators of socioeconomic position, such as parental education and employment status, were not associated with active commuting to school (10,15). Some of the inconsistency in findings may be due to differences in the age groups studied, in the other correlates included in analyses, or in the way active commuting was measured (11,12).

Family and household characteristics also have been identified as correlates of walking or biking to school in Australian and US studies. Having no adult at home after school was associated with greater likelihood of walking or biking for high school students but

not for younger children (10,15). Surprisingly, most studies that examined household vehicle access (either vehicles per driver or number of vehicles) found no significant association with active commuting (9,13–15,20). However, McDonald (5) found that children and adolescents in households with no vehicles were more likely to walk or bike to school. These findings may generally reflect high rates of vehicle ownership. Finally, children and adolescents in households with more children were more likely to actively commute (9,13,20).

Several US and Australian studies found that objectively measured distance to school was a significant barrier to active commuting and has been a key contributor to the decline in active commuting over time (5,14,15,21,22). Both children and adolescents living further from school were less likely to actively commute (5,15). Studies have also consistently found that adolescents and children living in more densely populated areas were more likely to walk or bike to school (9,17,18). Results regarding street connectivity (i.e., directness and density of connections in street and sidewalk system that enable walking and bicycling) have been mixed. Braza *et al.* (18) and Schlossberg *et al.* (22) found that elementary and middle school students were more likely to walk or bike to school with more street connectivity, whereas Kerr *et al.* (17) found no association among children aged 5–18 years. However, Kerr did find that greater neighborhood walkability (i.e., how friendly the built environment is for people to live, visit, shop, or enjoy spending time in an area – measured by a combination of residential density, pedestrian-oriented retail design, street connectivity, and land use mix) was associated with more active commuting. Previous findings for the association of active commuting with land use mix, completeness of sidewalks, and presence of a busy road on the school route have been inconsistent (15,17,20,22,23).

McMillan (24) argued that the built environment has an important but indirect influence on active commuting by children because parental decision-making mediates the relationship. Parents' perceptions that the school was too far away were associated with lower rates of active commuting among elementary and middle school students (25). Several Australian and US studies found that active commuting was associated with parental perceptions related to pedestrian and traffic safety; most included parents of elementary

and middle school students (15–17,20,25,26). Perceptions of having few other children in the area or other children to walk with were found to be barriers to active commuting among children (15,25). Few studies examined the role of the child's perception in active commuting and those that did found few perceptions to be associated, suggesting parental perceptions may be more important correlates at least for children (15,27).

The present study examined sociodemographic, family, and environmental characteristics associated with active commuting to school among adolescents, using a population-based data set that includes a number of factors not examined in previous studies. Few previous studies have focused on adolescents. Examining factors from multiple levels of ecological models simultaneously provides information useful for the development of policies to encourage more active commuting and allows identification of populations with the lowest rates of active commuting to school, which can inform targeted interventions.

METHODS

Data

This research used data from the 2005 California Health Interview Survey (28), a random-digit-dial telephone survey of more than 43,000 households designed to be representative of California's non-institutionalized population. One randomly selected adult (age 18 or older) was interviewed in each household. In households with adolescents (ages 12–17), one adolescent was randomly selected and interviewed directly after obtaining permission from a parent as well as consent from the adolescent. The interview completion rate for adolescents was 48.5%. Interviews were conducted in five languages: English, Spanish, Chinese, Vietnamese, and Korean. Detailed information about California Health Interview Survey methodology is available elsewhere (28). The current analyses included responses from 3,983 adolescents aged 12–17 years who attended school outside of their home.

Measures

Outcome measure

Responses to two questions were used to assess whether adolescents made any active trips to or from school in the previous week: (1)

how many days in the past week did you walk, bicycle, or skateboard to school? and (2) how many days in the past week did you walk, bicycle, or skateboard home from school? Adolescents who were not in school in the past week, but attended school in the past year (11%), were asked about a typical school week. Adolescents who responded 1 day or more to either question were categorized as engaging in any active commuting to school. Similar measures of active transport (active commuting) to school were used in previous studies (27,29). Evenson *et al.* (27) reported acceptable test-retest reliability of similar measures as well as rates of any active transport to school comparable to those in the current study.

Adolescent survey items

Adolescents reported their age, gender, and race/ethnicity (white, Latino, Asian, African-American, American Indian, or mixed race). In addition, they reported how often an adult was present after school, how much parents knew about their whereabouts after school, and name of the school they attended.

Parental survey items

Household income, household address, parental walking for transportation (walking to get some place in the past week), and perceptions of neighborhood safety (how often they felt safe in neighborhood) were reported by the adult respondents. Household income was examined as percent of the federal poverty level (below 200% or 200% and above) (30). The US federal poverty level is a monetary threshold based on total household income and number of people in the household, which is used to determine who is in poverty. In 2005, the threshold for 200% of the federal poverty level was \$39,942 for a family of four.

Objective measures

Using data obtained from CLARITAS (31), households were assigned to urbanicity levels (urban, suburban, and rural) based on population density of the household's zip code and surrounding areas. Urban areas have population density greater than 4,150 persons per square mile (ppsm) and are dense neighborhoods in central cities (the largest cities in metropolitan areas). Suburban

areas are moderate density neighborhoods that are adjacent to population centers (above 1,000 ppsm and not an urban area). Rural areas are isolated small towns or other less-developed areas surrounded by farmland or open spaces (lower than 1,000 ppsm) (19).

School names were matched to publicly available databases from the California Department of Education to determine school location and type (public or private) (32). Previous research suggested that children attending private school were more likely to be dependent on cars and, therefore, should be less likely to actively commute to school (16). School and household locations were geocoded and distance to school was calculated based on the shortest Euclidean (i.e., straight line) distance between home and school using GIS software. Distance to school was divided into four categories: < 800 m (approximately $\frac{1}{2}$ mile), 800–1,599 m, 1,600–3,199 m, and $\geq 3,200$ m. These categories are consistent with previous studies and with reports that 800 m is a reasonable walking distance for youth (5,14,15,26). However, because the current measure of active commuting included biking and skating, larger distance categories were also included.

Statistical Analyses

Logistic regressions were conducted to examine the association of individual, family, and environmental characteristics with active commuting to or from school on one or more days. Owing to missing values for some variables, regression analyses included 3,451 adolescents. Analyses were weighted to be representative of the California population and adjusted for the complex survey design of the California Health Interview Survey. The Office for the Protection of Research Subjects at the University of California, Los Angeles approved this research.

RESULTS

The average age of adolescent respondents in this analysis was 14.4 years, and 49% were female. Of the respondents, 40% were white, 34% Latino, 11% Asian, 9% African-American, and 5% mixed race; 10% lived within 800 m ($\sim 1/2$ mile) from school, and the

median distance to school was 2,700 m (~1.68 miles); 13% lived in rural areas, 19% in suburban areas, and 68% in urban areas. Nearly half (49.8%) reported walking, biking, or skateboarding to or from school at least once in the past week or in a typical week. One quarter (25%) reported active commuting both to and from school three or more days in a week. Table 1 displays additional characteristics of the adolescent sample.

Table 2 presents both the unadjusted weighted prevalence and adjusted odds ratios for active commuting to school by socio-demographic, family, and environmental characteristics. The unadjusted prevalence of active commuting varied by gender, race/ethnicity, income, indicators of parental supervision, parental walking for transport, distance to school, and urbanicity.

After adjusting for all factors in the logistic regression model, distance to school was most strongly associated with active commuting. Adolescents who lived within 800 m (~1/2 mile), between 800 and 1,600 m or between 1,600 and 3,200 m from school were more likely to walk, bike, or skateboard to school than those who lived more than 3,200 m (~2 miles) from school. Even after adjusting for distance to school, a number of socio-demographic, family, and environmental characteristics remained significantly associated with active commuting. Age was inversely associated with active commuting. Females were less likely to actively commute than males. Latino and mixed-race adolescents were more likely to actively commute than whites; however, African-American adolescents were not different from whites. Adolescents from lower-income families were more likely to actively commute than those from higher-income families, and adolescents attending public school were more likely to actively commute than those attending private school.

Indicators of parental supervision were associated with active commuting. Adolescents who had an adult present after school some or none of the time were more likely to actively commute than those who had an adult present after school most of the time. Adolescents who reported their parents knew little or nothing about their whereabouts after school were more likely to actively commute than those who reported their parents knew a lot. Adolescents in urban areas were more likely than those in rural or suburban areas to walk or bike to school. Neither parental walking for transportation

Table 1: Sample characteristics*

	<i>Unweighted n</i> (N=3,983)	<i>Weighted %</i> [†]
<i>Age (in years)</i>		
12-14	2,098	51.7
15-17	1,885	48.3
<i>Gender</i>		
Female	1,955	48.8
Male	2,028	51.2
<i>Race/ethnicity</i>		
White	2,115	40.4
Latino	1,030	34.1
Asian	352	10.7
African-American	231	8.5
American Indian	59	1.5
Mixed race	196	4.8
<i>Household income</i>		
< 200% FPL	1,281	41.5
≥ 200% FPL	2,702	58.5
<i>Urbanicity</i>		
Urban	2,397	68.1
Suburban	836	19.2
Rural	750	12.8
<i>Distance between home and school</i>		
< 800 m (~ 1/2 mile)	354	10
800-1,599 m (~ 1/2 to 1 mile)	699	19.4
1,600-3,199 m (~ 1 to 2 miles)	1,048	27
≥ 3,200 m (~ 2 miles)	1,761	43.6
<i>Adult present after school</i>		
Most of the time	3,340	83.8
Some or none of the time	743	16.2
<i>Parental knowledge of whereabouts after school</i>		
Knows a lot	3,475	83.9
Knows little or nothing	508	16.1

Table 1 (continued)

	Unweighted <i>n</i> (<i>N</i> =3,983)	Weighted % [†]
<i>Parent walks for transportation</i>		
Yes	1,668	49.5
No	1,934	50.5
<i>School type</i>		
Public	3,484	91.2
Private	379	8.8
<i>Parental perception of neighborhood safety</i>		
Always feels safe	2,334	61.9
Feels safe most of time	1,021	30.2
Feels safe some or none of time	196	7.9
<i>Any active commuting to school</i>		
Yes	2,143	49.8
No	1,840	50.3

*Characteristics of respondents who attend school outside the home.

[†]Results are weighted to be representative of the California population.

FPL, federal poverty level.

nor parental perceptions of neighborhood safety were associated with active commuting.

DISCUSSION

Consistent with previous research, distance to school was the strongest predictor of active commuting (5,15). However, even after adjusting for distance to school, a number of individual, family, and environmental characteristics remained associated with active commuting. Specifically, males, Latinos, adolescents from lower-income families, those attending public school, those whose parents know little or nothing about their whereabouts after school, and those living in urban areas were more likely to walk, bike, or skateboard to school.

Table 2: Factors associated with any active commuting to school among adolescents*

<i>Factor</i>	<i>Unadjusted prevalence (%)</i>	<i>Adjusted OR[†] (95% CI)</i>
<i>Age</i>		0.89 (0.83–0.95)***
<i>Gender</i>		
Female	46.6***	0.65 (0.52–0.81)***
Male	53.7	1.00
<i>Race/ethnicity</i>		
Latino	60.8***	1.37 (1.03–1.81)**
Asian	45.7	0.79 (0.55–1.14)
African-American	52.1**	1.25 (0.76–2.05)
American Indian	40.6	0.86 (0.32–2.35)
Mixed race	64.6***	1.71 (1.07–2.74)**
White	40.9	1.00
<i>Household income</i>		
< 200% FPL	62.0***	1.84 (1.41–2.41)***
≥ 200% FPL	41.9	1.00
<i>School type</i>		
Public	52.7***	1.97 (1.27–3.07)***
Private	25.9	1.00
<i>Adult present after school</i>		
Most of the time	48.6	1.00
Some or none of the time	58.6***	1.77 (1.33–2.35)***
<i>Parental knowledge of whereabouts after school</i>		
Knows a lot	47.9	1.00
Knows little or nothing	62.3***	1.71 (1.23–2.38)***
<i>Parent walks for transportation</i>		
Yes	53.5***	1.03 (0.83–1.29)
No	46.4	1.00
<i>Distance between home and school</i>		
< 800 m (~ 1/2 mile)	85.5***	11.99 (6.97–20.63)***
800–1,599 m (~ 1/2 to 1 mile)	72.5***	5.01 (3.71–6.79)***

Table 2 (continued)

Factor	Unadjusted prevalence (%)	Adjusted OR [†] (95% CI)
1,600–3,199 m (~ 1 to 2 miles)	49.9***	1.86 (1.44–2.40)***
≥ 3,200 m (~ 2 miles)	32.7	1.00
<i>Urbanicity</i>		
Urban	55.9	1.00
Suburban	40.3***	0.69 (0.52–0.91)***
Rural	35.3***	0.58 (0.43–0.79)***
<i>Parental perception of neighborhood safety</i>		
Always feels safe	48.7	1.00
Feels safe most of time	51.4	1.16 (0.92–1.47)
Feels safe some or none of time	55.2	1.17 (0.72–1.89)

*Results are weighted to be representative of the California population and are adjusted for complex survey design effects. Bold indicates statistical significance $p < 0.05$.

[†]Adjusted for all variables presented.

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$ compared to reference category.

CI, confidence interval; FPL, federal poverty level; OR, odds ratio.

Surprisingly few studies of active commuting have included individual race/ethnicity, and those that did have typically lacked sufficient samples to report active commuting behaviors for more than white and African-American or Latino adolescents. After adjusting for other factors, African-American adolescents were not more likely than whites to walk or bike to school, consistent with two previous US studies (14,19). However, a North Carolina study found the opposite (10). Present results indicated Latino adolescents were more likely than whites to actively commute, in contrast to Martin *et al.* (19) and McDonald (14), who found Latinos were not more likely to walk or bike to school after adjusting for other factors including income and distance to school. However, Braza *et al.* (18) found students attending California elementary schools with a greater proportion of Latino students were more likely to walk or bike to school. Some of these conflicting findings may reflect differences in the African-American and Latino populations in California compared to the rest of the United States or the State of North Carolina.

Current results indicated that adolescents living in urban areas were more likely to actively commute than those in suburban or rural areas after adjusting for distance, which is consistent with previous results from Canada and the United States (17,18,33). Taken together with the strong associations between distance and walking or biking to school found in this and previous studies, these results suggest that placing schools in or adjacent to residential areas may be a promising strategy to encourage more walking and biking to school. In the present study, urbanicity was defined on the basis of population density. However, this was likely correlated with the number of children in the area, and other studies have found that the presence of other children was associated with more active commuting (15,34). Thus, it is possible that social influences could have contributed to the association of urbanicity with active commuting in the present study.

Adolescents without adult supervision after school were more likely to actively commute. Previous studies in the United States and Australia that examined indicators of parental supervision produced mixed results. However, results were somewhat more consistent when the age of the children was considered. Evenson *et al.* (10) found that high school students with no adult at home after school were more likely to walk or bike to school, but this variable was not associated for middle school students. Timperio *et al.* (15) found no association between active commuting and adult supervision after school among children aged 5–6 and 10–12 years. Taken together, these findings suggest that indicators of adult supervision are important correlates of active commuting for adolescents but not for younger children. One possible explanation for these findings is that adolescents with single parents or with both parents working are less likely to have parental supervision after school and these parents in turn may be less able to provide transportation to or from school. For example, McMillan (20) reported children were more likely to walk or bike to school when parents perceived driving to be less convenient.

Similar to previous studies, current findings indicated parental perceptions of general neighborhood safety were not associated with active commuting among adolescents. Previous studies that included similar variables also found no association between perceptions of safety and walking or biking to school (15,17).

However, associations have been found between active commuting and safety characteristics more specific to walking or biking (e.g., traffic, pedestrian safety) (15,17). These findings suggest that general measures of safety are less helpful than more specific measures in understanding adolescent and parental safety concerns related to active commuting.

Parental walking for transportation was not associated with active commuting among adolescents, and this variable has not been studied previously in relation to adolescent active transport. However, current findings are consistent with a review that found no association between overall adolescent and parental physical activity (35). Previous research found low-income adults were more likely to walk for transportation, and current results indicated a similar association among adolescents (36). It is likely that factors such as income and distance rather than parental mode of transportation are more important correlates of active transport for adolescents. For example, children in families with fewer resources have been found to be more likely to actively commute (12). Additionally, lower-income families tend to have fewer vehicles per driver and are more likely to live within a mile from school; these factors may increase the likelihood of active commuting to school in this group (14,19).

There are some limitations to the present research: (1) The active commuting questions asked about walking, biking, or skateboarding to school in one question, so correlates of different modes of travel to school could not be examined separately. Previous research found some similarity in correlates of walking and biking (10). Not surprisingly, other studies suggested that walking to school was more sensitive to distance than was biking (22). One strength of the current measure of active commuting is that adolescents were asked about trips to and from school, because students often travel to and from school using different modes (22). (2) Using Euclidean, or straight line, distance between home and school likely underestimated the actual distance on the street. Euclidean distance measures probably resulted in greater underestimation of distance in less walkable areas, such as many suburbs. If higher-income adolescents are more likely to live in less walkable suburban areas, then distance would be more likely to be underestimated for higher-income adolescents and this could have influenced the

prevalence estimates for active commuting as a function of distance to school. However, given the similarity seen between the current results for distance and those from previous studies, it is likely that this measure of distance captured important variation in actual travel distances between home and school. (3) The current study was informed primarily by research from the United States and Australia, and research published in languages other than English was not reviewed. (4) The current study was not able to account for vehicle access. However, previous results regarding its association with active commuting were inconsistent (14,15).

Walking and biking to school can be important sources of physical activity for adolescents. Living further from school is an important barrier to active commuting. However, the present results suggest that sociodemographic and family factors are important correlates of active commuting even after adjusting for distance to school. Present findings suggest the following strategies would be potentially useful for encouraging active commuting to school and warrant further evaluation. First, placing schools in or adjacent to residential areas, particularly those with high concentration of students, may be a promising strategy to encourage more walking and biking to school. Second, examining the different barriers to active commuting faced by those living in urban, suburban, and rural areas could inform development of interventions specific to these different areas. Finally, future research should examine factors that encourage or discourage active commuting for particular groups of adolescents to better target interventions to these groups. Specifically, higher-income adolescents, white adolescents, and those with greater levels of parental supervision were less likely to actively commute. These findings suggest active commuting may be more likely when adolescents have fewer resources for alternate modes of transport to or from school. Increasing active commuting among populations that have other options for transport to or from school would increase overall levels of active commuting.

It is important to understand the individual, family, and environmental characteristics associated with active commuting to school when designing the interventions that may influence this behavior. Future research should examine additional physical and social environmental characteristics such as availability of sidewalks,

traffic safety, and social norms, along with individual and family characteristics.

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