Correlates of Walking to School and Implications for Public Policies: Survey Results from Parents of Elementary School Children in Austin, Texas

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ABSTRACT

Walking can be a healthy, sustainable, and equitable mode of transportation, but is not widely used for children's school travel. This study identifies multi-level correlates of walking to/from school and relevant policy implications. We surveyed parents/guardians of 2,695 students from 19 elementary schools in Austin, Texas, which featured diverse sociodemographic and environmental characteristics. Among the personal and social factors, negative correlates were parents' education, car ownership, personal barriers, and school bus availability; positive correlates were parents' and children's positive attitude and regular walking behavior, and supportive peer influences. Of physical environmental factors, the strongest negative correlates were distance and safety concerns, followed by the presence of highways/freeways, convenience stores, office buildings, and bus stops *en route*. Our findings suggest that society should give high priority to lower socioeconomic status populations and to multi-agency policy interventions that facilitate environmental changes, safety improvements, and educational programs targeting both parents and children.

Journal of Public Health Policy (2009) **30**, S177–S202.
doi:10.1057/jphp.2008.51

Keywords: walking, school, environment, children, disparity, policy

INTRODUCTION

In the United States, the percentage of students (5- to 18-year-olds) walking or biking to school declined dramatically, from 41% in 1969 to 13% in 2001, and this decline was greatest among minority and elementary school children (1). The prevalence of overweight among 6- to 11-year-olds increased from 4.2% in 1963–1965 to

18.8% in 2003–2004, with even higher rates among minority children (2,3).

Walking to and from school can increase physical activity, and may help combat childhood obesity (4–6). Walking is also an affordable and sustainable transportation mode that can improve environmental quality by reducing automobile traffic, fuel consumption, and air pollution (7). Further, it is possible that children's mental and social health would be enhanced through exposure to nature and social interactions while walking (8). The *Healthy People 2010* report identified increasing the rate of walking to school as a national health objective in the United States (9).

Despite these benefits, little empirical knowledge exists about the correlates of walking to/from school. Drawing from social ecological theory (10), a few studies have identified three domains of correlates of walking to/from school, including the personal, social, and physical environmental factors. Research on the impact of such personal and social factors as ethnicity, age, gender, and peer influences has shown inconsistent results. Several studies show disparities; for example, although low-income and minority children walk to/from school more often (11–13), they do so in environments that are less safe and/or of poorer quality than those encountered by non-minority children or those of higher socioeconomic status (SES) (14,15). Barriers to walking in the physical environment include long distances (7,11,16–21), crime, and traffic danger (19,21,22), whereas the availability and quality of pedestrian infrastructure (e.g., sidewalks, traffic signals) encourage walking (7,23,24). More study is needed about the roles of other physical environmental factors such as land uses, maintenance conditions, and visual quality.

Trends of school development show increases in building larger schools in remote areas near high-capacity roads; these roads facilitate automobile access at the expense of walking or biking (7). This trend is supported by public policies that encourage school consolidation to increase economic efficiency (25,26). Many states have implemented strict minimum acreage requirements for new schools, and funding formulas and building codes that favor the development of new schools over the renovation of existing neighborhood schools (7). More empirical knowledge is needed to justify and guide development of schools that are accessible to pedestrians.

This study seeks to fill gaps in the literature by identifying the correlates of walking to or from school among elementary school children in diverse sociodemographic and physical environments, and by exploring the implications for policy interventions. Disparities issues related to the environmental support for walking are also examined.

METHODS

Study Area and Schools

We conducted this study in the Austin Independent School District in Austin, Texas, which covers the city's central area and surrounding suburban neighborhoods. In the 2005–2006 school year, the Austin Independent School District had 74 elementary schools; 55.4% of the students were Hispanics and 60.3% were eligible for free or reduced-price lunch (27).

The researchers conducted a two-phase survey in collaboration with the city's Child Safety Program and the Austin Independent School District, as part of the city's efforts to apply for the Texas Safe Routes to School funding. (Safe Routes to School is a national effort, funded by the US Department of Transportation Federal Highway Administration, in which support is given to local communities to encourage and enable more children to walk and bike safely to school.) For the first phase in April 2007, the city selected a convenience sample of nine lower-SES schools, based on the percentages of students receiving free or reduced-price lunch. The second phase, in November 2007, included stratified random samples covering the full range of SES. The final sample consisted of 19 elementary schools, which represented the entire school district in terms of students' sociodemographic characteristics (ethnic composition and SES) and physical environmental conditions of attendance areas (distance to school, sidewalk completeness, traffic crash rate, and crime rate) (Figure 1 and Table 1).

Survey Instrument and Variables

The authors developed a three-page questionnaire, using information gathered from the English-language literature and three previously validated instruments. Items about sociodemographic information were taken from the PedsQL Family Information Form, which has

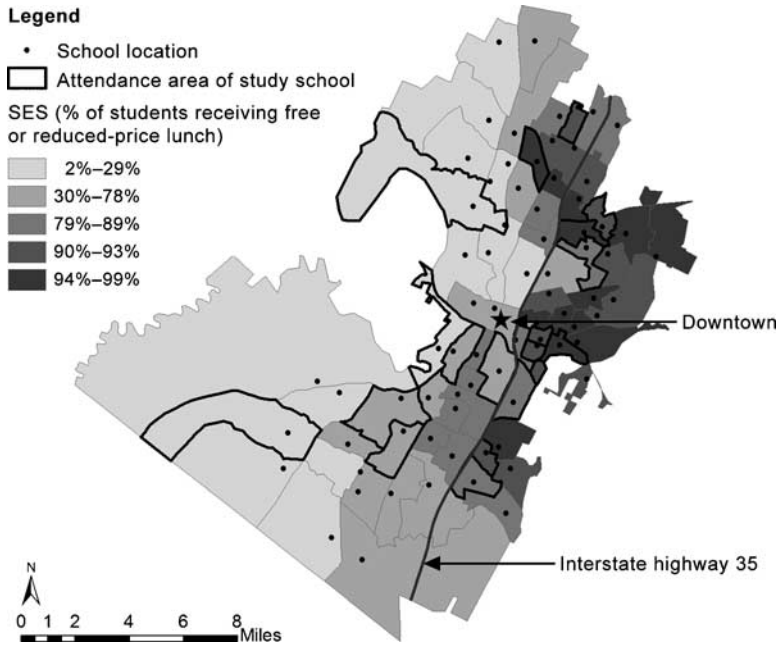

Figure 1
Socioeconomic status (SES) of elementary schools in the Austin Independent School District and locations of study schools

adequate reliability and validity (28). Items for personal attitude and behavior, social, and physical environmental factors were either adapted from two validated questionnaires with moderate-to-high reliability – the University of California at Irvine's Safe Routes To School Survey (29) and the Parental Survey from the "Active Where" project (30) – or developed by the researchers. The psychometric properties of the items developed by the current researchers are unknown. Most items in this instrument were measured on a 5-point Likert scale by asking to what extent the respondent agreed or disagreed with each statement, and were treated as continuous variables during the analysis.

To determine the main outcome variable – the use of walking as a typical mode of travel to/from school – parents/guardians were asked, "On a normal day, how does your child travel from home to school (from school to home)?" Table 2 shows the seven possible responses to this question. The three walking options (walking alone,

Table 1: Sociodemographic and physical environmental characteristics of 19 study schools compared to the mean of all elementary schools in the Austin Independent School District (AISD)

	Total enrollment	*Hispanic students (%)*	*Students receiving free or reduced-price lunch (%)*	*Students living within 1/2 mile of school (%)*	*Sidewalk completeness (%)*	*Yearly crash rate (per street mile)*	*Yearly crime rate (per 100 acres)*
Mean	639	67.2	74.1	27.2	30.4	6.1	71.5
Standard deviation	187	26.1	31.3	15.0	16.6	3.5	50.3
Minimum	353	10.7	5.7	8.0	7.9	0.8	5.1
Maximum	1007	96.5	97.8	73.3	66.4	13.2	185.5
Mean of all AISD elementary schools	*642*	*66.2*	*75.1*	*26.9*	*26.7*	*6.0*	*70.0*

Data sources: Texas Education Agency, AISD, Austin Police Department, City of Austin.

Table 2: Descriptive statistics of the mode share for the pooled sample from 19 study schools

Travel mode	*Mode share for home-to-school trip (%)*				*Mode share for school-to-home trip (%)*			
	Mean	*SD*	*Min.*	*Max.*	*Mean*	*SD*	*Min.*	*Max.*
Walk alone	2.3	1.8	0.0	7.0	3.2	2.6	0.7	9.3
Walk with friends	3.6	2.8	0.0	8.8	5.6	4.2	0.0	13.3
Walk with a parent/adult	21.9	9.1	7.7	38.5	22.7	10.7	4.7	44.3
Bike	1.4	1.6	0.0	5.4	1.3	1.5	0.0	5.2
School bus	15.7	16.1	0.0	44.2	18.0	17.0	0.0	49.6
Public bus	1.5	2.0	0.0	6.7	2.1	2.4	0.0	9.1
Private car, including carpool	53.4	12.8	30.2	76.3	47.1	15.0	19.5	71.5

SD: standard deviation; Min.: minimum; Max.: maximum.

with friends, or with a parent/adult) to or from school were coded as "Yes" for the outcome variable, indicating that the child typically walked to or from school. Independent variables included personal, social, and physical environmental factors (Table 3). Personal factors involved parents' and children's sociodemographic characteristics and attitudes and behaviors related to walking. Social factors included school and peer influences such as school bus availability and other children's and parents' walking behaviors. Physical environmental factors were parents' perceptions about safety (from traffic and crime) and walkability (e.g., travel distance, sidewalk quality, overall walking environment, physical barriers, and land uses) *en route* to school.

Survey Administration

The Institutional Review Board at Texas A&M University approved the survey. The researchers distributed a total of 11,880 bilingual questionnaires (English and Spanish) to parents or guardians of all students in the sampled schools. Teachers inserted the questionnaires into the school's weekly folio for each student to take home and

Table 3: Descriptive statistics and odds ratios for correlates of walking to or from school (unadjusted)[†]

Correlates (unadjusted)	*Coding scheme or individual observed variables*	*Percentage or mean (SD)*	*Odds ratio*
Personal sociodemographic factors			
Child's gender (Male %)	0=female, 1=male	46.2	0.946
Child's grade level	Pre-Kindergarten=−1, Kindergarten=0	1.837 (1.739)	1.017
Child's ethnicity (Hispanic %)	0=non-Hispanic, 1=Hispanic	68.9	1.386***
Parents' highest education	1=6th grade or less; …; 7=graduate or professional degree	4.084 (1.838)	0.838***
Single-parent (Yes %)	0=no, 1=yes	28.9	0.919
Number of family members		4.700 (1.459)	1.185***
Household's car ownership	Number of motor vehicles in the household	1.590 (0.838)	0.812***
Personal attitudes and behaviors			
Parents' personal barriers (*factor*)[‡]	1. "I have no time to walk with my child to/from school."	3.123 (1.387)	0.687***
	2. "It is easier for me to drive my child to/from school."	3.830 (1.321)	0.723***
	3. "Walking to school involves too much planning ahead."	2.912 (1.340)	0.645***
Child's personal barriers (*factor*)[‡]	1. "My child has too much to carry."	2.698 (1.225)	0.753***
	2. "My child gets too hot and sweaty."	3.186 (1.278)	0.897**

Table 3 *(continued)*

Correlates (unadjusted)	*Coding scheme or individual observed variables*	*Percentage or mean (SD)*	*Odds ratio*
Parents' and children's positive attitudes and regular walking behaviors (*factor*)‡	1. "Walking is a good way to interact with other people."	3.805 (1.168)	1.211***
	2. "Walking is a good way to exercise."	4.621 (0.800)	1.107§
	3. "My child walks quite often in his/her daily routine."	3.327 (1.306)	1.651***
	4. "My child thinks walking to school is 'cool'."	3.428 (1.214)	1.283***
	5. "I walk quite often in my daily routine."	3.658 (1.187)	1.258***
	6. "I enjoy walking with my child to/from school."	3.489 (1.229)	1.888***
	7. "My family and friends like the idea of walking to school."	3.279 (1.212)	1.363***
Social factors: school and peer influences			
School bus availability (Yes %)	0=no, 1=yes	33.9	0.227***
Positive peer influences (*factor*)‡	1. "Other kids walk quite often in their daily routines."	3.737 (1.077)	1.397***
	2. "Other parents walk quite often in their daily routines."	3.667 (1.205)	1.301***
	3. "Other kids walk to/from school."	3.942 (1.146)	1.536***

Table 3 *(continued)*

Correlates (unadjusted)	*Coding scheme or individual observed variables*	*Percentage or mean (SD)*	*Odds ratio*
Physical environmental factors: perceived safety and walkability			
Distance close enough (Yes %)	0=no, 1=yes	47.3	7.601***
Safety concerns (*factor*)‡	1. "My child may be taken or hurt by a stranger."	3.686 (1.332)	0.768***
	2. "My child may get bullied, teased, or harassed."	3.317 (1.346)	0.841***
	3. "My child may be attacked by stray dogs."	3.327 (1.351)	0.878***
	4. "My child may be hit by a car."	3.823 (1.306)	0.789***
	5. "Exhaust fumes will harm my child's health."	3.100 (1.250)	0.855***
	6. "My child may get lost."	3.037 (1.465)	0.701***
Presence of physical barriers	"Does your child have to cross the following on the route to school?"		
Highway/freeway (Yes %)	0=no, 1=yes	15.9	0.315***
Busy road (Yes %)	0=no, 1=yes	58.4	0.501***
Intersection without a painted crosswalk (Yes %)	0=no, 1=yes	20.4	0.606***
Sidewalk quality (*factor*)‡	1. "Sidewalks are wide enough."	3.443 (1.549)	1.103***
	2. "Sidewalks are well maintained and clean."	3.253 (1.493)	1.052§

Table 3 *(continued)*

Correlates (unadjusted)	*Coding scheme or individual observed variables*	*Percentage or mean (SD)*	*Odds ratio*
	3. "Sidewalks are separated from traffic by grass/trees."	2.693 (1.540)	1.113***
	4. "Sidewalks are NOT blocked by trash cans, power poles, or cars."	2.805 (1.515)	1.068*
	5. "People in the neighborhood will easily see and help my child in case of danger."	3.241 (1.256)	1.220***
	6. "Are there sidewalks along your child's way to school? 1=No; 2=Yes, on *very few* streets; 3=Yes, on *some* streets; 4=Yes, on *most* streets; 5=Yes, on *all* streets."	3.747 (1.256)	1.144***
Quality of overall walking environment (*factor*)[‡]	1. "It is well shaded by trees."	3.010 (1.253)	1.066[§]
	2. "It is quiet."	2.835 (1.381)	1.335***
	3. "It is well maintained and clean."	3.459 (1.180)	1.165***
	4. "Streets are well lit."	3.068 (1.236)	1.120**
	5. "It is convenient to walk to school."	3.148 (1.450)	1.759***

Table 3 *(continued)*

Correlates (unadjusted)	*Coding scheme or individual observed variables*	*Percentage or mean (SD)*	*Odds ratio*
Presence of land uses *en route* to school			
Convenience store (Yes %)	0=no, 1=yes	33.8	0.274***
Bakery/café/restaurant (Yes %)	0=no, 1=yes	21.1	0.207***
Office building (Yes %)	0=no, 1=yes	18.0	0.222***
Vacant lot (Yes %)	0=no, 1=yes	18.4	0.597***
Large parking lot (Yes %)	0=no, 1=yes	26.2	0.509***
Presence of bus stops *en route* to school (Yes %)	0=no, 1=yes	50.1	0.443***

† This table presents odds ratios from a series of bivariate logistic regressions that use individual independent variables to predict walking to or from school, without controlling for other variables. All perception or attitude variables were measured on a 5-point Likert scale ranging from "1=strongly disagree" to "5=strongly agree." In addition to the listed variables, eight other physical environmental variables were also collected in the survey, but were excluded from the analysis due to their non-significant associations with the outcome variable. These eight variables included the presence of playground, park, walking path or trail, community/youth center, and an intersection without street signs or stop sings, and if "there are nice things to see" and "streets are well lit" *en route* to school, as well as "how long have you lived in your current residence."

‡ Factors rather than individual items are used in the multivariate analysis presented in Table 4.

§ Odds ratios are marginally significant at the 0.1 level.

*$P<0.05$; **$P<0.01$; ***$P<0.001$.

SD: standard deviation.

return one week later. A cover letter accompanying the survey described the city's effort to apply for the Safe Routes to School funding and said that each student who returned a completed survey would be entered in an upcoming prize drawing in each school.

Data Analysis

We analyzed the survey results using SPSS 15.0 software (31). Data reduction was conducted using bivariate and factor analyses. Each independent variable was tested for its bivariate correlation with the outcome variable, and non-significant variables ($P>0.1$) were excluded from further analyses. However, exceptions were made for several non-significant sociodemographic variables because of their theoretical importance. Missing values (0%–12%) were imputed using (1) the mean of the corresponding school (for Likert-scale items); (2) the value from another respondent living nearby (for binary physical environment variables); and (3) a random imputation based on the percentage within each school (for other binary variables). Most items intended to measure parents' or guardians' perceptions, attitudes, and behaviors, and can be captured more effectively and efficiently through latent factors. Therefore, an exploratory factor analysis was performed for these 32 variables using a varimax rotation and a correlation matrix.

After data reduction, the odds of walking to/from school were predicted by estimating four multivariate logistic regression models in a sequential order. Four blocks of independent variables – sociodemographic, attitude and behavior, social, and physical environment – were added, one at a time, cumulatively into the previous model. The final model also included 18 dummy variables indicating school membership and another dummy variable for the time of survey, to help account for the potential impact of the school-level clustering and two different survey times. Finally, the bivariate associations between the student's SES and significant physical environmental correlates were examined to explore disparities in the physical environmental support for walking.

RESULTS

A total of 2,695 valid responses were returned, yielding a mean response rate of 22.7% (range: 9.2%–40.3%) across 19 study schools. Because data for several key independent variables (ethnicity, gender, and grade of students, and the percentage of students receiving school bus service) were available for the entire population, these data were used to examine the non-response bias. No serious bias was found based on these variables. A few schools had low response rates, but were retained in the analysis because their respondents were representative of the student population.

Mode Share and Travel Time

For the pooled sample, the mode share of students who walked was 27.8% and 31.5% for the trips to and from school, respectively. (A *mode share* is the percentage of people using a particular mode of transport, such as walking, biking, driving, and transit use.) From the 19 individual schools, some variations of mode shares were observed (Table 2). The total percentages of walking (alone, with friends, and with a parent or other adult) ranged from 8.7% to 46.8% for the morning trips and from 6.3% to 56.3% for the afternoon trips. The afternoon trips had a slightly higher rate of walking than the morning trips in both the pooled sample and the sub-samples of 15 individual schools. Biking and public transit were rarely used (mean $<2.1\%$). School bus usage is largely determined by service availability and accounted for 0% to 44.2% (mean = 15.7%) of the morning trips and 0% to 49.6% (mean = 18.0%) of the afternoon trips. The school district provides bus service for students who live more than two miles from school or who have to face hazardous conditions, such as crossing highways, to get to school. Private vehicles accounted for the largest mode share, with morning and afternoon mean values of 53.4% and 47.1%, respectively.

In 75% of walking trips, a parent or other adult accompanied the child. Travel times of walking trips were relatively short, being less than 15 min (76% of walking trips), 15–30 min (21.1%), or longer than 30 min (2.9%).

Bivariate and Factor Analysis

Significant bivariate associations with the outcome variable occurred in 47 of 58 tested independent variables (Table 3). From the factor analysis of 32 perception/attitude/behavior variables, seven factors were extracted: parents' personal barriers, children's personal barriers, positive attitude and regular walking behavior, positive peer influences, safety concerns, sidewalk availability and quality, and quality of overall walking environments. All individual items were loaded to only one primary factor with either moderate (0.58 and 0.49 for two factors) or high loadings (>0.60 for five factors). Cronbach's alpha was used to examine the internal consistency, and showed relatively low reliability (0.50 and 0.60) for children's and parents' personal barriers, and adequate (>0.70) or good (>0.80) reliability for five other factors. In total, the seven factors accounted for 57.5% of the variance in all individual items.

Correlates of Walking to or from School

For the four multivariate logistic regressions, the Nagelkerke R^2 was used as an estimate for the percentage of variance explained by each model and the comparison of four models. Although the predictive efficiency is not strong, using this pseudo-R^2 appears reasonable for comparing and exploring the model-fit differences among multiple nested logit models. The first model, with only sociodemographic variables, explained 4.8% of the variance in walking to or from school. In the second model, attitude and behavior variables were added, and they explained an additional 23.5% of the variance. In the third and fourth models, the additions of social and physical environmental variables increased the percentages of explained variance by 10.8% and 11.1%, respectively. The final full model showed an adequate fit ($P = 0.099$) and explained 51.4% of the variance (Table 4).

In the final model, from the personal factors, parents' highest level of education and household car ownership (proxies for SES) were negative correlates (odds ratio (OR) = 0.821 and 0.712, respectively). The number of family members was a positive correlate (OR = 1.134). Children's barriers was a factor captured by "having too much to carry" and "getting too hot and sweaty while walking,"

Table 4: Personal, social, and physical environmental correlates of walking to or from school (adjusted)[†]

Correlates (adjusted)	*Coefficient*	*Standard error*	*Odds ratio*	*Confidence interval (95%)*
Personal sociodemographic factors (explains 4.8% of variance)				
Child's gender (0=female, 1=male)	−0.198	0.109	0.820	0.662–1.016
Child's grade level	0.023	0.032	1.023	0.961–1.089
Hispanic ethnicity (0=no, 1=yes)	−0.098	0.167	0.907	0.654–1.257
Parents' highest education level (range: 1–7)	−0.197***	0.043	0.821***	0.755–0.893
Single-parent status (0=no, 1=yes)	−0.195	0.129	0.822	0.638–1.059
Number of family members	0.126**	0.040	1.134**	1.048–1.227
Household's car ownership	−0.339***	0.071	0.712***	0.620–0.818
Personal attitudes and behaviors (explains 23.5% of variance)				
Parents' personal barriers (*factor*)	−0.875***	0.063	0.417***	0.369–0.471
Child's personal barriers (*factor*)	−0.059	0.054	0.943	0.848–1.049
Parents' and children's positive attitudes and regular walking behaviors (*factor*)	0.422***	0.057	1.525***	1.364–1.706
Social factors: school and peer influences (explains 10.8% of variance)				
School bus availability (0=no, 1=yes)	−1.201***	0.150	0.301***	0.224–0.404
Positive peer influence (*factor*)	0.175**	0.061	1.192**	1.057–1.343
Physical environmental factors: perceived safety and walkability (explains 11.1% of variance)				
Distance close enough (0=no, 1=yes)	1.390***	0.127	4.014***	3.128–5.150
Safety concerns (*factor*)	−0.253***	0.056	0.776***	0.695–0.867

Table 4 *(continued)*

Correlates (adjusted)	*Coefficient*	*Standard error*	*Odds ratio*	*Confidence interval (95%)*
Presence of physical barriers (0=no, 1=yes):				
Highway or freeway	−0.485*	0.192	0.616*	0.422–0.898
Busy road	0.094	0.117	1.098	0.873–1.382
Intersection without a painted crosswalk	−0.268	0.149	0.765	0.572–1.024
Sidewalk availability and quality (*factor*)	0.044	0.059	1.045	0.930–1.173
Quality of overall walking environment (*factor*)	0.108	0.060	1.114	0.991–1.252
Presence of land uses *en route* (0=no, 1=yes):				
Convenience store	−0.548***	0.149	0.578***	0.432–0.774
Bakery/café/restaurant	−0.131	0.197	0.878	0.596–1.292
Office building	−0.536*	0.203	0.585*	0.393–0.872
Vacant lot	0.016	0.155	1.016	0.750–1.377
Large parking lot	0.072	0.143	1.074	0.812–1.423
Presence of bus stop *en route* (0=no, 1=yes)	−0.305*	0.122	0.737*	0.580–0.936
Time of survey† (0=April 2007, 1=November 2007)	−0.398	0.529	0.672	0.238–1.895
School membership†				
Highland Park Elementary School	−1.152*	0.546	0.316*	0.108–0.921
Mills Elementary School	−1.100*	0.494	0.333*	0.127–0.876
Blanton Elementary School	−1.009**	0.373	0.365**	0.176–0.757

† A set of dummy variables was entered into the model to indicate the student's school membership and the time of survey. For school membership variables, only those with significant results are listed in this table.
*$P<0.05$; **$P<0.01$, ***$P<0.001$.

and was not significant. However, parents' personal barriers (a factor captured by time constraint, convenience of driving the child to/from school, and perception of walking as requiring too much planning ahead) were a negative correlate (OR = 0.417). In addition, the factor capturing parents' and children's positive attitudes (walking being good for exercise and interaction, and being "cool" and enjoyable) and regular walking behavior were a positive correlate (OR = 1.525).

Social factors were also important. The child was less likely to walk (OR = 0.301) if the school provided bus service. The factor for positive peer influences (other children's and parents' regular walking behaviors) was a positive correlate (OR = 1.192).

For the physical environmental factors, a child was about four times more likely to walk if the parent perceived the distance to be close enough for the child. Parents' safety concerns (range: −2.8 to 2.0) and the need to cross highways or freeways were negative correlates (OR = 0.776 and 0.616, respectively). The factor for sidewalk availability and quality (maintenance, width, buffers from traffic, and no obstructions) was not significant. Another factor for overall walking environments, captured by maintenance, tree shade, quietness, street lighting, and perceived convenience of walking, was marginally significant (OR = 1.114, $P < 0.1$). The presence of bus stops (OR = 0.737) and certain features such as convenience stores (OR = 0.578) and office buildings (OR = 0.585) *en route* were negative correlates.

Analysis of the school membership variables showed that three schools were negatively associated with walking (OR = 0.316, 0.333, and 0.365, respectively). The time of survey was not significant.

Disparities in Perceived Environmental Support for Walking

To explore the disparity issues, bivariate correlations between parents' highest education (a proxy for SES) and each significant environmental correlate of walking to or from school were examined (Table 5). Parents with higher education were more likely to perceive the distance to school to be close enough for their children to walk (OR = 1.078, $P < 0.001$). The most-educated group (graduate or professional degree) was about 46% more likely to perceive the

Table 5: Bivariate correlations between socioeconomic status[†] and significant physical environmental correlates of walking to or from school

Physical environmental correlates of walking to or from school	*Coefficient*	*Standard error*	*Odds ratio*	*Confidence interval (95%)*
Distance close enough (0=no, 1=yes)	0.075***	0.021	1.078***	1.035–1.124
Safety concerns (*factor*)	−0.008	0.010	N/A	N/A
Presence of highways/freeways *en route* (0=no, 1=yes)	−0.087**	0.029	0.916**	0.866–0.970
Presence of convenience stores *en route* (0=no, 1=yes)	−0.005	0.022	0.995	0.953–1.040
Presence of office buildings *en route* (0=no, 1=yes)	0.196***	0.028	1.217***	1.152–1.285
Presence of bus stops *en route* (0=no, 1=yes)	−0.089***	0.021	0.915***	0.878–0.954

[†] Parents' highest education level was used as a proxy for the family's socioeconomic status, and was used to predict each physical environmental factor that showed significant association with walking to or from school.
**$P<0.01$, ***$P<0.001$.

distance to be walkable than was the least-educated group (6th grade or less). Parents' perception of safety was not associated with their level of education. Further, for children of well-educated parents, the route to school was less likely to cross highways/freeways (OR = 0.916, $P < 0.01$) and to pass bus stops (OR = 0.915, $P < 0.001$) and more likely to pass office buildings (OR = 1.217, $P < 0.001$). The presence of convenience stores *en route* was not associated with parents' education.

DISCUSSION AND CONCLUSION

This study examined the correlates of walking to or from school among elementary school children in Austin, Texas, based on a social ecological perspective. It is one of few studies to examine the multilevel correlates comprehensively, using a relatively large and representative sample.

Limitations

Several limitations should be recognized. First, this is a cross-sectional study and offers no insights into the causal relationships among the variables. The sampling process was not completely randomized, and a few schools had low response rates. The reliability of several survey items is unknown. There is also potential non-response bias because parents/guardians of walking students may be more likely to return surveys than those of non-walkers. The impact of age and gender was somewhat diluted because some parents mixed their responses for different children, who went to the same school, when filling out the questionnaire. In addition, although the clustering effect by school was partially addressed using dummy variables, the risk for Type I error may still remain because of the reduced variations resulting from this clustering.

Despite these limitations, this study has several important implications for future research and policy interventions.

Contribution to the Literature

Among our study children, a 15-min walk appears to be acceptable for travel to school. The percentage of students in our survey who

walked to or from school (27.8% and 31.5%, respectively) is much higher than that found in a national survey, in which only 17% of 5- to 18-year-old children walked to or from school at least once per week (21). There are several possible reasons for this finding. The present study site consisted of urban and suburban areas that are generally more walkable than rural areas (32). A substantial portion of the respondents were from lower-income families with either no private vehicle (6.9%) or only one vehicle (35.6%). Parents or guardians of children who walk may also be more likely to return the survey.

Contrasting with previous studies (7,11,16,23,24), sidewalk quality and overall walking environments were not significant in this study, possibly due to differences in environmental awareness and perception between walkers and non-walkers. Most walking children were accompanied by parents. Therefore, these parents may be more aware of the environmental problems (such as poor maintenance and sidewalk obstructions), and may be more likely to report them in surveys. This raises an important question about the validity and interpretability of the environmental perception measures used in walking and physical activity research and the need to address the interactive nature of behavior, awareness, and perception.

The negative impact of convenience stores, office buildings, and bus stops in this study contradicts previous studies of adult populations (33), in which such mixed land uses showed positive influences. One explanation is that travel to school is based on a predetermined destination (school) and therefore, having other diverse yet irrelevant land uses may make the route appear less safe and attractive for children's use. Second, in our study area, many convenience stores are located within or next to gas stations, and typical office developments are large complexes with extensive surface parking. Such automobile-centered environments may be unsafe for pedestrians, especially children. Future research should consider not only the types of land uses but also how they are developed at the site level and integrated into the community. An overly simplified approach may lead to misunderstanding of the environment–behavior relationships.

The comparison between this study and the researchers' previous study (15) in this area raised an important question about the

difference between objective and subjective measures of the physical environment. In terms of the distance, the previous study, using the *objective* measures, found that higher-SES students lived farther away from their school (15). However, the current study found the reverse of this association in terms of the *perception* of walkable distance and SES (using parental education as a proxy). It is speculated that the *perception* of acceptable walking distance may be confounded by safety, maintenance condition of the environment, and the availability of alternative travel options such as private vehicles. For safety, the previous study, using the *objective* measures, showed higher-SES schools had much lower vehicular crash and overall crime rates in their attendance areas (15). However, the current survey showed that SES was not associated with parents' *perception* of safety. In addition to the different units of analyses (school attendance areas for the previous study vs. individuals in this study), one explanation is that parents' *perceptions* may be exaggerated beyond the actual danger when it comes to their children's school transportation.

Implications for Public Policies

This study also has important implications for policy interventions. First, it highlights the limitations of current policies related to the selection of school locations (7,34) and the determination of schools' attendance areas. Centrally located neighborhood schools with barrier-free attendance areas can help remove impediments to walking to and from school, such as long distances or the need to cross a highway. Policy change is needed where minimum acreage requirements, school funding formulas, and building codes favor the development of new schools over the renovation of existing neighborhood schools. School consolidation policies should be re-examined for their impact on school transportation. Since 2003, three states have eliminated their minimum acreage requirements for new schools (26). It is worthwhile to follow up and examine the impact of such policy changes. It should also be noted that current efforts in creating safe routes to school using federal and local funding (23,24,35) focus on infrastructure improvements but do not change the way schools are located and developed. Without ensuring an appropriate school location and a walkable distance, improving

sidewalk or street crossing conditions will have limited impact on walking.

Second, this study confirms the importance of safety improvement (19,21,22) as one of the foremost action items for policy and environmental interventions in promoting walking among children. Stronger political support is needed to allocate sufficient funding for traffic calming, traffic management, construction and renovation of non-motorized transportation facilities, and other safety improvement projects, especially in areas around schools and in "hot spots" with high crash rates or poor infrastructure conditions. In previous interventions, sidewalk gap closures and replacing four-way stops with traffic signals have had a positive impact on encouraging walking to school (23,24). Policy support is also needed for programs such as the "Walking School Bus"; this approach involves parents or other volunteers leading a group of students as they walk to/from school, and thereby helps to overcome parental safety concerns and time constraints (36). The potential of this program is underscored by the finding that 75% of children who walked to/from school in this study were accompanied by a parent or guardian.

Third, in terms of the "big picture," decision making for school travel is a complex process involving multiple and interactive considerations. Policymakers should employ multi-level interventions and collaborate with multiple agencies. School developments or renovations should involve all stakeholders (school districts; transportation, planning, and health departments; parent–teacher associations; and other neighborhood organizations) and carefully consider the cost of school transportation.

Finally, disparities in school transportation require immediate attention and action. Compared to the children who do not walk, those who walk to/from school are more likely to come from lower-SES families and to live a distance from school that their parents consider to be non-walkable. These lower-SES children may be forced to walk because of limited access to private vehicles and because their parents work longer hours and have less flexible schedules. These disparities are further exaggerated by the fact that lower-SES and minority children have disproportionate exposure to traffic (14), pedestrian injuries (37), air pollution (38), other environmental hazards (39), and risk of obesity (2,3). Previous

efforts in New Zealand have shown that areas with higher rates of child pedestrian injury and lower SES were underrepresented in the "Walking School Bus" programs (36). Future interventions should give a high priority for targeted policy and environmental interventions in lower-SES areas. Examples include subsidized "Walking School Bus" programs and the allocation of federal and local funding for traffic-calming and pedestrian infrastructure improvements in these high-risk areas.

Acknowledgements: The authors acknowledge Chris Moore and other personnel in the city of Austin, Texas and the Austin Independent School District for their help with the survey. Preparation of this study was supported by a grant from the Robert Wood Johnson Foundation Active Living Research Program.

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