SafeRoutes
National Center for Safe Routes to School

Trends in Walking and Bicycling to School from 2007 to 2012

October 2013

The National Center for Safe Routes to School

U.S. Department of Transportation
Federal Highway Administration

Acknowledgments

The National Center for Safe Routes to School would like to express its appreciation to the Federal Highway Administration for supporting the development and continuance of the data collection and reporting system. We also wish to extend our thanks to the State SRTS Coordinators who championed the creation of a standardized data system and promoted its use such that the system is relevant and useful to countless organizations and communities nationwide. Of course, the National Center also wants to thank the multiple regional and local users of the data system for devoting their time and energy in providing quality data contributing toward the advancement of the Federal SRTS program. Finally, special thanks should be given to Dr. Raghavan Srinivasan at the University of North Carolina Highway Safety Research Center for his invaluable guidance in carrying out the study's design and analysis.

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Executive Summary

The Federal Safe Routes to School (SRTS) program was created with the enactment of the SAFETEA-LU transportation legislation in August 2005. In May 2006, the National Center for Safe Routes to School (National Center) was established with funding from the Federal Highway Administration (FHWA). Shortly thereafter, under the direction of FHWA, the National Center created standardized data collection instruments and began offering data processing services to all schools that collected school travel data using the instruments. These data provided a unique opportunity to analyze school travel patterns and to acquire an understanding how school- and household-level factors might have influenced school travel mode choices. This report describes a series of analyses involving parent survey data collected by schools throughout the United States starting in the year 2007 and through 2012. After linking parent survey data with school-level information from the National Center for Education Statistics, more than 525,000 parent surveys from nearly 4,700 schools located within all states and the D.C. were included in the analyses.

To examine student travel patterns and parental perceptions of active school travel over time, multinomial logit models which clustered responses by school were estimated. These models estimated the probability of choosing school travel modes as a function of school-level and household-level predictor variables. School-level variables included school income and the Census-defined locale in which a school was located. Household-level variables included students' sex and grade in school, distance the student lived from school, parents' level of education, whether the student asked parents for permission to walk or bicycle between home and school, how much fun parents perceived walking and bicycling to be for their child, how healthy walking and bicycling was for their child, and how much their child's school supported walking and bicycling to/from school.

Key findings from the analyses include:

- Walking to and from school increased significantly between 2007 and 2012. From 12.4% to 15.7% in the morning; and from 15.8% to 19.7% in the afternoon.
- Although walking increased among students who attended low-, medium- and high-income schools, walking increased especially among students who attended low-income schools (defined as enrolling 75% of students who were eligible to receive free or reduced price meals).
- Boys and girls were equally likely to walk to/from school.
- There was a small but significant decrease in bicycling to school between 2007 and 2012, from 2.6% to 2.2% in both the morning and afternoon.
- Boys were twice as likely to ride a bicycle to/from school as were girls.
- Busing decreased significantly between 2007 and 2012. Within one mile of school, the largest shift between travel modes occurred between busing and walking, with busing decreasing significantly and walking increasing significantly.
- Between 2007 and 2012, the percentage of parents who stated that their child's school supported walking and bicycling between home and school increased from 24.9 to 33 percent.

Additional findings include:

- Riding a bus to/from school most commonly occurred in rural areas.
- Being driven was most likely to occur in low- and medium-income schools located in cities.
- Younger students were most likely to be driven to school.
- Students attending low-income schools were the most likely to walk to/from school, whereas students attending high-income schools (defined as enrolling fewer than 40 percent of students who were eligible to receive free or reduced price meals) were the most likely to bicycle to/from school.
- Although schools located in suburbs, towns, and rural areas witnessed higher rates of walking over time, walking increased especially at schools located in cities.

Results from this study provide useful information about student travel patterns and parental perceptions about active school travel among a sizable population of schools around the country. Study results suggest several promising ways to promote safe walking and bicycling between home and school.

Potential ways include:

- Building upon the observed gains in walking;
- Leveraging school support for walking and bicycling by working with schools to frame active school transportation in positive ways to students and families; and
- Encouraging families to discuss traveling to school using travel modes other than the car.

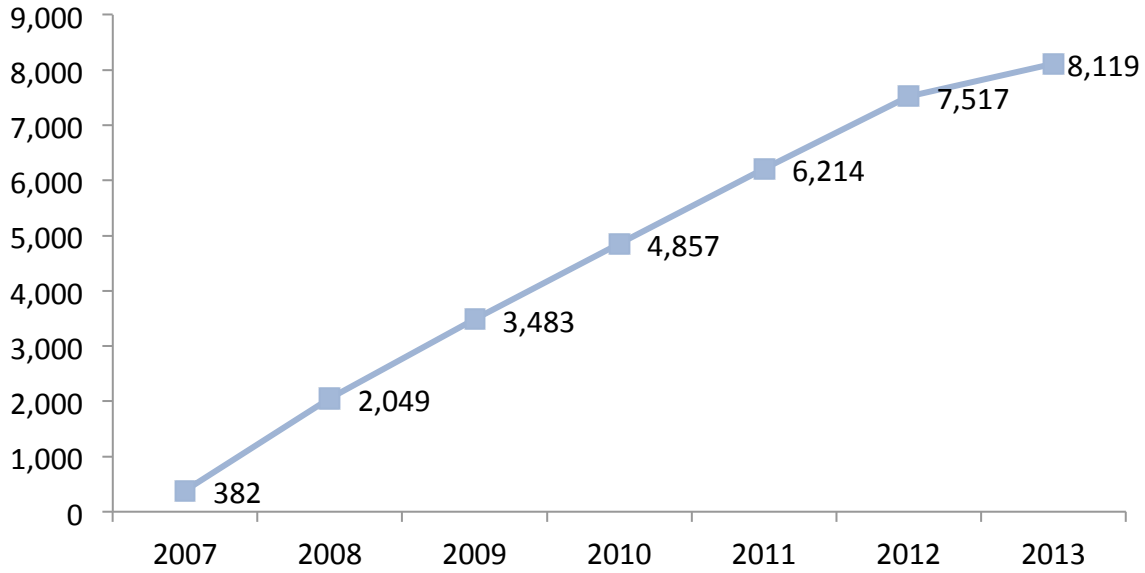
Study Context and Background

The *Safe Affordable Flexible Transportation Equity Act: A Legacy for Users (SAFETEA-LU),* the transportation legislation that created the Federal Safe Routes to School (SRTS) program, was enacted in August 2005. By the following year, the Federal SRTS program's Clearinghouse had been selected, most States had established full-time State SRTS Coordinator positions, and several States were in the process of developing means of evaluating the impacts of their SRTS programs. Elements of an effective and efficient Federal program were coming together. Meanwhile, the National Center for Safe Routes to School (National Center), under the direction of the Federal Highway Administration (FHWA), recognized the opportunity to create and put forth an evaluation program that would provide State SRTS Coordinators standardized school travel data collection forms and a centralized data management system.

The National Center sought to make collecting school travel information useful to a broad audience of local and regional SRTS stakeholders, State SRTS Coordinators and their colleagues, academic researchers, as well as FHWA and its federal partners. Thus, with support from FHWA, the Centralized Data Collection and Reporting System (Data System) was launched in early 2007. To complement the data system and provide evaluation-based guidance to local SRTS practitioners, the National Center (2008) published the *Evaluation Guide for Community SRTS Programs.*

Use of the Data System grew quickly. By the end of the first year that the system was offered, a total of 382 schools entered or sent parent survey and travel tally data to the National Center for entry. The following year, the number of schools using the Data System grew to 2,049, and by the end of 2012, this figure increased to 7,517 schools. As of September 1, 2013, a total of 8,119 schools from all 50 states and D.C. have used the Data System (Figure 1). Schools entered or submitted data to the National Center for a variety of reasons. Some schools collected parent survey data to satisfy state requirements to apply for SRTS funding. Others collected data to answer specific research questions, such as the extent to which a sidewalk project may have influenced students' participation in active school travel. Therefore, while the degree to which schools promoted walking and bicycling to school or related actions to address safety concerns is not known, it seems reasonable to assume that data-submitting schools were more likely to have an interest in Safe Routes to School and walking and bicycling to school compared to US schools in general. It should be noted that not all schools included in the following analyses set out to increase walking and bicycling (i.e., some aimed to address safety concerns first and foremost).

Figure 1. Number of data entering and submitting schools (2007-September 2013).



The National Center's (2010) first report using the national school travel data, was, *Safe Routes to School Travel Data: A Look at Baseline Results.* The *Baseline Report* provided insight into school travel patterns, including: the fact that distance to school is negatively associated with walking and bicycling; that family vehicle and schools bus are the most frequently used travel modes; and that though most students arrived at school in the family vehicle, many of these students shifted to riding the school bus or walking when traveling home from school. Two years later, the *Baseline Report* was followed with a multiple case study called, *Shifting Modes: A Comparative Analysis of SRTS Program Elements and Travel Mode Outcomes* (National Center, 2012a). In the *Shifting Modes* report, travel tally results and interviews with local program coordinators were used to explore how school-level planning and implementation of SRTS programs related to the percentage of students who walked and bicycled between home and school. This study found that successful SRTS programs were likely to possess four key program elements: (1) they identified an in-school leader to champion SRTS; (2) they conducted activities that reinforced walking and bicycling (e.g., frequent walker/bicyclist programs); (3) they generated parent support for SRTS; and (4) they established policies that support walking and bicycling to/from school (e.g., earlier dismissal for students who walk or bicycle home from school). More recently, the National Center's three-part *Getting Results* series showcased dozens of local programs that have reduced car traffic, speeding and distracted driving in proximity of schools, as well as those that have documented measurable increasing in walking and bicycling using the parent survey and travel tally instruments (National Center 2012b).

Given that thousands of schools have collected parent survey information over the course of several years, an exploration of trends in school travel patterns and parental perceptions related to walking and bicycling to/from school could be conducted. The primary aim of these exploratory analyses is to examine travel patterns and parental perceptions involving students enrolled in grades K through 8 whose parents completed parent surveys from the years 2007 through 2012.

The report discusses the following:

- How the study sample was derived and how data were prepared for analysis;
- Information included in the analysis;
- The modeling approach used to estimate changes in student travel patterns and parental perceptions of active school travel;
- Study results including descriptive and representative analyses;
- Modeling results that estimate the probability of walking, bicycling, riding the bus, being driven and using some other travel mode between home and school;
- Results from modeling sub-analyses which depict interactions between school mode choice and student- and household-level variables, including distance to school, students' sex, students' grade level in school, and school-level income;
- Modeling results pertaining to parental perceptions of walking and bicycling to/from school; and
- A discussion of the results' implications for the Safe Routes to School program in particular, and for active school travel more generally.

Methods

The analysis for this report used data derived from the parent survey instrument and information maintained by the US Department of Education's National Center for Education Statistics (NCES). Analysis began by linking parent survey data stored in the student travel database with school-level information maintained by NCES using unique school identifiers. School-level data gathered from the NCES included US Census-defined locale—which refers to a school's physical proximity to an urbanized area, or region with a densely settled core with densely settled surrounding area—(NCES, n.d.), school enrollment figures, and the proportion of students who are eligible to receive free or reduced price lunch, among other variables.

The National Center successfully matched 5,340 or 82 percent of all schools which had parent survey data in the database collected by the end of 2012. Of these 5,340 schools, 4,691 schools enrolled students in Kindergarten through eighth grade—grades which represent the primary focus of the Federal Safe Routes to School program—and included more than 10 valid parent surveys during any given time period of data collection. Schools submitted an average of 106 surveys per time period. Surveys and NCES information pertaining to these 4,691 schools are included in the following analyses.

Data preparation

After matching parent survey data collected at the 4,691 study schools with school-level information maintained by the NCES, three steps were performed to prepare the data for analysis. First, the schools were placed into three categories according to the percentage of each school's students who were eligible to receive free and reduced priced meals (FRPM) in 2011: low-income, medium-income, and high-income schools. Drawing upon work conducted by California's Safe Routes to School Technical Assistance Resource Center (TARC, 2010), low-income schools were defined as those schools where 75 percent or more of their students were eligible to receive FRPM; medium-income schools as those where between 75 and 40 percent of their students were eligible to receive FRPM; and high income schools as those where 40 percent or fewer of their students were eligible to receive FRPM.

Second, parents' perceptions about the degree to which their child's school supported walking and bicycling to/from school, as well as the extent to which parents thought walking and bicycling were healthy and fun for their child were collapsed into binary "agree" and "do not agree" categories. This was done to enhance interpretability of non-committal responses (i.e., "neutral" or "neither" responses).

The third and last step in data preparation involved collapsing four travel mode categories into two more inclusive categories. Specifically, the "family vehicle" and "carpool", as well as the "transit" and "other" response options were collapsed into "car" and "other" categories, respectively. These mode choices were combined in the analysis to improve the statistical power of estimation, and because combined, transit and "other" modes typically represent less than one percent of choices in school travel mode.

Data analysis and model estimation

Data analysis proceeded in three steps. First, descriptive statistics depicted school-level information including the study schools' locale and the percentage of students eligible to receive FRPM. The descriptive analysis also captured household-level information including how far the students lived from school, students' sex and grade in school, and parents' level of education.

The descriptive analysis is followed by an assessment of the representativeness of schools that submitted or entered data into the online data and reporting system. To examine representativeness, data-submitting schools were compared to school information maintained by NCES (i.e., schools' locale and income level) and to survey results derived from the 2009 National Household Travel Survey (i.e., students' distance from school) **(**McDonald, Brown, Marchetti, & Pedroso, 2011**),** which included a nationally representative sample of U.S. households.

Descriptive and representative analyses are followed by an exploration of school travel patterns and parental perceptions of walking and bicycling to school over time. School travel mode selections were estimated using multinomial logit models which clustered responses by individual schools. Multinomial logit is an efficient statistical method to study the selection of mode choices (Ashalatha, Manju, & Zacharia, 2013). However, this method relies on an assumption known as the independence of irrelevant alternatives (IIA). The IIA assumption implies that the relative odds between any two modes are not affected by the availability or the characteristics of another mode. Although there are statistical tests to test this assumption, these tests themselves have been criticized (e.g., Maddala, 1998). Nonetheless, a Hausman test detected no violation of the IIA assumption (χ^2 (93) = 15.51, p = 1.000). Still, a series of binary logit models were estimated as a way to corroborate the results from the multinomial logit models. The comparison between the results from these two methods is presented Appendix I. The results from the multinomial logit and the binary logit models are almost identical. Hence, it was concluded that the results from the multinomial logit models were quite reliable.

The models were estimated using Stata MP v. 13 program software (StataCorp, 2013). Across all multinomial logit model estimates, school-level predictors and household-level predictors were regressed onto the probability of using one of five mode categories: walk, bicycle, bus, other, and car (Table 1).

Table 1. Variables used in the analyses.

Variable Type	Explanation	Response Options
Outcome		
Arrival	"On most days, how does your child arrive and leave for school?"	Walk; Bike; School Bus; Family vehicle; Carpool; Transit; Other
Departure	"On most days, how does your child arrive and leave for school?"	Walk; Bike; School Bus; Family vehicle; Carpool; Transit; Other
Predictor		
Locale	U.S. Census defined locale in terms of how populated an area is and how far away from a population center it is located.	City; Suburb; Town; Rural
School income	The percentage of students enrolled in a school who were eligible to receive free or reduced price meals as of 2011.	N/A
Distance	"How far does your child live from school?"	Less than ¼ mile; ¼ mile up to ½ mile; ½ mile up to 1 mile; 1 mile up to 2 miles; More than 2 miles
Sex	"Is the child who brought home this survey male or female?"	Male; Female
Grade	"What is the grade of the child who brought home this survey?	Grade (K, 1, 2, 3…)
Education level	"What is the highest grade or year of school you completed?"	Grades 1 through 8; Grades 9 through 11; Grade 12 or GED; College 1 to 3 years; College 4 years or more; Prefer not to answer
Asked permission	"Has your child asked for permission to walk or bike to/from school in the last year?"	Yes; No
Fun	"How much fun is walking or biking to/from school for your child?"	Very Fun; Fun Neutral; Boring; Very Boring
School support	"In your opinion, how much does your child's school encourage or discourage walking and biking to/from school?"	Strongly Encourages; Encourages; Neither; Discourages; Strongly Discourages
Healthy	"How healthy is walking or biking to/from school for your child?"	Very Healthy; Healthy; Neutral; Unhealthy; Very Unhealthy
Year	Year in which survey was completed	2007 - 2012

Results

Descriptive analysis

All analyses derive from responses using 525,493 parent surveys collected at 4,691 schools across all states and D.C. As seen in Table 2, the majority of students attended schools in city and suburban locations, rather than in town and rural areas. Additionally, most students in the sample attended high- and medium-income schools. About one third of students lived beyond two miles from school and nearly a fifth of students lived with ¼ mile from school. In terms of age, students included in the study sample were concentrated in grades K through 5 and constituted nearly 80 percent of the sample. Slightly more than half of the surveys pertained to female students, and more than 70 percent of parents attended college at some point.

Table 2. School-level and household-level sample characteristics.

		Percent	n
Locale			
	City	30.3%	159277
	Suburb	32.1%	168526
	Town	21.3%	111983
	Rural	16.3%	85708
School-level income			
	Low	14.8%	77563
	Medium	36.5%	191647
	High	48.8%	256283
Female		51.9%	272731
Male		48.1%	252762
Distance			
	< 1/4 mi	19.0%	100054
	1/4 - 1/2 mi	13.1%	68840
	1/2 - 1 mi	17.5%	91751
	1 - 2 mi	19.3%	101420
	> 2 mi	31.1%	163428
Grade in school			
	K	12.3%	64583
	1	13.3%	69996
	2	13.2%	69313
	3	13.9%	73149
	4	13.4%	70626
	5	12.7%	66633
	6	9.2%	48188
	7	6.6%	34577
	8	5.4%	28482

Parent level of education			
	Grades 1 through 8	5.1%	26905
	Grades 9 through 11	4.5%	23595
	Grade 12 or GED	18.1%	95009
	College 1 to 3 years	30.5%	160170
	College 4 years or more	41.8%	219866

Representative analysis

Relative to nationally representative schools, students attending data-submitting schools were more frequently located in city, suburban and town locations, in slightly higher income areas, and lived closer to school as evident from Figures 2 through 4. These findings suggest that the following results may not readily apply to schools located in rural areas with lower income student populations.

Figure 2. U.S. Census-defined locale.

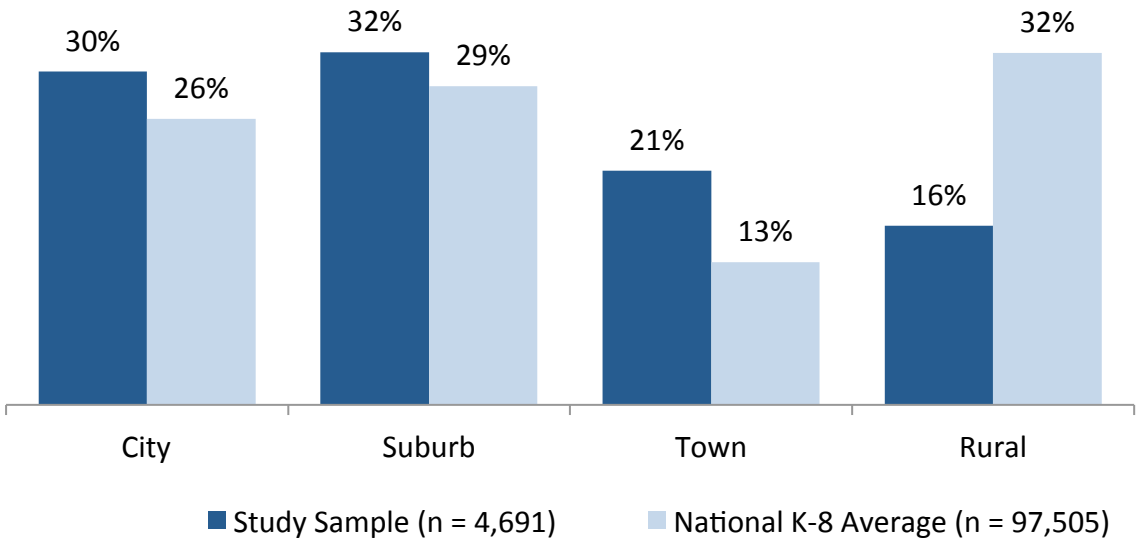


Figure 3. School-level income.

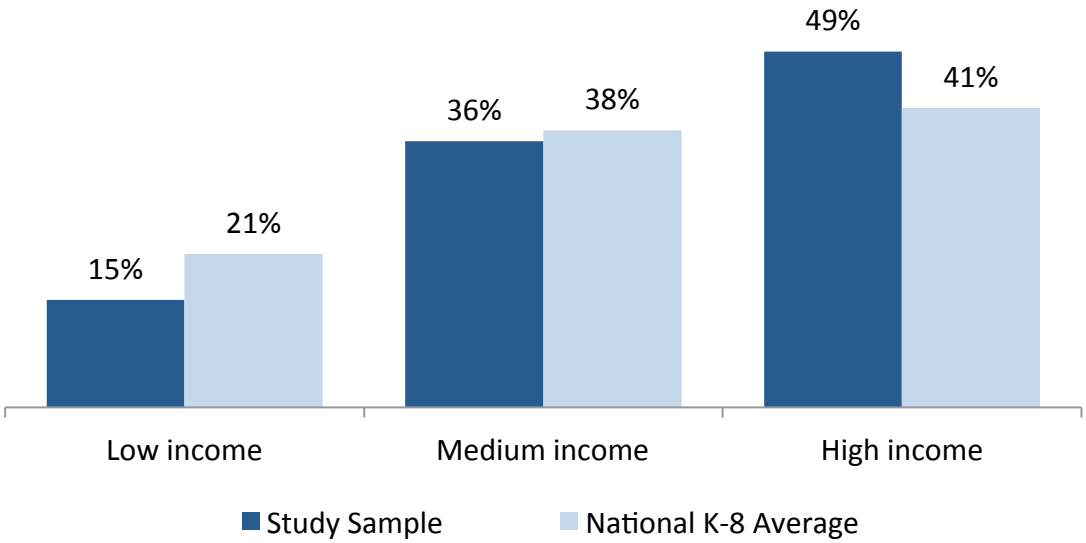
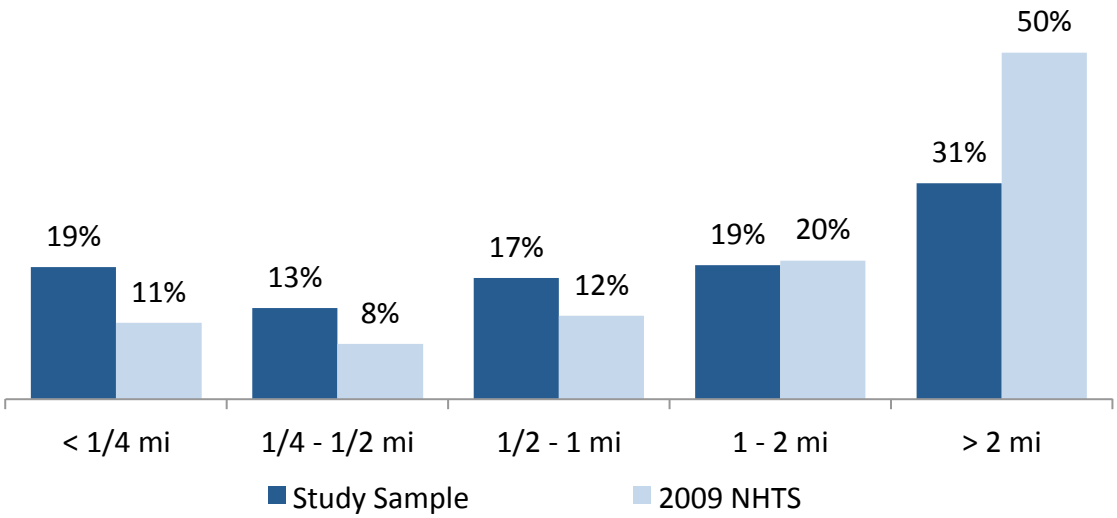


Figure 4. Distance from school.



Model estimates

Results derive from models that estimated the probability of walking, bicycling, riding a school bus, being driven in an automobile, or using some other travel mode in the both the morning and afternoon as a function of time, as well as school-level and household-level factors (displayed in Table 1). Data collected in 2007 and 2008 were combined in the analysis to account for the limited amount of data collected during those years. The following results provide predicted average marginal effects values for the different modes by year based on the multinomial logit models shown in Appendices F and G.

As seen in Figures 5 and 6, walking increased significantly between 2007-08 to 2012, from 12.4 to 15.7 percent in the morning, and from 15.8 to 19.7 percent in the afternoon. At the same time, busing decreased substantially, from 32.9 to 27 percent in the morning, and from 38.4 to 31.9 percent in the afternoon. Being driven to school increased moderately, from 51.3 to 54.7 percent in the morning, and from 42 to 45.3 percent in the afternoon (see Figures 5 and 6, as well as Appendix F and G for model output).

Considering general arrival and departure patterns, distance from school was strongly and negatively associated with walking and bicycling to/from school. Indeed, students living beyond ½ mile from school were only 16.3 percent (95% C.I. = 0.156 – 0.170) as likely as students living within ½ mile from school to walk. Student living beyond one mile from school were 48 percent (95% C.I.: 0.438 – 0.526) more likely to bicycle to school as those living within one mile of school. All else equal, older students (i.e., those in grades 6 through 8) were significantly more likely to walk and bicycle to school as younger students (i.e., students in grades K through 5). Boys were more than twice as likely to bicycle to school as were girls. Children who asked for permission to walk or bicycle to school were much more likely than children who did not ask for permission to walk and bicycle to school. Perceived school support for walking and bicycling was strongly predictive of walking and bicycling. Similarly, perceived enjoyment of walking and bicycling was predictive of walking and bicycling. However, perceived school support was most predictive of walking, whereas perceived enjoyment was most predictive of bicycling.

Busing was much more prevalent in rural areas and among children living farther from school. Older students were slightly more likely than younger students to ride a bus to school. There was no significant difference in the probability of riding a bus to/from school among students attending low and medium-income schools. Students whose parents had higher levels of education and who attended high-income city schools were most likely to ride in a car to school.

To provide insight into interactions between school travel over time and additional influential factors, several sub-analyses were collected. These analyses included interactions among school travel mode trends and: (1) distance to school, (2) students' sex, (3) their grade level in school, and (4) school-level income. Results from each of these sub-analyses are presented in the following sections. Within these sub-models, various interactions which examined the simultaneous influence of two variables on the outcome of mode choice were estimated. These included such interactions as those between students' sex and grade in school, and their combined impact on mode choice. Other interactions involved those between schools' locale and income level, and these variables' combined influence on mode choice. These sub-models were

not included in this report for the sake of brevity; nonetheless, their results are described in the following sections, as well as in Appendix B through E.

Figure 5. Arrival at school: 2007-8 to 2012.

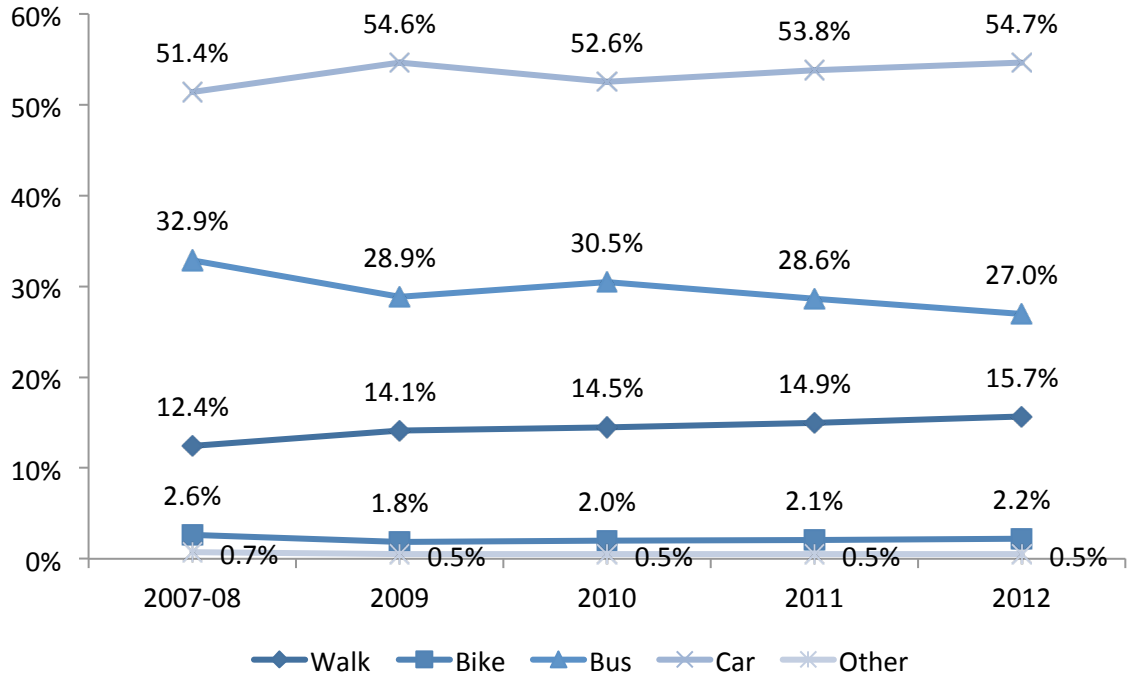
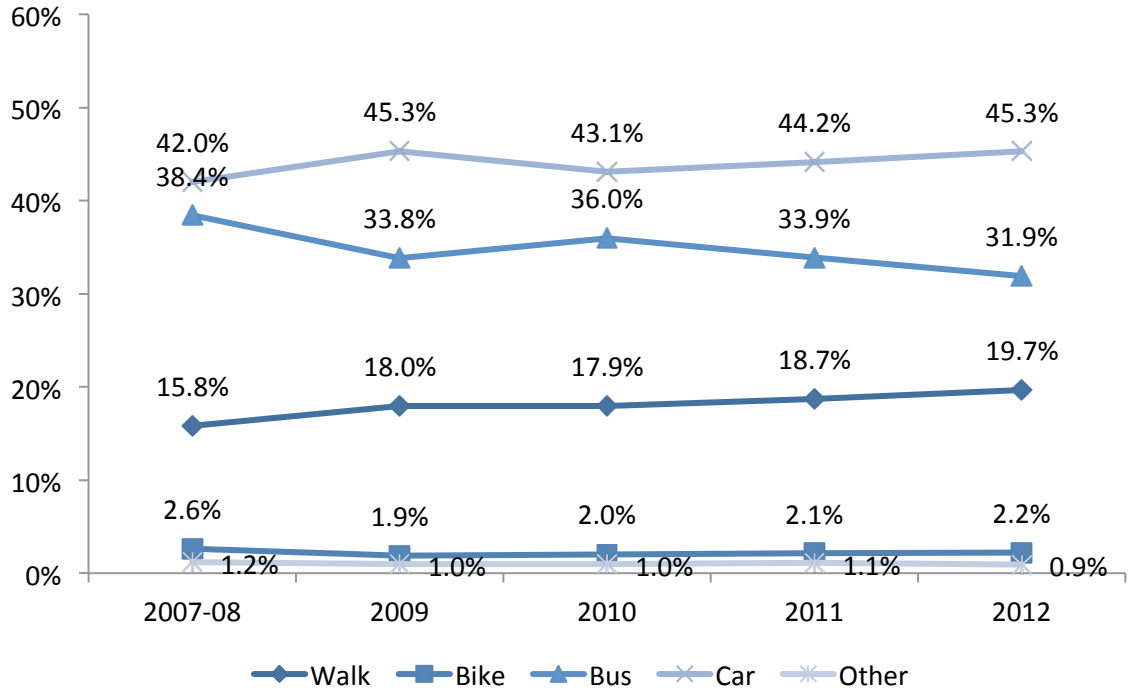


Figure 6. Departure from school: 2007-08 to 2012.



Distance from school

Within one mile of school. Among students living within one mile of school:

- Walking to/from school increased significantly between 2007-8 and 2012, from 23.8 to 29.4 percent in the morning, and from 29.4 to 35.3 percent in the afternoon.
- Bicycling between home and school decreased slightly yet significantly, from 4.4 to 3.7 percent in the morning and afternoon between 2007-8 and 2012.
- Busing decreased significantly, from 16.9 to 12.2 percent in the morning, and from 21.5 to 15.4 percent in the afternoon.
- Being driven to school remained stable at about 54 percent in the morning and 44 percent in the afternoon (Appendix B).
- Walking to school was much more likely to occur in cities compared to suburbs, towns, and rural areas. However, walking home from school was equally likely in cities and suburbs.
- Further, older students were the most likely to walk and bicycle to/from school.
- With respect to bicycling, students attending schools in cities and rural areas were equally likely to bicycle between home and school. Additionally, boys were more than twice as likely to bicycle to/from school as girls.
- Riding a bus to/from school was significantly more likely among older students who attended schools in towns and rural areas.

Between one and two miles of school. Among students living students living between one and two miles from school:

- Walking increased from 2.6 percent in 2007-08 to 3.3 percent in the morning, and from 4.6 to 6 percent in the afternoon between 2007-08 and 2012.
- Bicycling to/from school remained stable at around 2 percent.
- During this period, busing decreased significantly from 40.8 to 34.7 percent in the morning, and from 48.2 to 40.3 percent in the afternoon.
- Walking was most prevalent among those students attending low-income schools in city and suburban areas. However, walking home from school was equally likely among students attending schools located in cities, suburbs, towns, and rural areas.
- On the other hand, bicycling to/from school was most prevalent among students attending medium- and high-income schools in city locations.
- Parental perceptions of school support for active school travel predicted walking and bicycling between home and school, yet parents' report of enjoyableness was more strongly associated with bicycling.
- Within one to two miles from school, boys were nearly 2.5 times as likely to bicycle to/from school as were girls.
- Being bused to and from school was more prevalent at schools located in suburban, town, and rural areas, rather than in cities.

Beyond two miles from school. Among students living more than two miles from school:

- The proportion of students walking to and from school remained stable at about 0.6 percent and 1.7 percent, respectively.
- The same is true of bicycling, which remained at 0.3 percent to/from school between 2007-08 and 2012.
- Busing to/from school decreased significantly from 52.9 to 44.9 percent in the morning and from 58.8 to 51.1 percent in the afternoon during the study period, while being driven to/from school increased significantly from 45.5 to 53.7 percent in the morning, and from 38.4 to 45.9 percent in the afternoon.
- Students attending low-income schools in city, suburbs, and town locations were equally like to walk to school.
- Attending schools in low-income town locations was most predictive of walking home from school.
- Older male students attending high-income city schools were most likely to bicycle between home and school, whereas riding a bus to/from school was more likely at high-income schools located outside of cities (i.e., suburbs, towns, and rural areas).

Travel patterns among male and female students

- During the study period, the proportion of girls walking to and from school increased significantly from 12.3 to 15.5 percent, and from 15.8 and 19.3 percent, respectively.
- Older girls attending low-income schools in cities who asked permission to walk or bicycle were the most likely to walk to/from school.
- Parental perceptions of how much fun, how healthy, and how much their child's school supported walking and bicycling also strongly predicted walking between home and school.
- Conversely, older girls attending medium- and high-income city schools were most likely to bicycle to/from school.
- Unlike the case with boys, parents' education level was not predictive of bicycling among girls.
- Girls who asked for permission and parents' perception of enjoyableness and school support strongly predicted bicycling among girls.
- The proportion of boys walking to/from school increased from 12.5 to 15.8 percent in the morning, and from 15.9 and 19.6 percent in the afternoon between 2007-08 and 2012.
- Older boys attending low-income schools in cities who asked permission to walk or bicycle were most likely to walk to/from school.
- Parental perceptions of how much fun, how healthy, and how much their child's school supported walking and bicycling also strongly predicted walking between home and school.
- Similarly, older boys attending city schools were most likely to bicycle to/from school. Yet unlike walking, bicycling was most prevalent among boys who attended high-income schools.
- Boys who asked for permission and parents' perception of enjoyableness for their child strongly predicted bicycling among boys (Appendix C).

Grade in school

Younger elementary school-aged students (grades K – 2). Among students in Kindergarten through 2nd grade:

- Walking increased significantly from 12.5 to 15.7 percent in the morning, and from 14 to 17.1 percent in the afternoon between 2007-08 and 2012.
- Bicycling to/from school wavered between 1.5 and one percent in both the morning and afternoon.
- Busing decreased significantly, from 29.6 to 24.6 percent in the morning, and from 34.7 to 29.2 percent in the afternoon.
- Riding in a car increased slightly from 55.6 to 57.7 in the morning, and from 48.6 to 51.3 percent in the afternoon.
- Walking to/from school occurred predominantly in low-income city and suburban locations and among children whose parents reported positive perceptions of walking and bicycling.
- Among younger children, boys attending high-income city schools and whose parents perceived bicycling as enjoyable were most likely to bicycle between home and school.
- Boys attending high-income schools located outside of cities were most likely to ride a bus to/from school (see Appendix D).

Older elementary school-aged students (grades 3 – 5). Among children in 3rd through 5th grade:

- Walking increased significantly, from 13.6 to 16.6 percent in the morning, and from 17.7 to 20.3 percent in the afternoon.
- Bicycling decreased slightly yet significantly, from 3.3 percent to 2.7 percent in the morning and afternoon.
- Busing decreased significantly from 32.3 to 25.8 percent in the morning, and from 38.3 to 31 percent in the afternoon.
- Being driven to/from school in cars increased significantly from 50.1 to 54.4 percent in the morning, and 39.5 to 45.1 percent in the afternoon between 2007-08 and 2012.
- Walking to school was most prevalent among boys who attended low-income schools in city locations. Conversely, walking home from school was equally likely to occur in cities, suburbs, towns, and rural areas.
- Bicycling to/from school was equally likely at high-income schools located in cities and rural areas among this age group.
- Boys were more than twice as likely to bicycle to/from school as girls.
- Parents' positive perceptions of walking and bicycling predicted these behaviors between home and school, especially perceived school support for walking and perceived enjoyableness for bicycling.
- Boys attending high-income schools in locations outside of cities were most likely to ride a bus to/from school.

Middle school-aged students (grades 6 – 8). Among middle school-aged students:

- Walking increased significantly, from 9.7 to 13.5 percent in the morning, and from 15.7 to 20.6 percent in the afternoon.
- Bicycling increased slightly, from 3.4 to 3.9 percent in the morning and afternoon.
- Busing decreased significantly from 41.3 to 31.1 percent in the morning, and from 46.6 to 36.2 percent in the afternoon.
- Being driven to/from school increased significantly from 44.6 to 51.2 percent in the morning, and from 33.1 to 38.6 percent in the afternoon.
- Walking to/from school was most prevalent among boys attending low-income city and suburban schools.
- Middle school-aged boys were 3.5 times as likely to ride bicycles to/from school as middle school-aged girls.
- Further, students attending city schools and whose parents reported positive perceptions of active school travel were most likely to bicycle between home and school.
  Middle school-aged boys attending high-income schools outside of cities were most likely to ride buses to/from school.

School-level income

Low-income schools. Among students attending low-income schools:

- Walking increased significantly from 21.8 to 27.6 percent in the morning and from 24.6 to 31.5 percent in the afternoon.
- Bicycling stabilized at about 0.8 percent in both the morning and afternoon.
- Busing decreased from 22.4 to 16.3 percent in the morning, and from 25.5 to 19.4 percent in the afternoon.
- The percentage of students riding in cars to/from school increased slightly in the morning (54 to 54.6 percent), and stabilized in the afternoon at about 47 percent.
- Older boys attending city schools whose parents had positive perceptions of walking and bicycling were most likely to walk to/from school.
- Older boys whose parents thought active school travel was enjoyable for their child were equally likely to bicycle between home and school in cities, suburbs, towns, and rural areas.
- Older students attending schools in rural areas were most likely to ride a bus to/from school (see Appendix E).

Medium-income schools. Among students attending medium-income schools:

- Walking increased significantly, from 10.6 to 13.2 percent in the morning, and from 14.2 to 17.4 percent in the afternoon.
- Bicycling decreased slightly from 2 to 1.7 percent in both the morning and afternoon.
- The proportion of students who rode a bus decreased significantly from 32.7 to 24.5 percent in the morning, and from 38.8 to 30.1 percent in the afternoon.
- Riding in cars to/from school increased significantly, from 54.1 to 60.1 percent in the morning, and from 44 to 49.9 percent in the afternoon.
- In the morning, walking especially increased among students attending city schools, whereas in the afternoon, more students attending schools in cities and suburbs walked home from school.
- Walking was strongly predicted by parents who reported positive perceptions of walking and bicycling to/from school.
- Bicycling to/from school was most prevalent among older boys who attended city schools and whose parents thought that their child enjoyed bicycling.
- Students attending rural schools were most likely to ride a bus to/from school.

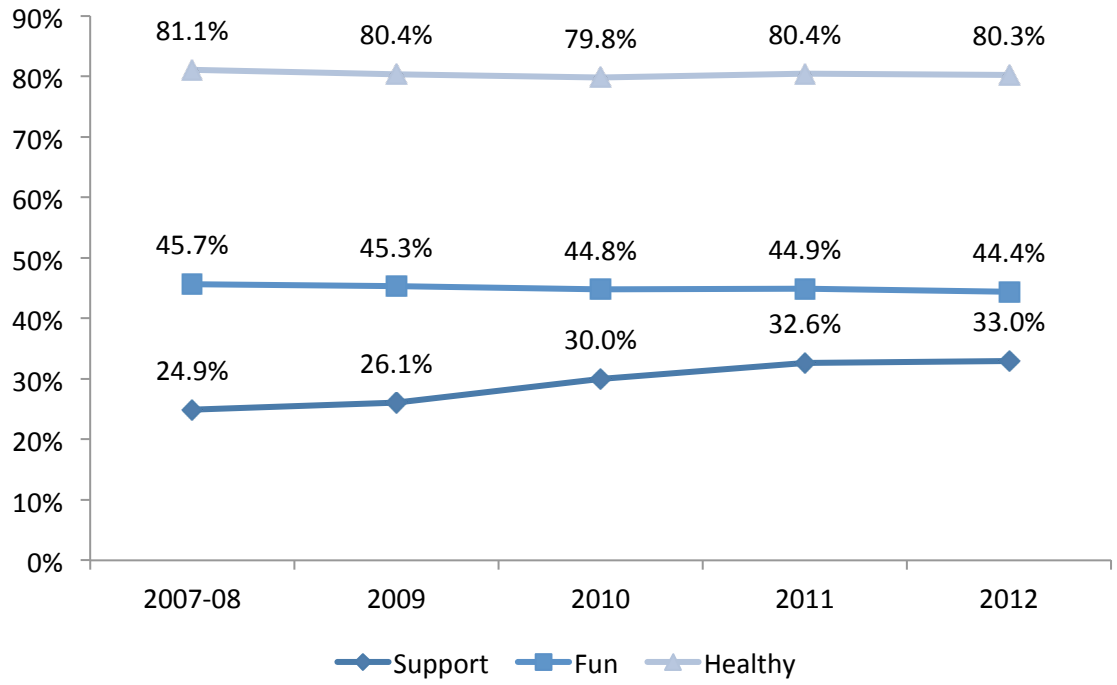
High-income schools. Among students attending high-income schools:

- Walking increased significantly from 11.6 to 14.2 percent in the morning, and from 15.1 to 17.3 percent in the afternoon between 2007-08 and 2012.
- Bicycling decreased from 3.5 to 3 percent in the morning and afternoon. Busing decreased significantly from 35.4 to 29.7 percent in the morning, and from 41.1 to 34.5 percent in the afternoon.
- Being driven to school increased significantly from 48.7 to 52.6 percent in the morning, and from 39.2 to 44.4 percent in the afternoon.
- Older students who lived closer to school and who attended schools located in cities were most likely to walk to school, whereas schools' location played less of a predictive role in walking home from school.
- Older male students attending city schools were most likely to bicycle to school, while school's location did not predict bicycling home from school.
- Among high-income schools, busing to/from school was most likely to occur outside of cities.

Parental perceptions of walking and bicycling

Between 2007-08 and 2012, parents' perceptions of active school travel remained fairly stable with one exception: the belief that students' schools supported walking and bicycling between home and school. Between 2007-08 and 2012, the percentage of parents affirming school support for active school travel increased significantly from 24.9 to 33 percent (Figure 7). A binary logit model which clustered responses by school and estimated the probability of affirming school support for active travel, revealed that support was more likely perceived by parents whose children were younger, lived closer to school, who walked to/from school, and who attended city schools. Further, parents who generally endorsed positive attitudes about active school travel were most likely to report school support for walking and bicycling (see Appendix H for model results).

Figure 7. Parental perceptions of walking and bicycling to/from school.



Discussion

This study explored school travel trends at 4,691 schools located in all 50 states and D.C. using responses from 525,493 completed surveys and school-level data maintained by the National Center for Education Statistics. Findings are quite positive for walking to school and provide encouragement for those who have been working to increase safe walking to school. Results also highlight noteworthy patterns among walking, bicycling, riding a bus, and being driven the school, as well as parents' perceptions of active school travel between 2007 and 2012.

Walking to and from school increased significantly between 2007 and 2012, from 12.4% to 15.7% in the morning, and from 15.8% to 19.7% in the afternoon. It especially increased among students who attended low-income schools located in cities. Boys and girls were equally likely to walk to and from school over the study period. Within one mile of school, the largest shift between travel modes occurred between busing and walking, with busing decreasing significantly and walking increasing significantly. Perhaps unsurprisingly, distance from school was the strongest predictor of walking and bicycling, with significantly less walking and bicycling occurring the farther students lived from school, which has been corroborated by past work (e.g., National Center, 2010; McDonald, et al., 2011). Several trends may have inspired greater awareness of, and participation in, walking among children. For example, during the study period, all states established Safe Routes to School programs and the number of schools participating in the Federal Safe Routes to School program grew from 1,833 to 13.863 (National Center, 2007 & 2012). Additionally, First Lady Michelle Obama's "Let's Move" campaign (Let's Move, 2013), which focuses on healthy eating and active living was instituted, and participation in International Walk to School Day increased from 2,760 to 4,281 (National Center 2007c & 2012c), to name just a few examples.

Unlike walking, bicycling to and from school decreased slightly but significantly between 2007 and 2012 (from 2.6 to 2.2 percent in the morning and afternoon). Students attending high-income schools located in cities were the most likely to bicycle to/from school. Older students were more likely to bicycle than younger students, and boys were twice as likely to ride a bicycle to/from school as were girls, a finding that is in keeping with previous research (e.g., McDonald, 2012). Considering school trips within one mile, bicycling to/from school was equally likely among students attending schools in cities and in rural areas. The decline in bicycling between home and school may be partially attributable to unobserved characteristics of the school communities that collected parent surveys in 2007 and 2008. That is, schools that collected parent surveys in the early days of the National Center's data system may have adopted SRTS more quickly than other schools. As a result, these early-adopting schools might have had a relatively large student bicycling population compared with schools that adopted SRTS later, therefore offering less of an opportunity for positive change during the study period. In other words, perhaps the "low hanging fruit" had been picked at the start. This "early adopter hypothesis" might partially explain why walking increased and bicycling decreased. Qualitative studies have found that parents tend to consider the quickest, most convenient ways to get their children to school (Ahlport, Linnan, Vaughn, Evenson, & Ward, 2008; Faulkner, Richichi, Buliung, Fusco, & Moola, 2010). Compared with walking—which under the right conditions can be done almost immediately and with relative ease—bicycling requires the acquisition of equipment and training in order to carry out. That is, children who wish to bicycle to and from school must have access

to a bicycle and helmet, must know how to ride, and must maintain the bicycle (e.g., by keeping a safe tire pressure and adjusting brakes). Despite this study's documented decrease in bicycling, there are reasons to believe that children and families are gaining interest: the first-ever National Bike to School Day event was held in May of 2012 with participation from 950 schools in 49 states and D.C.—by the following year, participation grew 80 percent to 1,705 schools in all 50 states and D.C. (National Center, 2012c/2013); "kidical mass" events—which engage children in safely riding a bicycle with members of their family and community—have been spreading rapidly throughout the country since their inception in Eugene, Oregon in 2008 (Kidical Mass, 2013); and the aforementioned Let's Move initiative was established during the study period.

As walking increased, busing to and from school decreased significantly between 2007 and 2012 (from 32.9 to 27 percent in the morning and from 38.4 to 31.9 percent in the afternoon). Within one mile of school, the largest shift between travel modes occurred between busing and walking, with busing decreasing significantly and walking increasing significantly. High-income schools documented higher school bus ridership than low- and medium-income schools. And riding a bus to/from school most commonly occurred in rural areas, where distances between home and school tended to be longer. One possible influence on the decrease in busing involved the cuts that school bus availability endured between 2008 and 2012. According to a survey conducted by the American Association of School Administrators (2012), the percentage of school districts that implemented bus transportation cuts grew from 10 percent in 2008-09, to 20 percent in 2009-10, 22.9 percent in 2010-11, and finally to 29.2 percent in 2011-12. The price of automotive diesel fuel—the fuel most often used by school buses—also rose sharply during the study period, from an average of $2.97 per gallon in 2007 to an average of $4.03 per gallon in 2012, a 35.6 percent increase (Bureau of Labor Statistics, 2013).

While travel by school bus dropped, being driven to and from school increased significantly between 2007 and 2012 (from 51.4 to 54.7 percent in the morning and from 42 to 45.3 percent in the afternoon). Students who attended low- and medium-income schools in city locations were the most likely to ride in cars between home and school. Further, younger students (i.e., those in Kindergarten through 2nd grades) were most likely to be driven, and girls living between one and two miles of school were more likely to be driven to school than boys living similar distances from school. Beyond two miles of school, the largest shift between travel modes occurred between busing and being driven, with busing decreasing significantly and being driven increasing significantly.

Parents' beliefs about walking and bicycling to/from school altered significantly during the study period. The percentage of parents who stated that their child's school supported walking and bicycling as a school travel mode increased significantly from 24.9 to 33 percent from 2007 through 2012. It appears that walking and perceived school support increased in tandem during this time. Though generally positive parental attitudes were associated with both walking and bicycling to/from school, walking was most closely associated with *perceived school support*, whereas bicycling was most closely associated with *perceived enjoyment* (i.e., fun). Children asking for permission to walk or bicycle also predicted both walking and bicycling to/from school, which suggests that active school travel represents a topic of conversation in many households, especially among those located within reasonable walking/bicycling distance of school.

Though this study offers valuable insights into school travel trends and associations between 2007 and 2012, it has some limitations. For one, travel patterns captured at the data-submitting schools do not necessarily reflect patterns at schools that did not submit data to the National Center, thereby limiting the generalizability of the study's findings. The schools that submitted and entered parent survey data ranged from those that collected data in order to apply for SRTS funds to those that collected data over multiple years in order to track their progress and identify areas in need of improvement. Moreover, given the study's national scope and exploratory structure, it remains uncertain as to the extent to which SRTS, active living, and health-related movements, as well as smaller scale built environment features, can be credited with the positive school travel outcomes seen in this study. Acquiring more detailed information on additional influencing factors, such as the types of countermeasures that were put in place and their timing as it relates to when data were collected, would help practitioners identify effective interventions and would better inform related policy decisions.

Nonetheless, results highlight several future research questions than can advance SRTS and active school travel. For example, why did bicycling decline over the study period? Is it because those schools that adopted SRTS earlier than average were over-represented in 2007-08 and therefore documented more bicycling than average? Further, why were boys twice as likely to bicycle than girls, and why were these differences even larger among older students (i.e., middle school-aged boys were 3.5 times as likely to ride bicycles to/from school as middle school-aged girls)? Moreover, how can SRTS stakeholders effectively promote walking, bicycling, and bus use as viable alternatives to driving? And how can practitioners adapt SRTS to address issues commonly experienced in rural areas? Students attending rural schools tend to live far from school: only 34.5 percent of students attending rural schools in this study lived within one mile of school, compared with more than 59 percent of students attending city schools. Programs that establish remote drop-off and pick-up locations and experiment with "walking at school" have potential to get more students in rural regions walking and bicycling and acquiring needed physical activity.

Study results also suggest at least three ways to promote walking and bicycling:

- The first way involves building upon the observed gains in walking. As more students walk between home and school, opportunities to develop walking school buses, "walking buddy" initiatives, and similar programs increase. It follows that as walking to school becomes a more accepted and normal daily activity, growing numbers of students are likely to walk (Murtagh, Rowe, Elliott, McMinn, & Nelson, 2012).
- The second way involves leveraging school support for walking and bicycling. In this study, perceived school support was strongly associated with walking to/from school. Institutions like schools can change or reinforce people's perceptions of 'what is possible, desirable and normal', a process known as policy feedback (Soss & Schram, 2007). Therefore, working with schools to discuss and frame active school transportation in positive ways has potential to reinforce and advance walking and bicycling to/from school.
- A third method of enhancing active school travel involves encouraging families to discuss traveling to school using travel modes other than the car. When children asked their parents for permission to walk or bicycle to/from school, they were much more likely to walk or bicycle than children who had not asked for permission. Beyond encouraging children to ask permission to walk or bicycle, SRTS practitioners should consider engaging families in identifying when, where, and how they will walk/bicycle between home and school: a process of creating "implementation intentions" (Gollwitzer, 1999). As an illustration, Bamberg (2000) found that encouraging college students to develop plans for when, where, and how they would use the local bus system significantly increased the students' later use of public transportation.

Conclusion

This study depicts school travel patterns at a sizable number of schools around the country. Student active travel patterns and parental perceptions of school support for walking and bicycling shifted in positive ways from 2007 through 2012. Greater numbers of students attending data-submitting schools walked to/from school and more parents believed that their child's school supported walking and bicycling as viable school commute options. On the other hand, bicycling decreased slightly yet significantly over the study period. Within a reasonable walking distance from school (i.e., one mile), busing decreased significantly while walking increased significantly over the study period. Study findings suggest that working with schools to build upon observed gains in walking and to frame active school travel in a positive light, as well as encouraging families to consider auto-alternative means of getting to and from school are promising ways of advancing active school travel.

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Appendix

Appendix A. Description and explanation of multinomial logit modeling approach

In this study, multinomial logit regression was used to predict the probability of choosing one of five school travel modes (i.e., walking, bicycling, riding a school bus, being driven in a car, or using some "other" travel mode) in a given year based on the influence of multiple predictor variables, such as a school's locale, a student's grade in school, how far away from school a student lives, etc. Multinomial logit regression uses maximum likelihood estimation—rather than the least squares approached used in Ordinary Least Squares regression—to evaluate the probability of choosing a particular travel mode.

Results from the multinomial logit models that estimated the probability of selection of walking, bicycling, riding the bus, and using some other mode vs. riding in a car to/from school are displayed in Appendix F and G. In other words, the 'car' was chosen as the reference mode. It is important to note that the selection of the 'car' as the reference mode is arbitrary – any of the other modes instead of the car could have been chosen as the reference mode, and that would not have changed the probability of choosing a particular mode. The following equations explain the structure of the multinomial logit models used in this study. See Greene (2012) for more information on maximum likelihood estimation, multinomial logit analyses, among other similar topics.

Based on the multinomial logit model, the probability of arriving at the school using mode 1 (walking) can be written as follows:

$$\Pr(Arrival = 1) = \frac{\exp(\beta_1 X)}{1 + \exp(\beta_1 X) + \exp(\beta_2 X) + \exp(\beta_3 X) + \exp(\beta_4 X)}$$

Similarly, the probability of arriving at the school using the other modes can be written as follows:

$$\Pr(Arrival = 2) = \frac{\exp(\beta_2 X)}{1 + \exp(\beta_1 X) + \exp(\beta_2 X) + \exp(\beta_3 X) + \exp(\beta_4 X)}$$

$$\Pr(Arrival = 3) = \frac{\exp(\beta_3 X)}{1 + \exp(\beta_1 X) + \exp(\beta_2 X) + \exp(\beta_3 X) + \exp(\beta_4 X)}$$

$$\Pr(Arrival = 4) = \frac{\exp(\beta_4 X)}{1 + \exp(\beta_1 X) + \exp(\beta_2 X) + \exp(\beta_3 X) + \exp(\beta_4 X)}$$

$$\Pr(Arrival = 5) = \frac{1}{1 + \exp(\beta_1 X) + \exp(\beta_2 X) + \exp(\beta_3 X) + \exp(\beta_4 X)}$$

Where β_1 through β_4 refer to vectors of coefficients that correspond to each of the modes (i.e., walk(1), bike(2), bus(3), other(4), [not car(5), given that it is the reference mode]); and

X refers to a vector of predictor variables (e.g., locale, school income, etc.).

To estimate the unique impact that the variable Year had on the probability of walking, bicycling, riding the bus, riding in a car, or using some "other" school travel mode, average marginal effects were calculated using Stata's *margins* command. An average marginal effect is an estimate of a population-averaged marginal effect on an outcome. In this case, the population is the total number of students included in a given survey year (e.g., 2010), and the outcome is the probability of selecting specific school travel modes in a given year. Once calculated, the average marginal effect is added to the proportion of students who used the five travel modes during the baseline year. As seen in Appendix B, the percentage of students who lived within one mile of school and walked to school in the morning increased from 23.8 percent in 2007-08 to 29.4 percent in 2012. This means that the (population-averaged) marginal effect of the year 2012 on walking to school was 5.6 percent (29.4% - 23.8% = 5.6%).

Appendix B. Multinomial average marginal effects of school arrival and departure patterns by distance and time.

Within 1 mile (n = 268,346)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	23.8%	27.0%	27.6%	28.3%	29.4%	29.4%	33.3%	33.5%	34.5%	35.3%
Bike	4.4%	3.1%	3.3%	3.4%	3.7%	4.3%	3.1%	3.3%	3.4%	3.6%
Bus	16.9%	13.7%	14.9%	13.7%	12.2%	21.5%	17.8%	19.9%	17.5%	15.4%
Other	0.8%	0.6%	0.6%	0.6%	0.6%	1.3%	1.0%	1.0%	1.0%	0.9%
Car	54.1%	55.6%	53.6%	54.1%	54.1%	43.5%	44.8%	42.3%	43.7%	44.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Between 1 and 2 miles (n = 102,062)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	2.6%	2.6%	2.6%	3.0%	3.3%	4.6%	5.0%	5.1%	5.0%	6.0%
Bike	2.1%	1.6%	1.7%	2.0%	1.9%	2.0%	1.5%	1.6%	1.9%	2.0%
Bus	40.8%	37.2%	39.1%	38.5%	34.7%	48.2%	43.3%	46.2%	45.1%	40.3%
Other	0.7%	0.5%	0.5%	0.5%	0.5%	1.1%	0.9%	1.0%	0.9%	0.9%
Car	53.8%	58.1%	56.1%	56.1%	59.5%	44.1%	49.1%	46.1%	47.1%	50.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

More than 2 miles (n = 155,085)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	0.6%	0.6%	0.6%	0.6%	0.7%	1.6%	1.7%	1.6%	1.6%	1.9%
Bike	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Bus	52.9%	47.4%	48.1%	45.9%	44.9%	58.8%	53.7%	55.1%	53.0%	51.1%
Other	0.6%	0.4%	0.3%	0.5%	0.4%	0.9%	0.8%	0.8%	1.2%	0.8%
Car	45.5%	51.4%	50.6%	52.7%	53.7%	38.4%	43.6%	42.2%	43.9%	45.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix C. Multinomial average marginal effects of school arrival and departure by students' sex and time.

Female (n = 272,375)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	12.3%	13.9%	14.3%	14.9%	15.5%	15.8%	17.7%	17.6%	18.2%	19.3%
Bike	1.8%	1.2%	1.3%	1.4%	1.6%	1.7%	1.`%	1.3%	1.4%	1.5%
Bus	32.9%	29.0%	31.5%	28.2%	25.8%	38.4%	33.8%	37.4%	33.5%	30.6%
Other	0.7%	0.5%	0.5%	0.5%	0.5%	1.1%	0.9%	0.9%	1.1%	0.8%
Car	52.3%	55.5%	52.5%	55.0%	56.7%	43.0%	46.5%	42.9%	45.8%	47.8%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Male (n = 253,118)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	12.5%	14.5%	14.8%	15.1%	15.8%	15.9%	17.8%	17.9%	18.3%	19.6%
Bike	3.6%	2.7%	2.8%	2.9%	3.0%	3.5%	2.7%	2.8%	2.8%	2.9%
Bus	32.9%	28.9%	30.5%	28.8%	26.9%	38.4%	34.2%	37.1%	33.9%	30.4%
Other	0.8%	0.7%	0.6%	0.7%	0.6%	1.3%	1.1%	1.1%	1.1%	1.0%
Car	50.2%	53.2%	51.2%	52.6%	53.6%	40.9%	44.3%	41.2%	43.9%	46.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix D. Multinomial average marginal effects of school arrival and departure by students' grade and time.

Kindergarten through 2nd grade (n =202,044)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	12.5%	14.0%	14.0%	14.7%	15.7%	14.0%	15.5%	15.6%	16.5%	17.1%
Bike	1.6%	1.0%	1.1%	1.3%	1.3%	1.5%	1.0%	1.1%	1.3%	1.3%
Bus	29.6%	26.1%	28.3%	26.2%	24.6%	34.7%	31.0%	33.3%	30.8%	29.2%
Other	0.6%	0.5%	0.6%	0.6%	0.7%	1.2%	1.1%	1.2%	1.1%	1.1%
Car	55.7%	58.4%	56.0%	57.2%	57.7%	48.6%	51.4%	48.8%	50.3%	51.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

3rd through 5th grade (n = 211,130)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	13.6%	15.1%	16.0%	16.0%	16.6%	17.7%	19.8%	19.8%	20.0%	20.3%
Bike	3.3%	2.4%	2.4%	2.5%	2.8%	3.3%	2.3%	2.3%	2.5%	2.7%
Bus	32.3%	27.8%	29.5%	27.6%	25.8%	38.3%	33.0%	35.1%	33.0%	31.0%
Other	0.7%	0.6%	0.5%	0.6%	0.4%	1.2%	1.0%	1.0%	1.1%	0.8%
Car	50.1%	54.1%	51.6%	53.3%	54.4%	39.5%	43.8%	41.8%	43.4%	45.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

6th through 8th grade (n = 112,319)

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	9.7%	13.1%	12.9%	13.2%	13.5%	15.7%	19.5%	19.1%	19.4%	20.6%
Bike	3.4%	3.1%	3.7%	3.9%	3.9%	3.4%	3.1%	3.6%	3.9%	3.9%
Bus	41.3%	35.1%	35.3%	31.3%	29.1%	46.6%	38.2%	40.5%	39.2%	36.2%
Other	1.0%	0.4%	0.2%	0.4%	0.3%	1.2%	0.8%	0.5%	0.8%	0.7%
Car	44.6%	49.9%	49.0%	49.3%	51.2%	33.2%	37.0%	35.5%	37.1%	38.7%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix E. Multinomial average marginal effects of school arrival and departure by school-level income and time.

	Low-income Schools (n = 75,723)									
	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	21.8%	27.2%	25.8%	26.4%	27.6%	24.6%	31.6%	29.8%	31.2%	31.5%
Bike	0.9%	0.6%	0.8%	0.7%	0.7%	0.9%	0.6%	0.8%	0.8%	0.7%
Bus	22.4%	15.9%	21.1%	17.5%	16.3%	25.5%	18.7%	24.3%	20.4%	19.4%
Other	0.9%	0.6%	0.8%	0.6%	0.8%	1.6%	1.3%	1.5%	1.3%	1.3%
Car	54.1%	55.8%	51.6%	54.7%	54.6%	47.4%	47.8%	43.6%	46.3%	47.1%
Total	100.0%	100%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	Medium-income Schools (n = 189,656)									
	Arrival					**Departure**				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	10.6%	11.5%	12.6%	12.5%	13.2%	14.2%	15.6%	16.3%	16.1%	17.4%
Bike	2.0%	1.4%	1.4%	1.5%	1.7%	2.0%	1.4%	1.4%	1.5%	1.7%
Bus	32.7%	30.9%	29.0%	28.8%	24.5%	38.8%	37.2%	35.5%	35.3%	30.1%
Other	0.6%	0.5%	0.6%	0.5%	0.5%	1.0%	0.9%	1.1%	1.1%	0.9%
Car	54.1%	55.7%	56.4%	56.4%	56.7%	44.0%	44.8%	45.7%	46.0%	49.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	High-income Schools (n = 260,114)									
	Arrival					**Departure**				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	11.6%	12.7%	13.0%	13.5%	14.2%	15.1%	16.1%	16.4%	17.0%	17.3%
Bike	3.5%	2.5%	2.7%	9.9%	3.0%	3.4%	2.5%	2.7%	2.8%	3.0%
Bus	35.4%	28.8%	31.7%	29.2%	29.7%	41.1%	33.5%	37.0%	34.2%	34.5%
Other	0.8%	0.6%	0.4%	0.6%	0.5%	1.2%	0.9%	0.7%	1.0%	0.8%
Car	48.7%	55.4%	52.2%	53.7%	52.6%	39.2%	46.9%	43.2%	45.0%	44.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Appendix F. Multinomial model: school arrival results.

Predictor (X)		Walk			Bike			Bus			Other		
		Coef (β_1)	Robust SE	*p*	Coef (β_2)	Robust SE	*p*	Coef (β_3)	Robust SE	*p*	Coef (β_4)	Robust SE	*p*
Locale													
	City	------	------	------	------	------	------	------	------	------	------	------	------
	Suburb	-0.161	0.043	0.000	-0.401	0.073	0.000	0.616	0.064	0.000	-0.698	0.095	0.000
	Town	-0.393	0.043	0.000	-0.471	0.078	0.000	0.566	0.059	0.000	-1.174	0.099	0.000
	Rural	-0.413	0.050	0.000	-0.295	0.096	0.002	0.870	0.066	0.000	-0.916	0.123	0.000
School income													
	Low	------	------	------	------	------	------	------	------	------	------	------	------
	Medium	-0.317	0.046	0.000	0.734	0.089	0.000	0.080	0.060	0.179	0.030	0.109	0.783
	High	-0.212	0.047	0.000	1.188	0.089	0.000	0.372	0.062	0.000	0.028	0.113	0.800
Distance													
	< 1/4 mi	------	------	------	------	------	------	------	------	------	------	------	------
	1/4 to 1/2 mi	-1.045	0.015	0.000	-0.049	0.031	0.115	0.528	0.022	0.000	-0.059	0.064	0.353
	1/2 to 1 mi	-1.814	0.022	0.000	-0.292	0.033	0.000	0.945	0.025	0.000	-0.189	0.069	0.006
	1 to 2 mi	-2.933	0.037	0.000	-0.734	0.047	0.000	1.469	0.030	0.000	-0.213	0.084	0.011
	> 2 mi	-4.234	0.057	0.000	-1.984	0.071	0.000	1.690	0.034	0.000	0.023	0.083	0.777
Female		-0.071	0.010	0.000	-0.776	0.028	0.000	-0.081	0.008	0.000	-0.284	0.046	0.000
Grade													
	K	------	------	------	------	------	------	------	------	------	------	------	------
	1	-0.101	0.020	0.000	0.014	0.056	0.795	0.067	0.020	0.001	-0.150	0.077	0.051
	2	-0.110	0.021	0.000	0.120	0.057	0.035	0.115	0.021	0.000	-0.113	0.077	0.144
	3	-0.070	0.025	0.004	0.362	0.059	0.000	0.151	0.024	0.000	-0.236	0.082	0.004
	4	0.017	0.026	0.524	0.702	0.063	0.000	0.168	0.027	0.000	-0.018	0.083	0.827
	5	0.150	0.028	0.000	0.934	0.064	0.000	0.234	0.030	0.000	-0.013	0.084	0.880
	6	0.411	0.040	0.000	1.290	0.082	0.000	0.294	0.046	0.000	0.066	0.156	0.675
	7	0.563	0.047	0.000	1.527	0.093	0.000	0.237	0.059	0.000	0.365	0.156	0.020
	8	0.635	0.053	0.000	1.500	0.096	0.000	0.152	0.062	0.014	0.568	0.154	0.000

Education level												
	Grade 8 or less	------	------	------	------	------	------	------	------	------	------	------	------
	Grades 9 - 11	-0.039	0.038	0.006	-0.244	0.089	0.006	0.336	0.033	0.000	-0.124	0.102	0.222
	Grade 12 or GED	-0.490	0.034	0.000	-0.237	0.061	0.000	0.047	0.029	0.109	-0.390	0.089	0.000
	College 1 - 3 years	-0.692	0.033	0.000	-0.244	0.056	0.000	-0.261	0.029	0.000	-0.490	0.087	0.000
	College 4 + years	-0.509	0.035	0.718	-0.021	0.059	0.718	-0.559	0.030	0.000	-0.556	0.087	0.000
Asked Permission		0.484	0.018	0.000	1.307	0.034	0.000	-0.458	0.017	0.000	0.252	0.044	0.000
Fun		0.892	0.029	0.000	0.892	0.029	0.000	0.049	0.011	0.000	0.206	0.048	0.000
School support		0.591	0.036	0.000	0.591	0.036	0.000	-0.345	0.025	0.000	0.295	0.072	0.000
Healthy		0.588	0.054	0.000	0.588	0.054	0.000	-0.132	0.011	0.000	-0.098	0.058	0.093
Year													
	2007-08	------	------	------	------	------	------	------	------	------	------	------	------
	2009	0.039	0.038	0.446	-0.351	0.070	0.000	-0.140	0.055	0.010	-0.309	0.104	0.003
	2010	0.090	0.038	0.036	-0.253	0.067	0.000	-0.048	0.050	0.331	-0.300	0.102	0.003
	2011	0.114	0.038	0.006	-0.214	0.070	0.002	-0.153	0.051	0.003	-0.271	0.116	0.020
	2012	0.156	0.040	0.000	-0.160	0.070	0.022	-0.245	0.055	0.000	-0.327	0.112	0.004
constant		-0.194	0.064	0.002	-5.574	0.125	0.000	-1.956	0.078	0.000	-3.242	0.138	0.000
N = 525,493; Log pseudolikelihood = -463294.96; Wald chi2(120) = 40409.75; Prob > chi2 = 0.000													

Note. Robust SE = Robust standard error; *p* significant at < 0.05.
Base outcome = Car.

Appendix G. Multinomial model: school departure results.

Predictor		Walk			Bike			Bus			Other		
		Coef (β_1)	Robust SE	*p*	Coef (β_2)	Robust SE	*p*	Coef (β_3)	Robust SE	*p*	Coef (β_4)	Robust SE	*p*
Locale													
	City	------	------	------	------	------	------	------	------	------	------	------	------
	Suburb	-0.017	0.039	0.657	-0.313	0.074	0.000	0.636	0.065	0.000	-0.362	0.082	0.000
	Town	-0.131	0.041	0.001	-0.323	0.081	0.000	0.730	0.061	0.000	-0.687	0.088	0.000
	Rural	-0.174	0.046	0.000	-0.130	0.101	0.201	0.985	0.069	0.000	-0.656	0.106	0.000
School income													
	Low	------	------	------	------	------	------	------	------	------	------	------	------
	Medium	-0.305	0.044	0.000	0.706	0.089	0.000	0.096	0.060	0.109	-0.079	0.086	0.358
	High	-0.247	0.045	0.000	1.152	0.089	0.000	0.339	0.063	0.000	-0.184	0.092	0.046
Distance													
	< 1/4 mi	------	------	------	------	------	------	------	------	------	------	------	------
	1/4 to 1/2 mi	-0.948	0.015	0.000	-0.124	0.032	0.000	0.402	0.020	0.000	-0.068	0.052	0.191
	1/2 to 1 mi	-1.650	0.020	0.000	-0.407	0.033	0.000	0.753	0.023	0.000	-0.201	0.054	0.000
	1 to 2 mi	-2.601	0.029	0.000	-0.867	0.045	0.000	1.234	0.028	0.000	-0.187	0.064	0.003
	> 2 mi	-3.531	0.041	0.000	-2.126	0.069	0.000	1.391	0.031	0.000	0.023	0.062	0.704
Female		-0.091	0.010	0.000	-0.798	0.028	0.000	-0.084	0.007	0.000	-0.227	0.033	0.000
Grade													
	K	------	------	------	------	------	------	------	------	------	------	------	------
	1	-0.032	0.020	0.110	0.100	0.059	0.092	0.092	0.018	0.000	-0.008	0.056	0.889
	2	0.003	0.021	0.880	0.250	0.060	0.000	0.154	0.020	0.000	-0.020	0.062	0.742
	3	0.120	0.024	0.000	0.545	0.062	0.000	0.215	0.023	0.000	-0.019	0.062	0.755
	4	0.296	0.026	0.000	0.929	0.063	0.000	0.267	0.026	0.000	0.041	0.063	0.519
	5	0.512	0.028	0.000	1.217	0.066	0.000	0.361	0.029	0.000	0.001	0.067	0.990
	6	0.926	0.037	0.000	1.666	0.083	0.000	0.462	0.048	0.000	0.016	0.125	0.897
	7	1.165	0.044	0.000	1.938	0.095	0.000	0.395	0.064	0.000	0.282	0.141	0.045
	8	1.311	0.048	0.000	1.959	0.096	0.000	0.294	0.066	0.000	0.493	0.134	0.000

Education level												
	Grade 8 or less	------	------	------	------	------	------	------	------	------	------	------	------
	Grades 9 - 11	0.000	0.034	0.996	-0.178	0.087	0.040	0.278	0.032	0.000	-0.218	0.094	0.021
	Grade 12 or GED	-0.429	0.030	0.000	-0.225	0.061	0.000	0.061	0.029	0.035	-0.319	0.075	0.000
	College 1 - 3 years	-0.601	0.030	0.000	-0.240	0.056	0.000	-0.185	0.029	0.000	-0.259	0.072	0.000
	College 4 + years	-0.550	0.032	0.000	-0.111	0.058	0.056	-0.458	0.030	0.000	-0.353	0.075	0.000
Asked permission		0.716	0.018	0.000	1.400	0.034	0.000	-0.392	0.017	0.000	0.185	0.037	0.000
Fun		0.175	0.013	0.000	0.823	0.028	0.000	0.022	0.011	0.040	0.028	0.035	0.432
School support		0.468	0.016	0.000	0.568	0.037	0.000	-0.351	0.026	0.000	0.147	0.055	0.007
Healthy		0.402	0.019	0.000	0.661	0.053	0.000	-0.097	0.011	0.000	-0.033	0.044	0.457
Year													
	2007-08	------	------	------	------	------	------	------	------	------	------	------	------
	2009	0.032	0.037	0.550	-0.345	0.070	0.000	-0.155	0.055	0.005	-0.218	0.081	0.008
	2010	0.070	0.036	0.095	-0.237	0.068	0.001	-0.040	0.050	0.432	-0.205	0.078	0.009
	2011	0.088	0.036	0.029	-0.205	0.070	0.003	-0.150	0.051	0.003	-0.135	0.097	0.166
	2012	0.117	0.035	0.006	-0.170	0.071	0.017	-0.258	0.054	0.000	-0.312	0.087	0.000
constant		-0.225	0.061	0.000	-5.569	0.125	0.000	-1.598	0.076	0.000	-2.764	0.119	0.000
N = 525,493; Log pseudolikelihood = -499640.08; Wald chi2(120) = 45856.55; Prob > chi2 = 0.000													

Note. Robust SE = Robust standard error; *p* significant at < 0.05.
Base outcome = Car.

Appendix H. Binary logit models predicting parental perceptions of walking and bicycling to/from school.

	Support					Fun					Health				
	Coef	Robust SE	p	Lower CI	Upper CI	Coef	Robust SE	p	Lower CI	Upper CI	Coef	Robust SE	p	Lower CI	Upper CI
Locale															
City	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Suburb	-0.547	0.056	0.000	-0.656	-0.437	-0.071	0.017	0.000	-0.104	-0.038	-0.069	0.018	0.000	-0.105	-0.034
Town	-0.683	0.063	0.000	-0.806	-0.561	-0.133	0.018	0.000	-0.169	-0.096	-0.059	0.020	0.003	-0.099	-0.020
Rural	-0.694	0.074	0.000	-0.840	-0.548	-0.108	0.020	0.000	-0.147	-0.069	-0.109	0.019	0.000	-0.147	-0.071
School income															
Low	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Medium	0.039	0.053	0.457	-0.064	0.142	0.040	0.019	0.032	0.003	0.077	0.176	0.022	0.000	0.132	0.219
High	0.301	0.053	0.000	0.198	0.405	0.139	0.019	0.000	0.101	0.176	0.335	0.022	0.000	0.291	0.379
Distance															
< 1/4 mi	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
1/4 to 1/2 mi	-0.116	0.014	0.000	-0.143	-0.088	-0.127	0.012	0.000	-0.151	-0.103	0.106	0.019	0.000	0.070	0.143
1/2 to 1 mi	-0.174	0.017	0.000	-0.207	-0.142	-0.248	0.013	0.000	-0.273	-0.224	0.030	0.017	0.079	-0.003	0.064
1 to 2 mi	-0.254	0.024	0.000	-0.301	-0.206	-0.390	0.013	0.000	-0.415	-0.364	-0.112	0.017	0.000	-0.145	-0.079
> 2 mi	-0.227	0.028	0.000	-0.282	-0.171	-0.444	0.014	0.000	-0.471	-0.417	-0.398	0.017	0.000	-0.432	-0.365
Female	0.033	0.007	0.000	0.019	0.046	-0.074	0.007	0.000	-0.088	-0.060	0.007	0.008	0.395	-0.009	0.023
Grade															
K	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
1	-0.012	0.015	0.426	-0.043	0.018	-0.048	0.013	0.000	-0.074	-0.022	-0.017	0.016	0.281	-0.048	0.014
2	-0.063	0.018	0.000	-0.099	-0.028	-0.071	0.013	0.000	-0.098	-0.045	-0.058	0.016	0.000	-0.090	-0.026
3	-0.092	0.020	0.000	-0.131	-0.052	-0.125	0.014	0.000	-0.153	-0.098	-0.075	0.016	0.000	-0.106	-0.043
4	-0.109	0.022	0.000	-0.152	-0.065	-0.214	0.014	0.000	-0.242	-0.186	-0.067	0.017	0.000	-0.100	-0.033
5	-0.112	0.025	0.000	-0.161	-0.063	-0.340	0.016	0.000	-0.372	-0.309	-0.044	0.018	0.014	-0.079	-0.009
6	-0.298	0.046	0.000	-0.388	-0.209	-0.585	0.019	0.000	-0.623	-0.547	-0.002	0.022	0.942	-0.044	0.041
7	-0.392	0.059	0.000	-0.508	-0.277	-0.844	0.025	0.000	-0.892	-0.796	0.045	0.024	0.057	-0.001	0.092
8	-0.357	0.066	0.000	-0.485	-0.228	-1.015	0.025	0.000	-1.064	-0.966	0.034	0.024	0.151	-0.012	0.081

Education level																
	Grade 8 or less	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
	Grades 9 - 11	-0.194	0.025	0.000	-0.243	-0.146	-0.139	0.025	0.000	-0.188	-0.090	0.021	0.028	0.450	-0.034	0.077
	Grade 12 or GED	-0.544	0.024	0.000	-0.590	-0.498	-0.347	0.020	0.000	-0.387	-0.307	0.046	0.022	0.032	0.004	0.089
	College 1 - 3 years	-0.657	0.024	0.000	-0.705	-0.609	-0.327	0.020	0.000	-0.366	-0.289	0.186	0.021	0.000	0.145	0.227
	College 4 + years	-0.440	0.027	0.000	-0.492	-0.388	-0.068	0.020	0.001	-0.107	-0.028	0.371	0.022	0.000	0.328	0.414
Asked permission		0.421	0.014	0.000	0.393	0.448	1.271	0.011	0.000	1.250	1.292	0.491	0.013	0.000	0.466	0.516
Fun		0.892	0.011	0.000	0.870	0.915	0.895	0.011	0.000	0.873	0.918	0.759	0.013	0.000	0.733	0.785
Healthy		0.802	0.013	0.000	0.776	0.828	2.523	0.016	0.000	2.492	2.555	2.512	0.016	0.000	2.481	2.543
Year																
	2007-08	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
	2009	0.071	0.049	0.149	-0.025	0.168	-0.023	0.018	0.199	-0.059	0.012	-0.060	0.021	0.004	-0.101	-0.019
	2010	0.290	0.047	0.000	0.197	0.383	-0.054	0.017	0.002	-0.087	-0.020	-0.102	0.020	0.000	-0.140	-0.064
	2011	0.429	0.049	0.000	0.332	0.525	-0.045	0.018	0.010	-0.080	-0.011	-0.055	0.020	0.006	-0.094	-0.015
	2012	0.446	0.050	0.000	0.349	0.544	-0.074	0.018	0.000	-0.109	-0.038	-0.066	0.020	0.001	-0.105	-0.028
constant		-1.442	0.059	0.000	-1.558	-1.327	-2.364	0.034	0.000	-2.430	-2.298	0.363	0.035	0.000	0.294	0.433

Note. Robust SE = Robust standard error; *p* significant at < 0.05; Lower CI = lower bound 95% confidence interval; Upper CI = upper bound 95% confidence interval.

Appendix I. Two models' travel mode average marginal effects estimates over time.

Multinomial logit model with clustered school-level responses

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	12.4%	14.1%	14.5%	14.9%	15.7%	15.8%	18.0%	17.9%	18.7%	20.5%
Bike	2.6%	1.8%	2.0%	2.1%	2.2%	2.6%	1.9%	2.0%	2.1%	2.2%
Bus	32.9%	28.9%	30.5%	28.6%	27.0%	38.4%	33.8%	36.0%	33.9%	31.9%
Other	0.7%	0.5%	0.5%	0.5%	0.5%	1.2%	1.0%	1.0%	1.1%	0.9%
Car	51.4%	52.6%	52.2%	53.8%	54.7%	42.0%	45.3%	43.1%	44.2%	45.3%

Binary logit models using GEE framework and autoregressive correlation structure

	Arrival					Departure				
	2007-08	2009	2010	2011	2012	2007-08	2009	2010	2011	2012
Walk	12.1%	14.2%	14.5%	15.1%	15.6%	15.5%	18.1%	17.9%	18.9%	20.4%
Bike	2.5%	1.9%	2.0%	2.1%	2.3%	2.5%	2.0%	2.1%	2.2%	2.3%
Bus	33.0%	28.5%	30.3%	28.5%	26.6%	38.8%	33.7%	35.7%	32.5%	31.4%
Other	0.7%	0.7%	0.5%	0.6%	0.7%	0.9%	1.0%	0.9%	1.0%	0.9%
Car	51.7%	54.7%	52.7%	53.7%	54.8%	42.3%	45.2%	43.4%	45.4%	45.0%

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