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Impact of the Safe Routes to School program on walking and biking: Eugene, Oregon study

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ABSTRACT

Policymakers in many countries, including the United States, United Kingdom, and Australia, have introduced programs to increase walking and biking to school through education, encouragement, and infrastructure improvements. The U.S. government has allocated over $1.1 billion to the federal Safe Routes to School program since 2005. However, there are few evaluations of the Safe Routes to School program. Our study used a robust quasi-experimental research design to measure the impacts of Eugene, Oregon's Safe Routes to School program on walking and biking. Using data collected between 2007 and 2011 at 14 schools with and without Safe Routes to School programs, we showed that the Safe Routes to School program was associated with increases in walking and biking. Education and encouragement programs were associated with a five percentage point increase in biking. Augmenting education programs with additional SRTS improvements such as sidewalks, crosswalks, covered bike parking, and Boltage was associated with increases in walking and biking of 5–20 percentage points. The study results illustrate the potential for the Safe Routes to School program to change behavior and should encourage other communities to plan for multi-modal school travel.

1. Introduction

The 2005 federal transportation bill created the Safe Routes to School (SRTS) program to "enable and encourage children…to walk and bicycle to school" and "to make bicycling and walking to school a safer and more appealing transportation alternative" (Federal Highway Administration, 2006). The legislation provided each state's Department of Transportation with funds to improve infrastructure within two miles of elementary and middle schools and to develop safety and encouragement programs. Over $1.1 billion has been authorized for the program as part of the original legislation and continuing resolutions through September 30, 2012 (National Center for Safe Routes to School 2013).

Previous studies have found increases in biking and walking as a result of SRTS interventions. In Auckland, New Zealand, schools with comprehensive school-level plans to encourage walking and biking through education, enforcement, and infrastructure improvements increased shares of walking and biking from 40.5% to 42.2% after three years (Hinckson et al., 2011). The Boarnet et al. (2005) evaluation of infrastructure improvements funded by California's state SRTS program found increases from 10% to 850% in the number of children walking to school at eight elementary schools and a decrease at one elementary school. Marin County (California) had one of the first SRTS programs in the United States. Evaluations of the Marin SRTS program showed an increase in walking from approximately 15% of students before the program began to over 20% two years later; biking increased from approximately 5% to 15% of students (Staunton et al., 2003). The National Partnership for SRTS analyzed school travel at ten low-income schools receiving a SRTS intervention and found mixed results. The student-reported proportion of students walking to school decreased at four schools, increased at three schools, and remained the same at one school after SRTS intervention (McMillan and Cooper 2009).

These studies suggest the potential for the SRTS program to change school travel behavior. However, the studies did not compare travel behavior at schools receiving SRTS interventions to schools without interventions. The lack of a control group raises validity concerns. For example, without a control group, it is impossible to establish whether increases in walking are due to the SRTS interventions, seasonal weather differences, or the maturation effect of the children aging by nine months (since many studies compare fall to spring). Similarly, the lack of control schools makes it difficult to account for shocks that may affect travel behavior in all families, such as changes in gas prices or employment. Some studies have used more robust research designs to evaluate the SRTS program. Mendoza et al. (2011) conducted a cluster randomized controlled trial of a walking school bus program (where adults chaperone

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children on the walk to school) for fourth-graders at eight low-income Houston public schools. They found students who received the walking school bus intervention walked to school more and increased their moderate-to-vigorous physical activity. However, the walking school bus was led by researchers, making it unclear what the program impacts would be for a school-sponsored effort. Wen et al. (2008) analyzed the impacts of a two-year SRTS program on 10–12-year-olds in Sydney using a cluster randomized controlled trial. They found increases in walking were higher for the treatment group. However, the effect was only evident using parent reports of school travel mode.

More research is needed on the impacts of the SRTS program using stronger research designs (Mackett 2013). Our study uses a quasi-experimental research design to evaluate the impacts of the SRTS program in Eugene, Oregon on walking and biking to and from school. The advantage of our approach is that it utilizes control schools and observes schools from 2007 to 2011. However, unlike some previous research, our study reflects real-world implementation of SRTS programs, as opposed to researcher-implemented programs. We find the SRTS program is associated with increases in walking and biking, and this effect remains after controlling for school-level factors that influence adoption of the program. The remainder of the paper describes the study area, our methodology, data, and results.

2. Study area

The 4J School District serves residents of Eugene, Oregon and surrounding areas, covering 155 square miles in the southern Willamette Valley. The district is comprised of 22 elementary schools, two K-8 schools, seven traditional middle schools, and four conventional high schools. Additionally, there are 4 alternative high school programs in the district, 1 of which is a program that exists on multiple campuses. Student attendance is roughly 16,500. Families in Eugene are assigned to a neighborhood school based on their location. However, all families are allowed to enter a lottery to be reassigned to any other neighborhood or magnet school. Previous research has shown that families attending a "choice" school tend to travel longer distances and to walk and bike less frequently (Yang et al., 2012).

The SRTS program became fully operational in the 4J School District in the fall of 2007 with the appointment of a full-time SRTS program manager. The program funds and administers a variety of interventions aimed at increasing walking or biking to and from school by K-8 students. Interventions are broadly classified into 4 categories, also known as the 4E's: engineering, education, encouragement, and enforcement. Engineering interventions are usually infrastructure improvements, such as sidewalk construction, crosswalks, and traffic signal improvements. Education programs aim to improve students' active commuting skills and awareness, as well as increase the safety of walking and biking activities. Similarly, encouragement interventions seek to raise the awareness of active commuting benefits among both students and their parents. "Walk and Bike to School Day" is one example of a program designed to increase enthusiasm for active commuting. The fourth "E" enforcement includes intervention measures such as the funding of street crossing guards, the placement of speed feedback trailers near schools, and increased police presence to enforce speed limits in school zones.

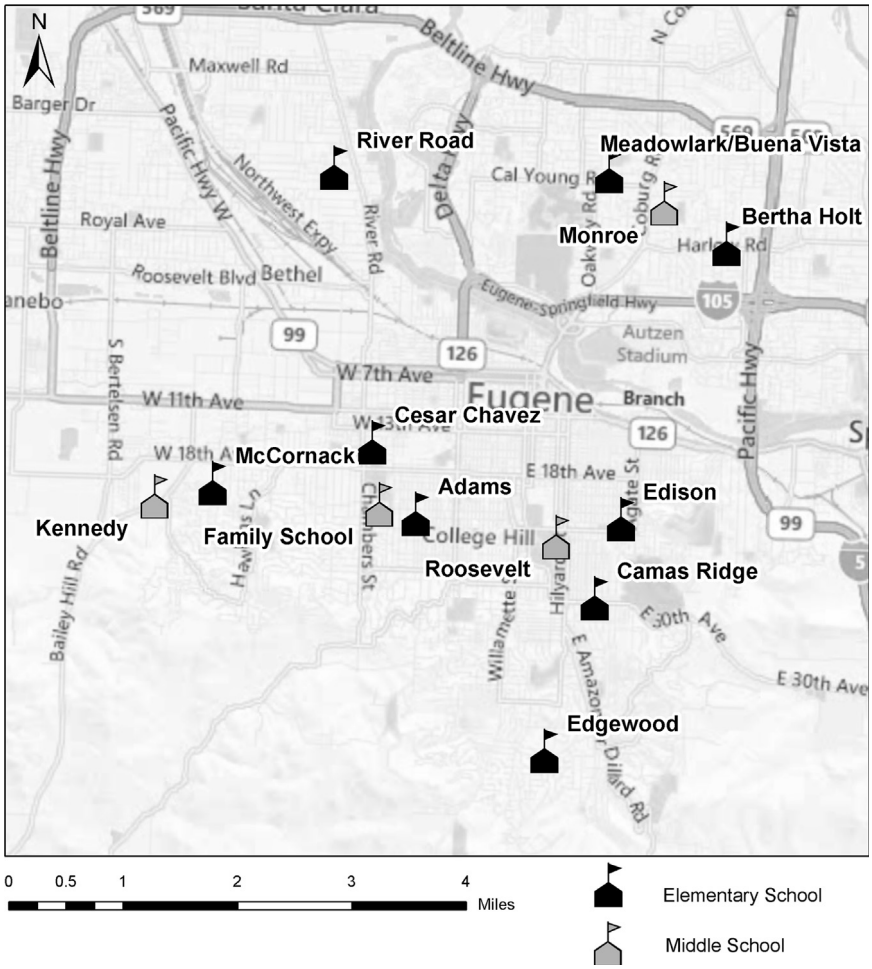

Fig. 1. Map of Eugene 4J schools.

Nine 4J elementary schools and four middle schools have implemented SRTS interventions (Fig. 1). Most 4J school district SRTS interventions have been in the categories of education, encouragement, and engineering. Two middle schools, five elementary, and one K-8 school have education and encouragement programs. The oldest of these began in fall 2007 and have generally been delivered consistently during the study period. One middle school took part in the Boltage (previously Freiker) program, which encourages biking by tracking how frequently students bike to school and offering prizes based on participation. Each student received a radio frequency identification tag for his helmet, and the school has a reader that counts each time a child bikes to school. In addition, infrastructure changes were made at several schools, ranging from improved bike parking at three schools to crosswalk and sidewalk improvements at five schools. The bike parking improvements were made early in the program; the crosswalk and sidewalk improvements were implemented during summer 2011 and, therefore, were not available during much of the study period.

3. Methods

Schools that receive SRTS funds are likely different from schools without a SRTS program. The potential differences range from the walkability of the local area to interest in the SRTS program and may be unobservable. This selection bias makes estimation of the causal impacts of the SRTS program difficult. Simple comparisons between schools receiving the program and those without SRTS might overinflate estimates of the program's impact. While a randomized control trial would eliminate these selection bias concerns, such a trial was not feasible in this case. Instead, we employ statistical techniques to address selection bias by controlling for demographic differences across schools and including a school-level fixed effect to account for time-invariant differences across schools such as the built environment near the school and the proportion of students living within one-mile of the school. Standard errors are adjusted for potential correlation between observations at the same school over time.

3.1. Functional form

The majority of this project's data was collected through classroom surveys and, therefore, represents grouped, not individual, information on school travel mode. We are interested in modeling the proportion of students who walk or bike to school, y_{ijt}, in school i, grade j, at time t, as a function of

- dummy variables for the SRTS interventions, D_{it};
- time-varying school factors, $x_{ijt,}$ such as enrollment and racial and ethnic composition;
- unobserved time-invariant school factors represented as a fixed school effect, c_i; and
- dummy variables for the school year, season, survey respondent, and time of day, T_t.

We modeled the proportion of students walking or biking to school separately using a logistic function, also known as fractional logit (Papke and Wooldridge 1996):

$$E\left[y_{ijt}|z\right] = \frac{e^{D_{it}\gamma + x_{ijt}\beta + c_i\delta + T_t}}{[1 + e^{D_{it}\gamma + x_{ijt}\beta + c_i\delta + T_t}]}$$

This approach ensured that predicted proportions would lie on the unit interval – something not guaranteed with linear regression – and was an improvement over transforming the proportion into a continuous variable that lies on the real number line, e.g. the log-odds ratio $\log[y/(1-y)]$. As Papke and Wooldridge (1996) discussed, the log-odds approach is problematic if the proportion takes on a value of 0 or 1 and, more seriously, creates difficulties in recovering the marginal effects of interest, e.g. the impact of the SRTS program on walking and biking to school. For the fractional logit model, we treat the data as a pooled cross section (with appropriate controls for time) rather than true longitudinal information. We do this because the panel is unbalanced. While linear models accommodate unbalanced panels, fractional logit does not. Panel fractional logit methods have only recently been developed, and the asymptotic properties of these estimators require balanced panel data (Papke and Wooldridge 2008). However, we control for school-level factors through dummy variables for each school.

3.2. Estimating the impact of the SRTS program on walking and biking

The impact of each SRTS intervention on walking and biking to school is given by the marginal effect. For the fractional logit model, the marginal effect for discrete variables is given by the discrete change in the outcome for each observation and then averaged over the sample. The average is weighted by the number of students surveyed.

4. Data

4.1. School trip travel mode

Data on school trip mode share were collected through three survey instruments. The primary instrument was the National Center for Safe Routes to School's student travel tally sheet. This instrument asks teachers or other volunteers to collect information about students' mode to and from school through hand-raising, i.e., “How did you arrive at school today?” and “How do you plan to leave for home after school?” Teachers collect this information on Tuesday, Wednesday, and Thursday. The second source of mode data is the National Center for Safe Routes to School's parent survey. This instrument collects usual travel mode to and from school by asking “On most days, how does your child arrive at and leave from school?” The third source of mode data was a specialized survey on school travel developed by the University of Oregon that asked about usual travel mode to school. The National Center tally and parent survey have been validated (McDonald 2011). The Oregon survey's measurement properties have not been established; however, the format of the question is similar to previously validated questions.

Data on student travel were collected between fall 2007 and fall 2011. Table 1 shows the resulting unbalanced panel. Modal data collected with the National Center's survey instruments were collected for administrative purposes. Each fall and spring, a subset of schools was surveyed by district SRTS staff. The University of Oregon survey data were collected in spring 2008 and 2010 to supplement information collected by the school district. Each school year, data were collected on 1000–2300 students or 16–42% of students attending the study schools. All data sets were aggregated to compute the proportion of students who walked and biked by school, grade, and survey week.

4.2. SRTS interventions

Information on the nature and timing of SRTS interventions at each school was collected through interviews with school personnel involved in the program and groundtruthing (Table 2). We used this data to determine the set of SRTS interventions in place

Table 1
School trip mode share data availability by school.

School	2007–08	2008–09	2009–10	2010–11	2011–12
Intervention Schools					
ATA/Family (K-8)		✓	✓		✓
Buena Vista ES		✓		✓	
Camas Ridge ES		✓	✓	✓	✓
Cesar Chavez ES		✓			✓
Edison ES		✓		✓	✓
Meadowlark ES[a]		✓		✓	
McCornack ES	✓				
Monroe MS	✓	✓	✓		✓
Roosevelt MS	✓	✓	✓	✓	✓
Control Schools					
Adams ES[b]	✓		✓		✓
Edgewood ES	✓		✓		
Holt ES	✓		✓		
River Road ES	✓		✓		
Kennedy MS	✓				
Total Number of Students Surveyed	1582	2303	1032	1121	1372

[a] Meadowlark closed after the 2010–2011 school year.
[b] SRTS program started in November 2011 after all surveying completed for this evaluation. Therefore, Adams is classified as a control school.

at each school for each set of travel mode data. For infrastructure programs, we collected the project completion date; thus it was assumed that travel surveys collected after the completion date were filled out by participants whose school had received the SRTS infrastructure treatment. For education and encouragement programs, the start and end dates were collected. We assumed that schools received the education and encouragement treatment if the travel data were collected six months after the intervention start date. For example, if a school began an education and encouragement program in September 2008, then we assumed that surveys collected after February 2009 were completed by participants whose schools had received the SRTS education and infrastructure treatment.

The analysis focused on combinations of treatments; five distinct SRTS treatment combinations were identified:

- education/encouragement only;
- education and crosswalks/sidewalks;
- education and Boltage;
- education and covered bike parking;
- education and two SRTS interventions (either covered bike parking+crosswalks/sidewalks or covered bike parking+Boltage).

The SRTS interventions received by each school changed over time as the Eugene SRTS program grew. For example, a middle school implemented education and encouragement programs during the 2007–08 school year; the next year the school added a Boltage program and in later years made infrastructure improvements. The impact of each treatment on walking and biking was assessed relative to schools with no SRTS interventions when the mode survey was conducted. We combined treatments where schools received education and two SRTS interventions due to relatively small numbers of mode data available for each intervention individually.

4.3. School characteristics

We assessed a variety of time-varying school characteristics that might correlate with school travel. Previous research has shown that rates of walking and biking are higher for low-income and minority groups (McDonald 2008b). We also included school achievement indicators because it is possible travel and school choice correlate with this factor. Student achievement was measured through an achievement index reported in the school and district report cards published annually by the Oregon Department of Education. Racial and ethnic composition by school and grade, as well as eligibility for free and reduced-price lunch at the school level, were assessed through data compiled by the US Department of Education's National Center for Education Statistics and the Oregon Department of Education. Both of these data sources are available for each academic year, allowing them to be included in the regression models.

Table 2
Summary statistics for schools with and without SRTS programs.
Source: School Demographics: National Center for Education Statistics, Oregon Department of Education; School Built Environment: ESRI, WalkScore.

	No SRTS programs (Control) ($n=5$)	SRTS program (Treatment) ($n=9$)	Difference	Mann Whitney p-value
School demographics (2010–2011)				
Elementary enrollment	351.0	318.0	−33.0	0.593
Middle school enrollment	511.0	415.8	−95.3	0.999
% American-Indian	1.5	1.2	−0.3	0.713
% Asian/Pacific-islander	2.7	3.8	1.1	0.540
% Black	3.1	2.8	−0.4	0.221
% Hispanic	15.6	14.3	−1.3	0.903
% Multi-racial	8.5	8.5	0.0	0.713
% White	68.5	69.4	0.9	0.327
% Free or reduced price lunch	48.2	44.8	−3.4	0.462
OR Achievement Index	89.5	89.8	0.3	0.999
School built environment				
% enrolled elementary students within 1 mile	55.6	55.4	−0.2	0.706
Median distance to school (miles)	1.1	1.2	0.1	0.706
Median block size within ½ mile (ha)	1.7	1.7	0.0	0.712
Median block size within 1 mile (ha)	1.7	1.5	−0.2	0.902
Distance to nearest major arterial (ft)	980.8	607.5	−373.3	0.462
Walk Score	50.2	67.7	17.5	0.019

Note: all buffers are based on network distance.

4.4. Local built environment

GIS data describing the school location, street network, and 2010 Census data were used to assess environmental characteristics. We measured potential walkers by analyzing distance to school at study elementary schools (middle school residential location data was not available). This is important since previous research has shown that walk rates decline rapidly outside 1 mile (McDonald 2008a). Other built environment measures included median block size within a 0.5 mile buffer of the school and the presence of major arterials, i.e., two lanes in each direction within a 0.5 mile buffer of the school. Visual inspection showed that all study schools had sidewalks near the school and, therefore, the presence of sidewalks was not included in the models.

5. Results

Schools receiving the SRTS program have demographics and test scores similar to those of control schools (Table 2). At both

school types, nearly 70% of the students are white, and approximately one in two students qualifies for free or reduced-price lunch. Schools engaged in the SRTS program have slightly lower enrollments, but the differences are not significant. The built environment near the treatment and control schools showed little variation. Distance to school was similar in treatment and control elementary schools with about 55% of students living within one mile of school in both groups. However, WalkScores varied significantly between treatment and control schools. A location's WalkScore relies heavily on the proximity of destinations such as stores and parks and likely reflects that treatment schools are located closer to retail establishments (Carr et al., 2011).

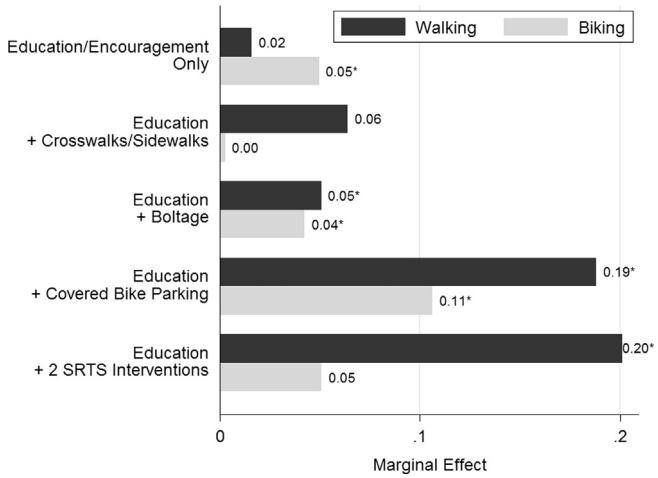

Fig. 2. Marginal effects of SRTS interventions. *Indicates significance of 0.05 or less.

Marginal effects computed from the statistical models showed that Eugene's SRTS program was associated with increased walking and biking for school travel (Fig. 2). Receiving only education and encouragement programs was associated with a non-significant increase in walking and a five percentage point increase in biking. SRTS interventions appeared to have a cumulative impact; schools with more types of interventions had larger proportions of students walking and biking to school. Improving sidewalks and crosswalks had a non-significant impact on walking and biking. However, the impact on walking was at the margin of significance ($p=0.058$), and the infrastructure improvements were completed late in our study period. The Boltage program was associated with an increase of five percentage points in walking and four percentage points in biking. In Eugene, providing covered bike parking was associated with large increases in walking (19 percentage points) and biking (11 percentage points). Receiving two SRTS interventions in addition to education and encouragement was associated with a 20 percentage point increase in walking and a non-significant increase in biking.

The full statistical models also showed the expected patterns on other covariates (Table 3). Student's grade-level strongly predicted walking with rates jumping sharply for middle school students. For biking, grade-level was not a predictor. School factors, such as racial composition, number of children enrolled in each grade, and students eligible for free and reduced price lunch, did not significantly affect walking and biking.

Table 3
Models of the proportion of students walking and biking for school travel.

	Outcome: proportion walking			Outcome: proportion biking		
	Coeff.	Marginal effect (95% CI)		Coeff.	Marginal effect (95% CI)	
SRTS interventions						
Education/encouragement only	0.119	0.016	(−0.032, 0.064)	**0.699**	**0.050**	(0.019, 0.080)
Education+crosswalks/sidewalks	0.438	0.064	(−0.002, 0.130)	0.051	0.003	(−0.031, 0.037)
Education+Boltage	**0.355**	**0.051**	(0.012, 0.090)	**0.617**	**0.042**	(0.007, 0.077)
Education+covered bike parking	**1.094**	**0.188**	(0.095, 0.281)	**1.211**	**0.106**	(0.018, 0.195)
Education+2 SRTS interventions	**1.155**	**0.201**	(0.088, 0.315)	0.713	0.051	(−0.026, 0.128)
Grade-level variables						
Grade 1	0.137	0.014	(−0.033, 0.060)	−0.116	−0.013	(−0.094, 0.067)
Grade 2	−0.202	−0.018	(−0.049, 0.014)	−0.154	−0.018	(−0.107, 0.072)
Grade 3	0.008	0.001	(−0.040, 0.041)	0.156	0.019	(−0.033, 0.072)
Grade 4	0.158	0.016	(−0.008, 0.039)	0.222	0.028	(−0.043, 0.098)
Grade 5	0.277	**0.029**	(0.001, 0.056)	0.482	0.064	(−0.019, 0.147)
Grade 6	**1.461**	**0.220**	(0.123, 0.317)	−1.045	−0.092	(−0.233, 0.050)
Grade 7	**1.467**	**0.221**	(0.117, 0.326)	−1.009	−0.089	(−0.229, 0.050)
Grade 8	**1.467**	**0.221**	(0.116, 0.327)	−1.422	−0.111	(−0.248, 0.026)
Log enrollment	0.173	0.027	(−0.039, 0.093)	0.825	0.063	(−0.011, 0.136)
Percent white	**1.239**	**0.193**	(0.000, 0.385)	−0.824	−0.062	(−0.408, 0.283)
Percent black	−0.956	−0.149	(−0.743, 0.445)	−2.785	−0.211	(−0.508, 0.086)
Percent Hispanic	1.225	0.191	(−0.099, 0.481)	0.141	0.011	(−0.411, 0.433)
School-level variables						
Achievement index	0.013	0.002	(−0.001, 0.005)	0.009	0.001	(−0.002, 0.003)
Percent FRL	1.047	0.163	(−0.057, 0.383)	1.487	0.113	(−0.134, 0.360)
Survey/trip variables						
2008–09	0.163	0.026	(−0.048, 0.100)	0.002	0.000	(−0.064, 0.064)
2009–10	0.012	0.002	(−0.065, 0.069)	−0.056	−0.005	(−0.078, 0.069)
2010–11	−0.153	−0.022	(−0.123, 0.078)	−0.509	−0.035	(−0.136, 0.065)
2011–12	0.056	0.009	(−0.138, 0.155)	−0.193	−0.015	(−0.152, 0.122)
Spring	0.143	0.022	(−0.003, 0.048)	**−0.675**	**−0.047**	(−0.074, −0.020)
Morning	−0.069	−0.011	(−0.037, 0.015)	0.082	0.006	(−0.001, 0.013)
Parent report	0.027	0.004	(−0.021, 0.029)	0.187	0.015	(−0.005, 0.034)
Constant	**−4.895**			**−7.342**		

Bold indicates significance of 0.05 or less.

6. Discussion

This study provides robust evidence of the ability of Eugene's SRTS program to increase walking and biking for school travel. To place the impacts of the Eugene program in context, consider that the U.S. experienced a decrease of 35 percentage points in the proportion of elementary and middle school students walking and biking to school between 1969 and 2009 (McDonald et al. 2011). The Eugene interventions showed increases in walking and biking of 5–20 percentage points – a substantial portion of the nationwide decline. This provides strong evidence of the impacts of the SRTS program in Eugene.

But do results from Eugene, Oregon generalize to other areas? The answer is no, but there are lessons that all communities can learn from the Eugene model. First, many schools in Eugene are located close to residential areas and have existing sidewalk infrastructure – walking to school is possible. Distance to school has been identified as a critical barrier to walking and requires explicit consideration in planning decisions (Stewart et al., 2012). Decisions about where to locate new schools and residences impact how easy it is to walk and bike (McDonald 2010, Beaumont 2003). Making schools accessible by foot and bike should be considered long before a school is ever built and should be part of the development approval process for large subdivisions.

Second, Eugene has made a substantial investment in SRTS and been successful in seeking funding through the SRTS program to pay for those investments and a full-time, on-site SRTS coordinator. Having a coordinator makes it easier for schools to participate in SRTS programs because it lessens the time burden on existing staff. Third, the Eugene program has evolved slowly. Most early efforts focused on education and encouragement; infrastructure improvements – with their long planning timelines – were implemented later. This means that communities with limited resources can focus on low-cost strategies, such as education and encouragement, while continuing to seek funds for infrastructure improvements.

Finally, the Eugene SRTS program was effective in creating excitement and awareness of SRTS interventions. For example, our analysis showed that providing covered bike parking and Boltage had substantial impacts on walking as well as biking. Why should interventions aimed at bikers affect walkers? The covered bike parking was implemented in conjunction with the University of Oregon's designBridge program. This program brought design students from the University to the schools and involved the community in the design and construction. This way, the bike parking implementation created excitement about walking and biking; this excitement translated to increased non-motorized travel.

7. Conclusion

This study demonstrates that Eugene's Safe Routes to School program has increased walking and biking as school transport modes. Education and encouragement programs were associated with a five percentage point increase in biking. Walking and biking increased most when schools implemented multiple SRTS interventions. While these results are particular to Eugene, they provide evidence of the positive impacts of the SRTS program and identify elements of the Eugene SRTS program that could be replicated.

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