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Household interactions and children's school travel: the effect of parental work patterns on walking and biking to school

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Abstract

This study evaluates how household interactions affect walking and biking to school. The cross-sectional research design uses a representative sample of trips to school by US youth ($n = 8231$) to test how parental employment status and commute patterns affect non-motorized travel. Results from a binary logit model show that young children (5–14) with mothers who commute to work in the morning are less likely to walk or bike to school after controlling for individual, household, and neighborhood factors. Policymakers may therefore want to create programs that allow parents to share chaperoning responsibilities for the school trip to address parental time constraints.

Keywords: Children; School; Walk; Bike

1. Introduction

From 1980 to 2002, the proportion of overweight children aged 6 to 19 tripled in the United States (Ogden et al., 2006). At the same time, levels of physical activity have declined. To combat these trends, policymakers in the United States have set a goal of having 50% of children with trips of less than one mile walk to school by 2010 (US Department of Health and Human Services, 2000). Efforts to achieve this have focused on improving the infrastructure for walking and biking and educating students about non-motorized options. However, there has been less consideration of how household interactions, particularly coordination between parents' work and children's school schedules, affect the decision to walk and bike to school.

Previous research in childhood geography and travel behavior suggests that intra-household connections place strong constraints on what activities people can participate in and how they can get there. Understanding these constraints is critical to creating effective interventions aimed at increasing walking to school. The goal of this study is to consider how household interactions affect non-motorized travel to school to see if policies beyond infrastructure and education might be important strategies for achieving national goals for walking to school. Specifically, this study asks: (1) who children travel with on the school trip and (2) how parental employment status and work travel patterns influence children's walking and biking to school.

I find evidence that the work status of mothers – but not fathers – is associated with walking and biking to school. Specifically, children whose mothers work full time and commute to work in the morning are less likely to walk or bike to school than students with mothers not leaving for work in the morning. This suggests that parental time constraints need to be addressed if policymakers hope to increase rates of active school travel. The following sections provide an overview of current research on children's travel, describe the study methodology, and present research findings. The final section of the paper explores how policy options for increasing walking and biking to school can accommodate parental time constraints.

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2. Children's travel

Rates of walking to school vary widely across the globe. Less than 15% of US schoolchildren walked or biked to school in 2001 (Martin and Carlson, 2005). This compares with a walking rate of approximately 50% for British children in 1999–2001 and 27% of children in Melbourne, Australia in 1993–1996 (Ampt, 1996; Pooley et al., 2005). There have been well-documented declines in walking to school in the United States and the United Kingdom in recent decades (McDonald, 2007; Pooley et al., 2005).

Part of the decline in walking to school may be related to an overall decrease in children's independent spatial mobility. In their seminal study, Hillman et al. (1990) showed that English schoolchildren had less travel freedom in 1990 than in 1971. In 1970, 94% of 10 and 11 year old British children were allowed to walk to school unaccompanied by an adult (Hillman et al., 1990). By 1990 the number was 54% and in 1998 the number was 47% (O'Brien et al., 2000). This suggests that parents are changing their definition of when it is safe to let a child walk to school unaccompanied.

Other studies have also found a decline in independent travel, but have shown that context moderates the effects. O'Brien et al. (2000) found that children's freedom was higher in a lower-density new town than London. Similarly, Kytta (1997) showed that Finnish children in rural areas had more travel freedom than peers in a city and small town.

This decrease in travel freedom may be associated with parental concerns about traffic dangers and the risk of abduction or harassment (Beuret and Camara, 1998; diGiuseppi et al., 1998; Martin and Carlson, 2005; Surface Transportation Policy Project, Transportation and Land Use Coalition, & Latino Issue Forum, 2003; Tranter, 1996). Parents of younger children (5–11 years) may be most concerned with these issues. For example, over 40% of the parents of primary school-aged children reported that their children faced traffic obstacles; closer to 30% of parents of older children listed this as a barrier (Dellinger, 2002). Geographers have noted that safety concerns have led parents to limit the time children spend playing in public spaces, and the safety-imposed restrictions are more severe for girls than boys (Valentine, 1997b).

Walking rates for children are also affected by individual-level factors, particularly age and sex. Girls are less likely to walk than boys are with the differences being most prominent at younger ages (Evenson et al., 2003; McMillan et al., 2006; O'Brien et al., 2000) and in suburban areas (Vliet, 1983). Household factors such as car ownership affect mode choice (Bradshaw and Atkins, 1996; diGiuseppi et al., 1998). The built environment appears to exert a small, but significant, effect on walking to school. In a study of Oregon middle schools, Schlossberg et al. (2006) found that urban form – as measured by higher intersection densities and lower proportions of dead-ends – was associated with walking to school. McMillan's (2007) study of California elementary students found a modest relationship between urban form and walking. Boarnet et al. (2005) and Staunton et al. (2003) have shown that changes in the built environment, such as sidewalk and street crossing improvements, can make students more likely to walk to school. Analyses of walking by youths aged 5–18 in the Atlanta region found that the effect of urban form factors such as intersection density, residential density, and mixed land uses on walking was moderated by household vehicle access and income (Kerr et al., 2007). In that study, youth from families with more vehicle access and higher incomes exhibited stronger associations between walking and urban form.

2.1. Household interactions

Analyses of travel suggest the presence of children has a strong effect on adult travel patterns. Jones (1979) showed that a small change in school starting time affected the travel patterns of every household member. Rosenbloom (1987) found that the presence of children had a stronger effect on maternal, as opposed to paternal, travel behavior. More recently, modelers have attempted to use household interactions to predict activity scheduling and tripmaking (see *Transportation* 32(5) for a review of current intra-household modeling efforts). Travel models that incorporate household interactions have shown that the presence of children affects adult activity and travel scheduling (Gliebe and Koppelman, 2005). While this research confirms that household interactions are important to understanding travel behavior, the computational intensity of the models has often led to a focus on adult behavior or a limited set of activities.

An exception to this is the work of Vovsha and Petersen (2005) and Yarlagadda and Srinivasan (2007). Using data from Atlanta, Vovsha and Petersen (2005) found that 40% of children are escorted on the way to school and 35% on the way home and household females were most likely to escort children. They found that having a school within walking distance did not reduce demand for escorting in the morning (although it did in the afternoon). However, their analysis only considered automobile trips. Yarlagadda and Srinivasan (2007), in a sample of San Francisco Bay Area households, found that mothers traveling to work were less likely to walk their children to school and more likely to drive them. The travel behavior of fathers had less influence.

3. Methodology

3.1. Design and sample

This study uses a cross-sectional research design to explore the importance of household interactions on children's school travel. Chi-square tests and binary logit models identify the role of household interactions in rates of walking and biking to school for a national sample of

US youth. Data for the analysis come from the National Household Travel Survey (NHTS), a population-based, random-digit dial phone and mail survey which captures information on all trips undertaken by household members on a designated survey day as well as socio-demographic information (for complete details of survey design see the NHTS User's Guide (US Department of Transportation, 2004)). The survey, which was collected by contractors to the US Department of Transportation between March 2001 and May 2002, gathered information on 66,000 households in the United States and had a weighted person-level response rate of 34.1%. This analysis focuses on 8231 children between the ages of 5 and 18 who traveled between home and school on the morning of the survey day and for whom complete household socio-demographic information including number of vehicles owned, household size and composition, and household income are available.

3.2. Measures

The primary unit of analysis is the child's trip tour between home and school. School destinations were determined by a trip purpose of "go to school as a student." For each child, we compiled information on their trip to school, household demographics, and neighborhood characteristics. If the survey recorded multiple tours between home and school for a child, only the first tour was used in the analysis.

3.2.1. Trip characteristics

Following Cervero and Duncan (2003), distance between home and school is the primary measure of the trip. In the 2001 NHTS, distances were self-reported in either blocks or miles. Following Agrawal and Schimek (2007) who showed that the standard NHTS coding of short trip distances is inaccurate because many trips of less than a half mile are coded as "0 miles", I recoded any trip reported as "0 blocks" to 0.055 miles (based on the NHTS' assumption that a block is 1/9 of a mile) and recoded trips reported as "0 miles" to 0.25 miles (using the midpoint of the interval from 0 to 0.5 miles). For cases where students made intermediate stops between home and school, trip distance was calculated as the sum of the distance for each unlinked trip between home and school.

3.2.2. Individual, household, and neighborhood characteristics

The child's age and sex were the primary measures of individual characteristics. In the NHTS, only the race of the first household respondent – often the mother or father – is recorded. Therefore race and ethnicity were measured at the household level. Information on household income and number of vehicles per licensed driver were also extracted from demographic questions. The DOT contracted with Claritas, Inc. to add a measure of residential density at the block group level. Because this was a national survey, it was impossible to obtain richer measures of local land use.

3.2.3. Household interactions

The NHTS gathers information on relationships among all household respondents making it possible to identify mothers and fathers (or primary guardians) for each child. Trip records also indicate which family members were on the trip and whether any non-household members accompanied the child. For definitional purposes, children riding the school bus were classified as traveling with non-household members.

Information on mother and fathers' work status, occupation, education, and distance to work were incorporated into the children's travel records. Data on parents' travel mode to work and time departing for work on survey day were also included using two dummy variables for each parent: mother/father travels to work in am and mother/father travels to work in pm (reference category: mother/father not in paid labor force). Mother/father travel to work in am equated to the parent traveling to work before 10 am on the survey day. Data on siblings, including the number of siblings, and ages of oldest and youngest sibling, were also calculated and included in the final dataset.

3.3. Analysis

Chi-square analyses were used to examine the relationship between travel mode to school, travel companions for the school trip and mother's work status. Binary logit models of children's non-motorized school travel (defined as walking or biking) were also computed to more directly control for individual, household and neighborhood-level covariates. Variables were included in the final model if they were significant at the 90% level or if there was a strong theoretical reason for keeping them in the model. Separate models were estimated for elementary and middle school students (ages 5–14) and high school students (ages 15–18) due to expected behavioral differences (Evenson et al., 2003; Hillman et al., 1990). Person-level sample weights supplied by the DOT were applied to account for the stratified survey sampling design.

For the binary logit models, only students living within 3 miles of their school (representing 93% of walking and 99% of biking trips to school) were included in the analysis. This criteria, which follows Cervero and Duncan's (2003) approach in studying adult walking behavior, ensured only trips which could reasonably be completed by walking or biking were studied. In addition, only children from two-parent households were considered in the binary logit models in order to assess the differential impact of mothers and fathers on children's active school travel. These restrictions reduced the sample size to 4059 students from 2579 households. The presence of siblings in the sample required the use of robust coefficient standard errors to account for correlations in behavior between children from the same household.

3.3.1. Interpreting model results

Coefficients from logit models tend to be uninformative at face value; therefore odds ratios, marginal effects, and predicted probabilities are presented. The odds ratio represents how much a 1 unit change in the independent variable will affect the likelihood of walking or biking versus not walking or biking. Marginal effects represent the effect of a 1 unit change in the independent variable on the probability of walking or biking (Ben-Akiva and Lerman, 1985). This study reports the average marginal effect by computing effects for each variable at the individual-level and then averaging over the sample. Several authors have shown this is preferable to computing the effects on the 'average individual' because of the non-linear shape of the probability curve (Ben-Akiva and Lerman, 1985; Train, 2003). The predicted probability of walking for certain variables of interest, e.g., parental work status, are also presented to give a sense of the absolute effects.

4. Results

The students in this sample make 55% of their trips to school via the private automobile; school buses are the other dominant mode, accounting for 31% of trips. Walking accounts for 12.5% of trips; biking represents 0.8%. Modal patterns vary substantially across the country (Fig. 1). Walking rates are highest in the western United States with the Pacific and Mountain census divisions having 18% of students walking to school. The lowest rates of walking, 1%, were reported in the East South Central division that includes Alabama, Kentucky, Mississippi, Tennessee, Virginia, and West Virginia.

Data on travel companions reveal that students make 11% of school trips by themselves. Within the household, mothers are most likely to be the child's travel companion (30%) and are very likely to drive children to school. Fathers (11%) and siblings (6%) are also important travel companions. Children make a large portion of trips

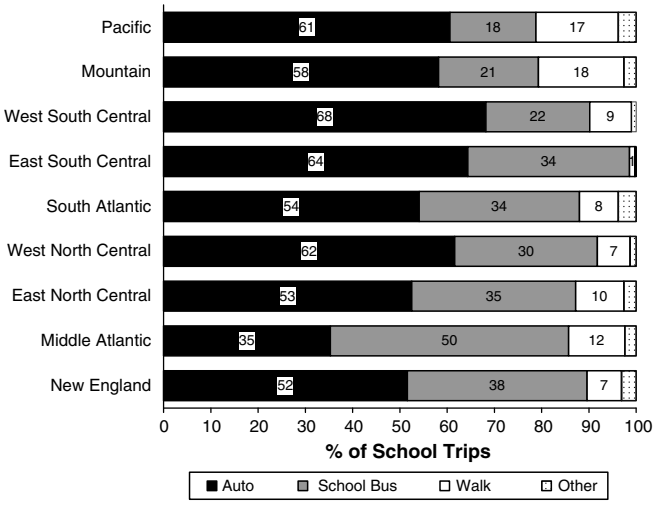

Fig. 1. School trip mode choice by census division.

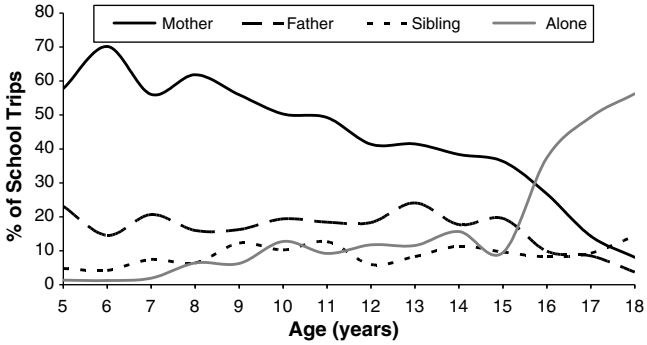

Fig. 2. Children's school trip travel companions (excluding school bus trips). Note: Percentages exclude trips made on the school bus. Does not show the 'other' category that includes trips taken with other household adults, and non-household members.

(40%) with non-household members, generally on the school bus.

The importance of household interactions in mode choice for school trips is strongly moderated by the child's age (Fig. 2). Until children reach driving age, they rely heavily on their mothers. These findings confirm results from earlier studies that showed that mothers had primary responsibility for children's travel (Rosenbloom, 1987; Rosenbloom and Burns, 1993). Once students reach driving age, they are much more likely to travel by themselves because they have access to automobiles but also because they have permission to travel further on their own (Hillman et al., 1990; Valentine, 1997b). The proportion of trips made with fathers does not vary strongly with age again showing the differences in paternal and maternal travel behavior.

Combining children's travel mode with companionship information shows that mothers drive 27% of children to school; this is second only to the school bus in mode/companionship share (Table 1). Table 1 also reveals that mother's work status strongly influences whether children

Table 1
School trip mode choice and companionship by mother's work status

	Mother employed	Mother homemaker
Auto		
With mother	27.8%	27.0%
With father	12.2	12.1
With sibling	4.1	2.7
Other	14.1	11.8
Walk		
With mother	0.5	5.2
With father	0.3	0.7
With sibling	2.2	3.6
Other	5.8	5.8
School bus	30.8	29.5
Public transit	1.1	1.0
Bike	1.0	0.6
Total	100	100
N	4618	2619

Note: Only includes children from two-parent households. Other includes non-household members and traveling alone.

walk to school. In two-parent households, children of mothers employed outside the home exhibit different modal choice ($\chi^2 = 74.27$, df = 5, $p < 0.0001$) and companionship patterns ($\chi^2 = 39.89$, df = 4, $p < 0.0001$) than children whose mother is a homemaker. Differences in walking rates account for most of the variation in behavior between children whose mothers are at home and those working outside the home. While the overall walking rate differs significantly (8.8% vs. 15.2%, $\chi^2 = 70.08$, df = 1, $p < 0.0001$) between the groups, the most striking difference occurs for walking trips made with mothers. Children of mothers in the paid labor force make 0.5% of their school trips by walking with their mothers, while children whose mothers are at home make 5.2% of trips to school by walking with their mothers ($\chi^2 = 158.31$, df = 1, $p < 0.0001$).

4.1. Binary logit model

Before considering the effect of household interactions on school travel, it is useful to review the effects of trip, individual, household, and neighborhood factors to see how they correspond to previous research. The models of non-motorized travel to school show that a critical factor in walking to school is trip distance (Table 2). Each mile of distance between home and school decreases the probability of walking or biking to school by 21% points for elementary and middle school students and 14 points for high school students. These findings confirm results from studies in Australia (Timperio et al., 2006), Oregon (Schlossberg et al., 2006), Florida (Ewing and Greene, 2003), California (McMillan, 2007), England (Black et al., 2001), and the United States (McDonald, 2008a) which also found distance to be a critical factor.

Holding all other factors constant, walking rates increase by 2% points per year as children age which concurs with the findings of previous research (Hillman et al., 1990; Joshi and Maclean, 1995). The effect is only significant in children 5–14. For older students, having a driver's license decreases the probability of active travel by 9% points. Because such a large proportion of older students are licensed this means that the likelihood of walking plateaus or declines during high school. Other individual covariates were also important. For 5–14 year olds, girls were less likely to walk to school with being female decreasing the probability of walking by 5% points. There was no effect of gender for high school students. This finding supports the results of previous studies of gender and school travel in younger children (Hillman et al., 1990; McMillan et al., 2006).

The odds of walking to school increase by a factor of 3.2 for Hispanic students aged 5–14. Other minorities are also more likely to walk to school than whites are, but those coefficients are on the margin of statistical significance ($p = 0.10$). In a detailed analysis of the effects of race and ethnicity on active school travel, McDonald (2008b) found that racial differences may be best explained by automobile access and household income.

The density of the local neighborhood (defined as the block group) has a significant positive association with

Table 2
Binary logit model coefficients, odds ratios, and marginal effects

	Elementary and middle school (5–14 years old)				High school (15–18 years old)			
	Odds Ratio	*p* (coefficients)	Marginal effects	*p* (marginal effects)	Odds Ratio	*p* (coefficients)	Marginal effects	*p* (marginal effects)
Trip distance (miles)	**0.10**	0.000	**−0.209**	0.000	**0.05**	0.000	**−0.136**	0.000
Age (years)	**1.22**	0.000	**0.018**	0.000	1.50	0.125	0.018	0.123
Female	**0.57**	0.014	**−0.051**	0.013	1.45	0.442	0.017	0.429
Number of siblings	0.96	0.744	−0.004	0.744	**1.46**	0.036	**0.017**	0.035
Driver's license					**0.14**	0.005	**−0.090**	0.009
African–American	2.03	0.098	0.070	0.121	0.48	0.447	−0.029	0.403
Asian	3.13	0.098	0.119	0.139	2.91	0.345	0.055	0.396
Latino/hispanic	**3.23**	0.013	**0.124**	0.030	3.62	0.211	0.068	0.283
Multi-racial	1.57	0.236	0.043	0.259	2.86	0.250	0.054	0.309
Vehicles per driver	0.92	0.781	−0.007	0.781	0.56	0.397	−0.026	0.396
HH income ($000)	0.99	0.187	0.000	0.184	0.99	0.592	0.000	0.586
Father travels to work in am	2.27	0.064	0.070	0.048	1.25	0.728	0.010	0.727
Father travels to work in pm	1.79	0.221	0.055	0.242	2.58	0.309	0.045	0.348
Mother travels to work in am	**0.42**	0.002	**−0.077**	0.002	1.95	0.180	0.029	0.188
Mother travels to work in pm	0.68	0.196	−0.033	0.180	0.80	0.742	−0.010	0.736
Residential density (000)	**1.02**	0.031	**0.002**	0.027	**1.05**	0.002	**0.002**	0.002
Constant	0.83	0.853			0.03	0.400		
N	3212				847			
LL	−988.06				−150.38			
$\chi 2$	160.50				126.62			
Pr($\chi 2$)	<0.001				<0.001			
Pseudo *R*2	0.410				0.552			

Note: Sample includes children from two-parent households with trips of less than 3 miles to school. Dummy variables for census region and survey month were included in the models as control variables but are not reported here. Please contact the author if interested. Bold indicates significance at the 95% level.

active travel for younger and older students. For example the reference person living at New York City-type densities (~25,000 people per square mile) would have a predicted probability of walking or biking to school of 15%; the same person living at Atlanta-like densities (~3000 people per square mile) would have a 11% likelihood of active commuting for the same length trip. This confirms findings in adult travel that density has a modestly positive association with the amount of walking (Cervero and Kockelman, 1997; Ewing and Cervero, 2001; Lee and Moudon, 2006).

4.1.1. Household interactions

The model shows that household interactions are important in the decision to walk to school. Specifically, the probability of younger children walking or biking to school decreases by 8% points when their mother commuted to work in the morning. In contrast, high school students were more likely to use active modes when their mothers went to work although the effect was not statistically significant. Children of mothers who held jobs outside the home but did not leave for work in the mornings did not experience a statistically effect on their active travel.

The work and travel behavior of fathers had a less significant impact on students' use of active modes for school travel in either model. For elementary and middle school students, having a father that travels to work in the morning increases the likelihood of walking to school by 7% points, but the estimated coefficient is at the edge of statistical significance ($p = 0.06$). It is not clear from theory or other empirical evidence why this is the case.

These findings suggest that mothers traveling to work in the morning find it more convenient to drop younger children at school on their way to work rather than walking with them. McMillan (2007) in a survey of elementary school primary caregivers found that the convenience of driving for parents decreased walking and biking to school. Data from the United Kingdom also showed that convenience was a primary reason for dropping children at school (Bradshaw, 1995; Joshi and Maclean, 1995). Considering over 90% of work trips are made by auto and there are 1.06 cars per licensed driver in this country (Hu and Reuscher, 2004), it is not surprising younger children are less likely to walk when their mothers have to get to work. The data also show that the mother's work trip had either no effect or actually increased non-motorized travel for older children. This finding reflects the increased independence of high school students and the importance of driving. It seems likely that a mother who drives to work makes it less likely that a vehicle will be available for the teen; this requires them to find an alternate means of getting to school.

To better understand how the mother's commute affects children's behavior, Fig. 3 shows the probability of walking or biking to school for trips of different distances when the mother travels to work in the morning, the mother commutes to work in the afternoon, or the mother is not in the paid labor force. All other factors are held at their mean. The graphs demonstrate that elementary and middle school students with mothers who leave for work in the morning ("AM Commuters") have the lowest probability of non-motorized travel.

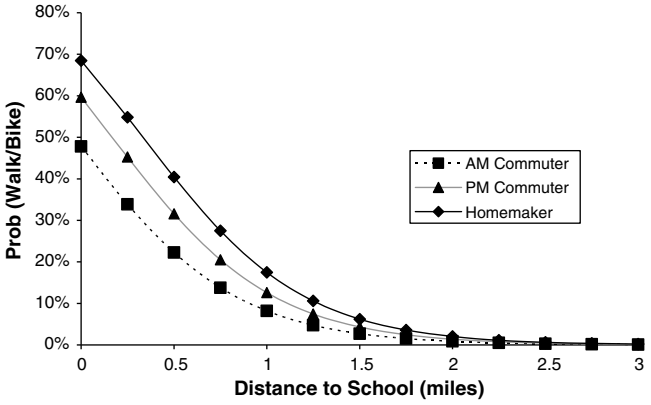

Fig. 3. Predicted probability of active travel to school by mother's work and commute status for elementary and middle school students.

Having siblings is associated with higher rates of walking and biking for high school students, but there is no significant effect for elementary students. Our original hypothesis was that children with more siblings would be more likely to walk and bike across all ages. The data do not support this hypothesis that may reflect the declining importance of the sibling caretaker in today's middle-class families (Valentine, 1997a).

5. Conclusions

This study shows that across the United States: (1) household interactions are important because children make nearly half of their school trips with a family member and (2) the commute patterns of the mother is significantly associated with walking and biking to school for children aged 5–14. These finding extend previous research showing mothers often have primary responsibility for children's travel (Raux and Rosenbloom, 1986; Rosenbloom, 1987; Rosenbloom and Burns, 1993) and that parental convenience is an important criteria for mode choice (Bradshaw, 1995; Joshi and Maclean, 1995; McMillan, 2007).

The implication of these findings is that policymakers and advocates wishing to increase pedestrianism among youth need to consider options that address parental time constraints. Current policies designed to increase active commuting to school, e.g. SR2S, focus on engineering improvements to increase safety along the route to school. While this is certainly a necessary step, it may not be sufficient to increase walking rates. SR2S programs may be more effective when they couple engineering and safety improvements with programs that reduce the need for parents to accompany their children to school. One program that may accomplish this is the walking school bus where parents share responsibility for taking a group of children from their neighborhood to the school (Martin and Carl-

son, 2005). By taking turns escorting children to school, parents are able to minimize the required time. Several areas have embraced this program (although some schools have noted liability concerns (Baker, 2004)). However, walking school buses do little to increase children's independent mobility (Kearns et al., 2003).

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