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Impact of information about health and academic benefits on parent perception of the feasibility of active transportation to school

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ABSTRACT

The percentage of students walking or biking to school in the United States has fallen drastically over the past decades. This decline has important implications for children's health, as walking and biking to school result in health benefits, including more physical activity and lower risk of obesity. Influencing parents to consider active transportation to school (ATS) is a necessary step in behavior change. Our research examines the impact of providing parents with information about the health and academic benefits of ATS on parent perception of ATS feasibility. Parents given information about ATS benefits were hypothesized to perceive ATS as more feasible, as measured by responding that there is an additional morning or afternoon during the week when their child could walk or bike to or from school. Treatment and control surveys were distributed to parents with children attending elementary school in Alameda County and Richmond, California. Discrete choice models developed from this data indicated that information about ATS benefits did not have a significant effect on parent perception of ATS feasibility. The two models provided further insight into ATS behavior and parent perception of ATS feasibility. Greater walk time to school, higher parent education levels, lack of sidewalks along the route to school, and child participation in after-school activities located outside the school campus decreased perception of ATS feasibility. Walk time to school, vehicle ownership, and lack of sidewalks decreased ATS behavior, while having an adult in the home with flexible work hours increased it. Minorities were less likely to participate in ATS every day. Based on these results, providing more after-school activities on school grounds, constructing sidewalks along routes to school, and locating schools in dense, mixed-use areas are supported as strategies to increase ATS behavior.

1. Introduction

Since 1969, the percentage of kindergarten through 8th grade students biking or walking to school in the United States has fallen from 47.7% to 12.7% (McDonald et al., 2011a). This change has serious implications for children's health, as walking and biking to school result in health benefits, including more physical activity and lower risk of obesity (Larouche et al., 2014). Moreover, school travel now accounts for 5-7% of vehicle miles traveled and 10-14% of private vehicles on the road during morning peak hours (McDonald et al., 2011a). Encouraging active transportation to school (ATS) thus has the potential to improve children's health, lower the greenhouse gas emissions associated with school travel, and reduce traffic during peak hours. Research also indicates that children who walk or bike are more likely to consider active modes as adults, suggesting the potential for additional environmental and health benefits in the future (Black et al., 2001). However, many factors prevent children from walking or biking to school. Eight main barriers have been identified: distance to school, parental fear of traffic and crime, family schedule constraints and values, neighborhood and family resources and culture, weather, and school characteristics (Stewart et al., 2012). This study targets "family schedule constraints and values." It seeks to identify whether providing parents with information about the impacts of ATS on children's health and academic performance affects parent perception of the feasibility of their children walking or biking to school,

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whether accompanied or alone. The results could impact strategies ATS programs such as Safe Routes to Schools (SRTS) use to increase the number of children walking or biking to school.

The following sections provide further background, research objectives and hypotheses, methodology, results, policy and equity implications, and study limitations, before concluding with final policy recommendations and suggestions for future research.

1.1. Background

Various research supports a wide range of health, environmental, and equity benefits from supporting ATS. Walking and biking to school result in health benefits for children, including more physical activity, lower risk of obesity, more positive emotions, and less stress (Carver et al., 2010; Faulkner et al., 2009; Hodgson et al., 2012; Hosking et al. 2011; Larouche et. al., 2014; Lee et al., 2008; Martin et al., 2016; Pooley et al., 2010; Ramanathan et al., 2014; Tudor-Locke et al., 2001; Waygood et al., 2017; Westman et al., 2013). Furthermore, partaking in physical activity is positively associated with academic performance in young people and can influence brain structure and cognitive performance (Dijk et al., 2014; Singh, 2012). ATS has positive climate impacts, too, because as more people walk and bike in the mornings, fewer cars are on the road, resulting in decreased traffic congestion and greenhouse gas emissions (Bearman and Singleton, 2014; Marshall et al., 2010; Rome, 2011; Singleton, 2014; Wilson et al., 2007). Finally, ATS interventions can also improve equity, as research suggests that investing in walk and bike infrastructure near schools reduces transportation expenses for families (McDonald et al., 2016).

The SRTS program has aimed to promote ATS since Congress incorporated it into the 2005 federal transportation bill SAFETEA-LU, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (McDonald and Aalborg, 2009). A meta-analysis by McDonald et al. (2014) tracked 801 schools from 2007 to 2012 and determined that after schools participated in the program for five years, the proportion of students walking and bicycling to school increased by 31%, on average. Many other studies have also shown that SRTS projects, interventions, and funding increase the likelihood of walking and biking to school (Boarnet et al., 2005a, 2005b; Carlin et al., 2016; Hoelscher et al., 2016; McDonald et al., 2013, 2014). Types of SRTS interventions include physical changes, such as traffic calming, crosswalks, sidewalks, separate bicycle lanes/cycle tracks, and school placement in dense neighborhoods (McDonald, 2010a). Other SRTS interventions are legislative, dealing with school policies encouraging ATS (Chriqui et al., 2012); organizational, including walking school buses, walk or bike to school days, and crossing guards (Mendoza et al., 2011, 2012); and educational, such as creating a school culture that informs students and/or parents about the benefits of ATS through curriculum, family activities, and newsletters (McKee et al., 2007; Villa-González et al., 2017). In this study, providing information on ATS benefits was chosen as a low-cost intervention that could be implemented on a large scale. While the main aim of this research was to examine the impact of an educational intervention, our results suggest benefits from several of the intervention categories just described.

SRTS program evaluation is based on student and parent surveys; information about the reliability of these surveys has implications for the accuracy of our own survey-based study. McDonald et al. (2011b) examined test-retest reliability between a SRTS parent travel survey that was sent home with the student and returned to the teacher and a follow-up survey mailed to the parents two weeks later. The researchers found high reliability on questions about travel mode, travel time, education, and income (objective questions), but more variability in yes/no questions pertaining to parent attitudes and barriers to modes of travel (subjective questions) (McDonald et al., 2011b). In our survey design, we attempted to improve upon the variability of yes/no questions by allowing respondents to select their top three perceived barriers to ATS.

Of great relevance to our study, there has been substantial research on parents' decisions to drive their children to school even short distances. Studying children between the ages of 10 and 14 in Oakland, Berkeley, Albany, and Richmond, CA zip codes, McDonald and Aalborg (2009) used data collected from telephone surveys to investigate parents' reasoning for driving their children to school. 75% percent of parents driving their children less than 2 miles to school cited convenience as a reason, primarily in terms of the "time advantage of driving over walking." Indeed, time constraints are significant ATS predictors for parents (Weigand and McDonald, 2011). Evidence also suggests that parental attitudes about active modes play an important role in ATS behavior, as children are more likely to walk and bicycle to school if their parents value their children's physical activity (Davison et al., 2008). To support a comprehensive model for school travel mode choice, McMillan (2005) introduced a conceptual framework in which ATS behavior is determined by urban form, real and perceived neighborhood and traffic safety, household transportation options, sociodemographics, social/cultural norms, and parental attitudes. Mitra (2013) extended McMillan's proposed framework by including the policy context, natural environment, child's attitudes and physical/cognitive development, and household schedule constraints as additional factors in school travel mode choice. Within this framework, our research targets the interaction between parental attitudes and time constraints in ATS behavior. It examines whether increasing parents' perception of health and academic benefits from ATS decreases their sense that time constraints prevent their children from participating in ATS, by inducing a reprioritization of ATS in their schedules.

1.2. Research objectives and hypotheses

Determining the effect of providing parents with information about the health and academic benefits of ATS could support this approach as a low-cost strategy to encourage walking and biking to school. Specifically, we asked parents, "Is there a single additional morning or afternoon during the week when your child(ren) could walk or bike to or from their elementary school (accompanied or alone)?" For the treatment group, we provided a paragraph about the health and academic benefits of ATS before asking this question. We followed this question with a set of queries about the respondent's characteristics, including socioeconomic information, current school commute modes, distance from school, availability of pedestrian and bicycle infrastructure along the route to school, and perceived barriers to ATS.

The treatment group was hypothesized to yield a higher percentage of parents responding that they have an additional morning or afternoon for ATS. This hypothesis hinged on the idea that parents' perceptions about ATS feasibility can be influenced with new information. After learning about their children's potential health and academic benefits from walking or biking to school even once per week, parents were expected to prioritize ATS in their schedules at a higher rate. This study measured momentary changes in parents' priorities rather than actually asking parents to complete ATS, thereby targeting the effect of the intervention on early stages of behavior change (Prochaska and DiClemente, 1986). Prochaska and DiClemente's Transtheoretical Model of behavior change (TTM) proposes that people changing a behavior move through stages, including "pre-contemplation," "contemplation," "preparation," "action," and "maintenance," and that interventions should target a person's current stage to most successfully move them through the transition to behavior change. Both the control and treatment surveys caused parents to at least momentarily consider what ATS might involve, because answering questions about distance to school, availability of pedestrian and bicycle infrastructure along the route, and potential times to complete ATS led parents to visualize the route they would take with their children and when. With respect to the hypothesized additional impact from providing information on ATS benefits in the treatment survey, Waygood et al. (2012) discuss how presenting information on new travel modes can cause people to move from "pre-contemplation" to "contemplation" of mode change by helping them understand the benefits and drawbacks of the switch. Bamberg (2014) also suggests that, while positive information about alternatives may not be sufficient to change behavior, it can support deliberate decision-making. Accordingly, parents provided with information about ATS health and academic benefits were expected to more carefully consider potential modifications to their schedule that would make occasional ATS possible, thus more fully shifting to "contemplating" ATS than parents who did not receive the information about ATS benefits.

TTM has been criticized for lack of evidence that interventions targeted to the proposed stages are more successful at changing behavior than non-targeted interventions, or that moving people from one early stage to the next increases the likelihood of behavior change (West, 2005, 2006). However, the critique agrees that "individuals who are thinking of changing their behavior are more likely to try to do so than those who are not" and that "people who try to do something are more likely to succeed than those who do not" (West, 2005). It also recommends that interventions aim to shift individuals' "moment-to-moment balance of motives" to consistently favor the desired alternative behavior. Borrowing the TTM language of "pre-contemplation" and "contemplation" in this study simply helps to convey the intervention's desired effect of causing parents to consider trying ATS, while the research itself actually measures the effectiveness of beneficial information about ATS in shifting this "moment-to-moment balance of motives" in schedule prioritization.

2. Methodology

The data required to complete this study come from surveys distributed to parents with children in elementary school in Alameda County and the City of Richmond, California, which are situated on the east side of the San Francisco Bay across from San Francisco. 41 elementary school Parent Teacher Associations (PTAs) were selected for outreach based on the schools' socioeconomic diversity, terrain conducive to walking and biking, and geographic diversity within the East Bay. This was done to increase the heterogeneity of respondents so the models would be informed by a rich dataset. We also hoped this would allow an analysis of equity with regard to ATS behavior and perceptions, for ATS behavior has been shown to differ across income and ethnicity groups (Babey et al., 2009).

The web-based survey was offered in English and Spanish and was distributed using Qualtrics. Surveys in both languages were pretested by numerous individuals to ensure comprehension and ease of use. Two schools were provided with paper surveys upon request. The survey was advertised by contacting PTAs that then distributed the survey via their member email lists. Besides individual school PTAs, umbrella PTA organizations such as the Peralta District PTA were contacted, and they then distributed the web-based survey to their constituent elementary school PTAs. When parents visited the survey link, they were randomly assigned to the treatment or control group. The information about ATS benefits was provided as a treatment to approximately half of the survey takers, while the control group was given the same survey without this information. Precautions were taken to ensure anonymity and that any information leaked would pose minimal risk to the well-being of the parents and their children.

To assess the effect of information about ATS benefits on parent perceptions, we asked questions about the perceived feasibility of children participating in additional ATS as well as about factors other than the benefits information that may influence this perception. These factors included current school travel mode choice and the perceived barriers that hinder participation in ATS. Sociodemographic data were obtained through questions on household income, ethnicity, parents' education level, number and ages of children in the household, presence of an adult with a flexible work schedule, and number of vehicles owned or leased, as these factors were expected to influence mode choice to school and potential response to the treatment. Survey questions also asked about travel time to school via several modes of transportation, perceived presence of walking and biking infrastructure on the route to and from school, and participation in after-school activities on and off the school campus. The complete survey is available from the corresponding author upon request.

Using the data collected from this survey, two discrete choice models were built to investigate school travel decisions and suggest potential policies to support ATS. Discrete choice models describe choices between alternatives, with the characteristics of the respondents and of the alternatives incorporated as indicators that drive these choices. These models determine the significance of several factors influencing parents' school travel mode choice, such as household income or walk time to school. Discrete choice models can also forecast growth or decline in participation of ATS through policy and infrastructure interventions, such as improved walking facilities. Both models were built using a Python coding package called PyLogit (Brathwaite and Walker, 2016). All variables included in the model were dummy variables, meaning they had a value of one if the characteristic was true for that respondent and a value of zero if it was not true.

The first model is a binary logit model, with the two choices being the parent perceiving that there was or was not an additional morning or afternoon during the week when their child could walk or bike to or from school. All variables asked about in the survey were tested in this model to determine whether they had a statistically significant impact on parent perception of ATS feasibility. Parents who reported that their children already walked or biked to and from school every morning and afternoon were excluded from this model because it was not possible for them to find an additional time to participate in ATS.

The second model is more general, as it focuses on the current frequency of ATS and does not depend on presence of the ATS benefits statement. It is a multinomial logit model, with alternatives of participating in ATS every day, frequently (once or more per week), infrequently (a few times a year or once a month), or never. While the ordered outcome variables could warrant the use of an ordered logit or ordered probit model, we chose multinomial logit because our data did not support the proportional odds assumption underlying the ordinal models. As with the first model, this multinomial logit model was built by testing all variables asked about in the survey to see if they had a statistically significant impact on the frequency with which parents allowed their children to perform ATS. The results of these models and their policy implications are discussed in the following sections.

3. Results

245 parents responded to the survey. 49 of these reported doing ATS every morning and afternoon, and were thus removed from the data when creating the model that focused on parents' perception of whether there was an additional morning or afternoon for ATS. The small sample size raises concerns about response bias, especially as White and high-income families are overrepresented in the sample. These problems are discussed further at the end of the results section and in the study limitations section of this article.

The survey results were first analyzed to determine if the paragraph on ATS benefits impacted the number of parents responding that there was an additional morning or afternoon during the week when their children could walk or bike to or from school. Although a slightly larger portion of the treatment group reported that their children could participate in ATS an additional time (30 out of 72, compared to 45 out of 125 for the control group), the difference was not statistically significant (p-value of .20).

The first model shows which attributes or characteristics influence parents' likelihood of perceiving that their children have an additional morning or afternoon during the week for ATS. The results for the first model are shown in Table 1. When the walk time to school is 30 minutes or less, parents are more likely to perceive that there is an additional morning or afternoon for ATS. If both parents have a bachelor's or more advanced degree, parents are less likely to perceive additional ATS as feasible. These findings match those of Larouche et al. (2015) that school travel time and parent education are negatively correlated with ATS behavior in the United States. Finally, our model also shows the intuitive results that parents are less likely to perceive ATS as feasible if the route to school lacks sidewalks or if their children participate in after-school activities somewhere other than at school.

The baseline probability among our sample of perceiving that there is an additional morning or afternoon for ATS is 38%. Plugging values from our sample into the model indicates that this probability would increase to 42% if all after-school activities were moved to the school campus, to 44% if all families had sidewalks the entire length of the route to school, to 68% if walk time to school fell to between 10 and 30 minutes for families that currently have walk times greater than 30 minutes, and to 76% if all families had walk times to school of 10 minutes or less. Among the 35% of our sample whose children have off-campus after-school activities, the model predicts that shifting those activities to the school campus would increase their probability of perceiving that there is an

Table 1
Binary logit model of perception of ATS feasibility.

β_i	Coefficient	Standard error	$P > \|z\|$
Alternative Specific Constant	**-0.839**	**0.490**	**0.087**
5 or 10 min walk time to school	***3.779***	***0.724***	***0.000***
15, 20, 25, or 30 min walk time to school	***3.297***	***0.481***	***0.000***
(35 min or greater walk time to school)	(0)	(—)	(—)
Both parents have at least a bachelor degree	***-1.067***	***0.452***	***0.018***
(One or both parents have less than a bachelor degree)	(0)	(—)	(—)
Child in after-school activities not on school campus	***-0.961***	***0.456***	***0.035***
(Child in after-school activities on school campus or child not in after-school activities)	(0)	(—)	(—)
Sidewalks none or only some of the way to school	***-1.334***	***0.526***	***0.011***
Sidewalks half or most of the way to school	-0.513	0.521	0.324
(Sidewalks all the way to school)	(0)	(—)	(—)
Log-likelihood at zero	-135.9		
Log-likelihood at convergence	-74.0		
Number of observations	196		

[a] $p < 0.05$ is bold and italicized; $p < 0.10$ is bold. Some non-significant results are left in to show trends.
[b] These coefficients are all for the case of perceiving that there is an additional morning or afternoon during the week for ATS. The base case is perceiving that there is not an additional morning or afternoon for ATS. The reference variables for each category of coefficients are shown in parentheses. The coefficients of the base case and the reference variables have been restricted to zero.

Table 2
Multinomial logit model of frequency of ATS behavior.

β_i	Coefficient	Standard error	$P > \|z\|$
Alternative Specific Constant			
Never	0	—	—
Infrequently (a few times per year or once a month)	***-1.093***	***0.411***	***0.008***
Frequently (once or more per week)	***-1.749***	***0.445***	***0.000***
Every Day	***-3.182***	***0.737***	***0.000***
Owns 3 or more vehicles			
Never	0	—	—
Infrequently	***1.433***	***0.561***	***0.011***
Frequently and Every Day	0.430	0.776	0.580
(Owns fewer than 3 vehicles)	(0)	(—)	(—)
Adult with flexible work hours in household			
Never, Infrequently, and Frequently	0	—	—
Every Day	***1.416***	***0.630***	***0.025***
(No adult with flexible work hours in household)	(0)	(—)	(—)
5 or 10 min walk time to school			
Never	0	—	—
Infrequently	***2.827***	***1.229***	***0.021***
Frequently	***5.126***	***1.147***	***0.000***
Every Day	***6.963***	***1.173***	***0.000***
15, 20, 25, or 30 min walk time to school			
Never	0	—	—
Infrequently, Frequently, and Every Day	***2.192***	***0.425***	***0.000***
(35 min or greater walk time to school)	(0)	(—)	(—)
Sidewalks none or only some of the way to school			
Never	0	—	—
Infrequently, Frequently, and Every Day	***-1.765***	***0.491***	***0.000***
Sidewalks half or most of the way to school			
Never	0	—	—
Infrequently, Frequently, and Every Day	***-1.135***	***0.482***	***0.019***
(Sidewalks all the way to school)	(0)	(—)	(—)
Minority			
Never	0	—	—
Infrequently	-0.039	0.488	0.936
Frequently	-0.945	0.637	0.138
Every Day	***-1.445***	***0.692***	***0.037***
Prefer not to provide ethnicity			
Never	0	—	—
Infrequently	-0.252	0.648	0.698
Frequently	-0.821	0.810	0.310
Every Day	***-3.219***	***1.344***	***0.017***
(Non-Hispanic White)	(0)	(—)	(—)
Perceive weather as a barrier to ATS			
Never	0	—	—
Infrequently	**2.254**	**1.189**	**0.058**
Frequently and Every Day	***3.994***	***1.179***	***0.001***
(Do not perceive weather as a barrier to ATS)	(0)	(—)	(—)
Log-likelihood at zero	-339.6		
Log-likelihood at convergence	-190.2		
Number of observations	245		

[a] $p < 0.05$ is bold and italicized; $p < 0.10$ is bold. Some non-significant results are left in to show trends.
[b] The coefficients of the base case ATS frequencies have been restricted to zero. The reference variables for each category of coefficients are shown in parentheses. The coefficients of the reference variables have been restricted to zero.

additional morning or afternoon for ATS from 30% to 41%. Of course, these predictions are only coarse approximations, as using the model to estimate responses to policy interventions involves many assumptions, including that the relationships in the model remain valid across a range of values for the independent variables and that the independent variables are uncorrelated.

The second model provides insight on the behavior of the parent by estimating parameter coefficients for factors that influence how frequently people walk or bike to school with their child or allow their child to walk or bike to school on their own. The alternatives in this model involve participating in ATS never, infrequently, frequently, and every day. The model results are shown in Table 2. This model confirms the *a priori* hypotheses in many ways. For example, sidewalk infrastructure and shorter walk times to school are correlated with more frequent ATS behavior. Also, if there is a parent with flexible work hours in the household, the child is more likely to participate in ATS every day. Interestingly, if the respondent cites weather as a barrier to ATS, their children are more likely to participate in ATS frequently or every day. This may be because children often doing ATS are more likely to notice weather as a factor that occasionally prevents them from walking or biking to school. Owning three or more vehicles, meanwhile, increases the likelihood of participating in ATS infrequently as compared to never, frequently, or every day. This could stem from a combination of social class and affinity for driving; parents with three or more vehicles may be wealthier and thus more likely to engage in occasional school-organized "walk-or-bike-to-school days," as indicated by research showing that parent involvement in elementary school events is correlated with income (Lee and Bowen, 2006). However, parents with three or more vehicles may also have more affinity for driving that leads them to drive their children to school the rest of the time. Unfortunately, we could not test the significance of owning no vehicles or one vehicle due to insufficient representation of families with these characteristics in our sample.

Among our sample, the baseline probability of never doing ATS is 42%, doing ATS infrequently is 20%, frequently is 15%, and every day is 22%. Plugging values from our sample into the model as before indicates that these probabilities would change to 32%, 28%, 17%, and 23%, respectively, if all families had sidewalks along the entire length of their routes. They would change to 23%, 34%, 19%, and 24% if walk time to school fell to between 10 and 30 minutes for families that currently have walk times greater than 30 minutes. Reducing walk time to school to ten minutes or less for all families in our sample would decrease the probability of never doing ATS to 4% and that of infrequent ATS to 9%, while increasing the probability of frequent ATS to 25% and everyday ATS to 62%. Again, these estimated outcomes are only rough approximations.

Factors that were not statistically significant in either of the models were household income (the first and second models had p-values of 0.58 and 0.17, respectively, for household incomes greater than 140K, and of 0.74 and 0.78 for 100K to 140K, with less than 100K as the reference variable); number of children (with one child as the reference variable, p-values of 0.21 and 0.43 for two children and of 0.50 and 0.88 for three or more children); and perceiving terrain (0.40 and 0.75), child schedules (0.89 and 0.54), parent schedules (0.28 and 0.30), or the need to carry things (0.76 and 0.69) as barriers to ATS. The references for this last set of variables are not perceiving these factors as barriers. In this paragraph, the p-values listed for the second model are for participating in ATS at all, with never participating in ATS as the base case. The lack of significance for household income could be due to insufficient variation in this variable among our sample, as described in the following paragraph. Finally, while the structure of our survey did not allow testing how ATS behavior varied with children's age or grade level, this relationship is an important focus for future research.

The survey results were analyzed to determine if the sample was representative of the population of students attending school in Richmond and Alameda County. White respondents were overrepresented in our sample, making up 51% of our sample but 19.5% of the target population, while Hispanic and Black respondents were underrepresented, making up 4% and 2% of our sample but 34% and 11% of the target population, respectively (Education Data Partnership, 2016). Other minority groups were also underrepresented, with Asians, Filipinos, and Native Hawaiian or Pacific Islanders making up 16%, 0%, and 0% of the sample but 24%, 5%, and 1.1% of the target population. Parents with household incomes over $140k were overrepresented in our sample, making up 56% of those who reported income as opposed to about 31% in the target population (U.S. Census Bureau, 2015). All other income brackets were underrepresented, especially those with household incomes between 30k and 60k and those making less than 30k, which made up 5% and 1% of our sample but about 18% and 15% of the target population, respectively.

Current commute patterns among respondents were analyzed to determine if they matched with that of the target population. Respondents were allowed to select all the modes their children take to or from school during an average week, and many respondents selected multiple modes. About 73% of respondents reported car as a frequent mode to and from school, while about 28% reported walk as a frequent mode, about 12% reported bike, about 8% reported carpool, and about 4% reported bus. While frequency of ATS behavior is not currently collected for the target population, the Metropolitan Transportation Commission reported that, during the 2013-14 school year, 52% of Alameda County students reported riding in the family car to and from school, 30% reported walking, 3% reported biking, 8% carpool, and 3% school bus (MTC, 2015). Our results appear roughly representative, as bicycle may appear more often in our "frequent mode" data because it was allowed to be reported as one of many modes.

4. Discussion

The two logit models were used to interpret potential policy and equity implications for promoting ATS. The results support other studies' findings that providing sidewalks along the route to school, offering walking school buses (WSBs), and enabling shorter walk times to school through school siting practices and denser development would increase perception of ATS feasibility as well as actual ATS behavior. This study also supports the novel intervention of increasing provision of after-school activities on the school campus as a way to increase perception of ATS feasibility. The results further add to the literature in showing that providing parents with information about the health and academic benefits of ATS did not affect perception of ATS feasibility. The findings depart from other studies in that, after accounting for other factors, minorities were measured as less likely to participate in ATS every day. Each of these results is discussed below.

First, while the information about ATS benefits was not found to have a significant effect on the proportion of parents who perceived that there was an additional morning or afternoon for ATS, this does not mean that providing information about ATS benefits is an ineffective strategy to encourage ATS–nor is it evidence for or against the stages of behavior change model. Rather, it indicates that providing parents with a short, written summary of ATS health and academic benefits does not shift the "moment-to-moment balance of motives" underlying school travel decisions (West, 2005). Interventions involving provision of benefits information at a larger scale may successfully achieve this shift. For instance, perhaps communicating the benefits to parents in person or having the information repeated by teachers, at PTA meetings, in school assemblies, and even by family pediatricians would have led to a statistically significant increase in parent perception of ATS feasibility, as suggested by McKee et al. (2007) and Villa-Gonzalez et al. (2017). Our results do support several other interventions, as discussed below.

Based on the results of the behavior model, providing more sidewalks along common routes to school would increase ATS behavior, echoing the results of Boarnet et al. (2005a, 2005b). Among our sample, ensuring that all families have sidewalks along the entire route to school would increase the probability of everyday, frequent, and infrequent ATS from 22% to 23%, 15% to 17%, and 20% to 28%, respectively, while reducing the probability of never doing ATS from 42% to 32%. The provision of sidewalks could also be expanded to providing other amenities, such as crossing guards or signed and flashing pedestrian crossings, to increase the perceived and actual safety of ATS.

The location of after-school activities is another factor that our model shows influences the perception of ATS feasibility. The first model indicates that having after-school activities that are not on the school campus decreases parent perception of ATS feasibility. Hence, planning more after-school activities to occur on or near campus could promote ATS. We could not find discussion of this intervention in other research. Having more after-school activities located on campus means parents do not have to shuttle children to different sites, thus allowing for the option of active transportation from school to home after the activity has ended. The Oakland Unified School District (OUSD) is currently working with the California Department of Education and Oakland Fund for Children and Youth Funding to provide after-school programs at schools, and there are already 42 elementary school OUSD after-school program sites (OUSD, 2017). OUSD's design and plan for after-school programs could be used as an effective guide for other school districts.

Both models indicate that enabling shorter average distances and walk times to school would be the most effective way to increase ATS in the long run. Promoting school placement in dense areas and increasing dense, mixed-use development around existing schools would reduce average distance and travel time to and from school. As described in McDonald (2010), school siting practices should support "community-centered" schools that are small in size, fit into the served neighborhood, and safe for children to access by walk or bike. Local and regional land planners should work with school facility planners to ensure the provision of safe pedestrian and bicycle infrastructure around school sites.

A short-term solution that reduces walk time for parents are WSBs. WSBs consist of an adult walking with children along a known route with pedestrian infrastructure to and from school. Parents can volunteer to trade off days supervising the WSB or the school can pay trained adults to fill this role (Waygood et al., 2015). This intervention builds on our finding that families are more likely to do ATS every day when at least one adult in the home has flexible work hours. A WSB provides another adult to supervise children along the walk to school and thus mimics the role of an adult in the home with flexible hours. WSBs have been shown to increase and sustain ATS behavior and have also shown positive results for urban, low-income elementary school students (Mendoza et al., 2009, 2012). WSBs should be implemented in a 30-minute walk radius from schools to target families in this zone, which the models show currently have an inclination to do ATS. This recommendation is consistent with research by McDonald and Aalborg (2009), which estimated that WSBs could affect the behavior of 60% of parents who presently drive their children less than 2 miles to school.

The short-term and long-term solutions presented in this paper must consider possible equity implications. While our model indicates that minorities are less likely to do ATS every day (after accounting for other factors), this may be because Hispanic and Black respondents were highly underrepresented in our sample. A consistent finding in the ATS literature is that Hispanic and Black students are more likely to walk or bike to school and to do so without safe commute infrastructure, such as sidewalks, lighting, or marked crosswalks (McDonald, 2008; Royne et al., 2016). Those who actively commute are also more likely to be exposed to violence, air pollution, and high traffic levels (Pabayo et al., 2012; Pooley et al., 2010). Safe sidewalks and other pedestrian and bicycle infrastructure should be provided in low-income and minority neighborhoods. After-school programs, especially those on the school campus, should be fully funded or free to students from low-income families. WSBs and community-centered schools in low-income and minority neighborhoods should aim to reduce the potential for unsafe commutes. Barriers to ATS for underserved communities should be assessed through effective outreach, such as assistance programs or public meetings. The results from this paper, and from assessment of local conditions, should be presented to local governments to encourage the development of policies and bike/pedestrian plans that prioritize investment in low-income areas. Collaboration between schools, social justice groups, active transportation programs, and local and regional jurisdictions will be necessary to address equity issues that arise in the development of solutions that improve and encourage ATS.

4.1. Study limitations

The study has several limitations regarding the use of a survey and discrete choice models as well as applicability of the results to urban areas outside of Alameda County and Richmond. Understanding these limitations allows more informed interpretations of the model results.

First, the use of a survey could lead to respondents' lack of comprehension, policy response bias, and selection bias, all of which could affect the data. For instance, respondents in the treatment group may have had an incomplete understanding of the ATS benefits statement. If this statement was not fully understood, the effect of the treatment may not have been as strong when parents considered whether there was an additional morning or afternoon for ATS. We aimed to avoid this problem with a simple question asking for an answer that, if the respondent understood the statement, was apparent. Some respondents in the treatment group did not answer this question correctly, and were thus removed from the data used to develop the model. Policy response bias is when the respondent answers questions thinking that there is a "correct" answer. For example, parents may have said their children walk or bike to school once a week, but in truth, they do so much less frequently. The data collected also exclude a significant portion of parents that could have participated. Since the distribution method of these electronic surveys was through PTAs, parents who are not on the PTA email list were not represented. We received no responses to the Spanish or paper versions of our survey, indicating lack of representation of parents with language or technology barriers to participation. The skew in our sample towards White and high-income respondents could also indicate self-selection bias among those who chose to take the survey. While we had responses from 50 unique schools, slightly over half of the responses were from just four schools, which tended to have high test scores. This could skew results toward characteristics unique to those schools. The treatment group could also suffer from self-selection bias, as respondents whose surveys began with information about ATS benefits may have been more likely to continue if their child already performed ATS.

Another aspect of this study with limitations is the use of a discrete choice model to determine the significance of factors that influence ATS perceptions and behavior. The logit model used to explain patterns in the data relies on assumptions that may not be reasonable. One assumption is that decision-makers are highly rational and know their entire choice set and the characteristics of each alternative. The model also assumes that decision-makers aim to maximize utility, an unobserved parameter comparable to "happiness." While in some settings these assumptions work, parents may not act rationally nor be trying to maximize utility. There may be other models that could better capture parents' behavior, such as the random regret model, where decision-makers minimize the anticipated regret of a decision. The decisions that maximize utility may not be those that minimize regret, especially when parents are faced with decisions relating to their children's safety.

Lastly, this study was conducted in Alameda County and Richmond, California, where parents may have different attitudes toward ATS than parents living in other parts of the country. Also, since the study was done in a highly urbanized region, the results may not suitably inform policy in rural communities where the built environment and barriers to ATS are different.

4.2. Policy recommendations and future research

While providing parents with information about ATS health and academic benefits was found not to have a statistically significant impact on parent perception of ATS feasibility, this research yielded results that support several other policy recommendations to promote ATS. The first four recommendations are in order of increasing time and/or cost to complete, while the fifth applies to all planned interventions:

1. Organize WSBs and other programs that reduce the time cost of ATS for parents.
2. Promote use of school buildings and grounds for after-school activities to limit the need to travel between locations.
3. Construct sidewalks and other pedestrian and bicycle infrastructure on routes to school.
4. Build schools in areas with dense, mixed-use development and encourage such development around existing schools.
5. Examine the equity implications of any interventions and involve vulnerable populations such as low-income individuals, minorities, disabled individuals, and women in the planning and implementation process.

Models estimated from responses to our survey indicate that these interventions would increase parent perception of ATS feasibility, increase the probability of participating in ATS frequently or every day, and decrease the probability of never doing ATS. This would in turn decrease VMT and congestion associated with school travel from their current levels of 5-7% of total VMT and 10-14% of private vehicles on the road during morning peak hours.

Regarding the last policy item about ATS equity, future research is recommended to better understand the factors influencing ATS behavior and perception of ATS feasibility among low-income and minority families in the East Bay. Such research should include targeted outreach to schools with high proportions of low-income, minority, and English as a Second Language students, potentially through in-person communication with community groups and after-school activities associated with these schools. More complete and representative data from these families would inform strategies to meet their specific needs and also improve the models presented in this paper, enabling a stronger analysis of the impact of policy interventions on ATS levels in Richmond and Alameda County, California.

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