

Impacts of parental gender and attitudes on children's school travel mode and parental chauffeuring behavior: results for California based on the 2009 National Household Travel Survey

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Abstract Research has shown that parental attitudes are a significant predictor of children's active commuting (walking or biking) to school. However, the impact of parental gender on parental attitudes, and the link between parental attitudes and the gender gap in parental chauffeuring behavior have not received much attention. This paper examines these questions by applying discrete choice models to California data from the 2009 National Household Travel Survey while controlling for a wide range of variables characterizing parents, their children, households, schools, and the local built environment. Our results, conveyed via odds ratios, show that mothers are more likely to have higher concerns about traffic volume, which in turn reduces the likelihood that their children will walk or bike to school. Moreover, even though parental attitudes significantly influence parental chauffeuring behavior, their ability to explain the gender chauffeuring gap is limited. When holding equal concerns, mothers are still more likely than fathers to chauffeur their children to school. Finally, while distance to school and several land use measures (e.g., population density, urbanization level, and percentage of renters) are statistically significant, the impact of an objective measure of walkability is quite small. These results suggest that interventions targeting an increase in children's walking and biking to school should focus on the concerns of mothers, especially as they relate to traffic characteristics.

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Introduction

Ever since active commuting (walking or biking) to school was proposed as a policy intervention to reduce childhood obesity in the U.S., it has attracted much research attention. Studies have reported that parental attitudes as well as characteristics of children, households, schools, and the local built environment can be significant predictors of children's school travel mode (e.g., Larsen et al. 2009; Leslie et al. 2010; Napier et al. 2011). However, relatively little is known about how parental attitudes are formed, and to our knowledge no research has explicitly discussed the effects of parental gender on parental attitudes toward children's active commuting to school. Since a number of studies indicate that women usually exhibit greater concerns about traffic and street safety for themselves (e.g., Loukaitou-Sideris 2005; Yavuz and Welch 2010), we hypothesize that mothers often have greater concerns about letting their children walk or bike to school, which in turn affects their children's school travel mode.

In addition, children's school travel mode and parental escort behavior are usually jointly decided. Some studies show that mothers usually take more household responsibilities to chauffeur or escort their children even after controlling for work status and commuting patterns (Vovsha and Petersen, 2005; Liu et al. 2012), which has been attributed by some researchers to women's traditional gender roles in the division of household labor (e.g., Schwanen 2007; Giuliano and Schweitzer 2010). However, to our knowledge, gender differences regarding concerns about children's active commuting to school have not yet been analyzed quantitatively to explain the within-household chauffeuring or escorting gap.

Unlike previous research that focuses on the gender of children to explain how children travel to and from school (e.g., McMillan et al. 2006; Leslie et al. 2010; Clifton et al. 2011; McDonald 2012), we investigate specifically how the gender of parents affects parental attitudes (related to distance to school, traffic characteristics, and crime), children's school travel mode, and parental chauffeuring behavior after controlling for land use as well as household, children, and school characteristics; Fig. 1 depicts the relationships we examined and how our study contributes to the literature.

Understanding how gender interacts with attitudes is essential to craft more effective policies to promote walking and biking to school by children. We focus on California because it is the largest state by population, it is an add-on state for the 2009 National Household Travel Survey (NHTS), and its built environment, ethnic composition, and social make-up are quite diverse, which also allows us to examine the impacts of these characteristics on parental attitudes, children's school travel mode, and parental chauffeuring behavior.

Literature review

Given the extensive literature reviews by Davison et al. (2008) and Sirard and Slater (2008), we focus mainly on studies published after 2007 (see Table 1 for a summary).

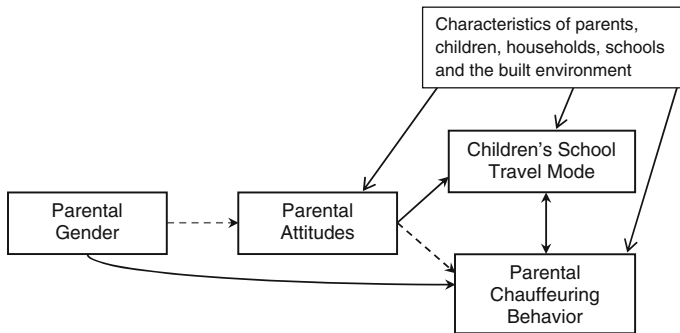


Fig. 1 Conceptual relationships explored in this paper, a *solid link* indicates that it has been explored in the literature; a *dashed link* indicates that it has not yet been explored in the literature and that it is investigated in this paper.

Trends and predictors of children's school travel mode

A number of studies show a decrease in children's active commuting to school over time (McDonald 2007a; Buliung et al. 2009; Grize et al. 2010), with the sharpest decline occurring in the U.S. (McDonald et al. 2011). There is also consistent evidence that girls walk or bike to school less than boys (Yeung et al. 2008; Larsen et al. 2009), but the difference in biking is more prominent (Leslie et al. 2010; McDonald 2012). Moreover, more children travel by active modes from school to home than from home to school (Leslie et al. 2010; McDonald 2012).

Parental attitudes play an important role in children's active commuting to school. Most studies indicate that when parents perceive fewer barriers or more potential benefits, their children are more likely to walk or bike to school (e.g., Hume et al. 2009; McDonald et al. 2011). Kerr et al. (2006) report that parental concerns are the strongest predictor of children's active commuting to school, but school distance was not included in their model.

In addition, parental socio-demographic characteristics such as education level, work status, and commuting patterns have been found to be associated with their children's travel mode to school (McDonald 2008a; Zhu and Lee 2009; Panter et al. 2010).

The effects of parental participation in active or transit transportation have been examined only in a few studies, and the evidence is mixed. From McMillan et al. (2006), the time parents spend on walking can reduce the gender gap in children's active commuting to school, but Babey et al. (2009) disagree. According to Zhu and Lee (2009), regular walking by parents positively correlates with children's walking to school, but their study relies on indirect measures of walking. Moreover, Martin et al. (2007) found that children are more likely to actively commute to school when their parents are physically active.

Several household characteristics also affect children's school travel mode. In general, African-American and Hispanic students, students from low-income families, and students whose households have no access to a car are more likely to walk or bike to school, while White and Asian students, students from high-income families, and students whose households own more cars are more likely to be driven to school (McDonald 2008b; Yarlagadda and Srinivasan 2008; Babey et al. 2009; Rodríguez and Vogt 2009; Zhu and Lee 2009; Clifton et al. 2011).

In addition to gender, children's age is closely related to their school travel mode. While most studies report that older children are more likely to walk or bike to school (e.g., Yeung et al. 2008; Rodríguez and Vogt 2009; He 2011; McDonald et al. 2011), McMillan et al. (2006) found an inverse connection. A few studies also investigated the relationship between children's attitudes and their active commuting to school (Martin et al. 2007; Rodríguez and Vogt 2009; Leslie et al. 2010; Napier et al. 2011). Similar to parental attitudes, children are more likely to walk or bike to school when they believe the built environment is safer and more attractive.

Of various school characteristics, distance between home and school has consistently been found to be the most significant factor of children's active commuting to school (Yeung et al. 2008; Mitra et al. 2010). Moreover, children who attend public school are more likely to walk or bike to school (Babey et al. 2009), but the provision of school bus service has the opposite effect (Zhu and Lee 2009). However, while Braza et al. (2004) find that students are more likely to actively commute to school in smaller schools, Ewing et al. (2004) do not. Also, school quality seems to have no influence on children's active transportation to school (He 2011).

A wide range of land use characteristics has been examined to explain children's school travel mode. Some researchers compare areas with different levels of urbanization (Babey et al. 2009; Grize et al. 2010), communities with different levels of walkability (Panter et al. 2010; Napier et al. 2011), local land use attributes such as density and diversity (McMillan 2007; Larsen et al. 2009; Mitra et al. 2010; Clifton et al. 2011), or the presence of various neighborhood facilities and amenities (Leslie et al. 2010). Overall, the built environment has been found to have significant but small to moderate effects on children's active commuting to school. Although school distance could be seen as a built environment attribute, we categorize it as a school characteristic because households in the same neighborhood may send their children to different schools (e.g., private schools or some magnet schools).

Factors influencing parental attitudes and escort behavior

Although parental attitudes are a significant predictor of children's school travel mode, only a few papers discuss how parental attitudes are shaped. Lam (2001, 2005) find that fathers, parents of older children, and parents who work full-time, who have experienced injuries, or who speak Chinese or Arabic (used as a proxy for culture) tend to perceive roads as less dangerous for their children. School location matters: the closer the school is, the less likely the parents are to be concerned about children's active commuting to school (Seraj et al. 2012). The built environment also influences parental attitudes: living in neighborhoods with less traffic and a higher walkability can reduce parental concerns (Lam 2001; Kerr et al. 2006; Napier et al. 2011). Parents also express concerns about gangs and fights when their children travel to and from school in neighborhoods with high crime and violence rates (Meyer and Avi Astor 2002). Moreover, mothers who have a higher fear of crime and a lower sense of community are more likely to be concerned about the outdoor safety for their children (Prezza et al. 2005), which suggests that parents extend their own concerns to their children.

Studies of parental escort behavior consistently report that mothers are more likely than fathers to perform chauffeuring or escort duties (e.g., Schwanen 2007; Liu et al. 2012), and women's traditional gender roles in the division of household labor is the most common explanation. Work status and commuting patterns also significantly affect parental escort behavior: parents who do not work or who work part-time, and parents who enjoy more

flexibility at work and whose workplace is closer to home are more likely to chauffeur or escort their children (e.g., Yarlagaadda and Srinivasan 2008; Liu et al. 2012). Moreover, land use characteristics such as accessibility, population density, and residential location are related to parental chauffeuring or escorting (e.g., Schwanen 2007; Yoon et al. 2011).

However, while children's school travel mode and parental escort behavior are believed to be jointly decided, we found only one paper (Yarlagaadda and Srinivasan 2008) that examines them jointly, and no statistical study that explores if parental attitudes explain gender differences in escorting children to school (McDonald and Aalborg (2009) relied on open-ended interviews to explore why parents drive their children to school). These limitations motivate our work.

Data

NHTS data

The 2009 NHTS provides a unique opportunity to analyze the relationship between parental gender, parental attitudes, children's school travel mode, and parental escort behavior. In the California add-on sample, which we analyze in this paper, one parent per household was asked to answer a series of questions regarding safe routes to school for one of their randomly selected children aged 5–15 years. In addition to children's usual travel mode to and from school, these questions probe parental attitudes about distance to school, traffic characteristics (volume and speed), crime, and the weather, as these attitudes may motivate parents to allow their children to walk or bike to and from school. We do not analyze parental concerns about the weather since it is usually not a restrictor in California.

Of the 2,857 respondents who answered these questions, 1,642 live within 2 miles from school. We focus on these households since active commuting to school does not seem a reasonable option for children living more than 2 miles away from school (according to Nelson et al. (2008), 2.5 miles is a barrier beyond which children are unlikely to walk or bike to school). 729 respondents who live within 2 miles from school also completed a travel diary for their children, thus providing information about children's school travel mode and whether or not the parents surveyed accompanied their children to school on their survey day. A child's earliest trip from home to school as a student on his/her survey day was counted as a trip to school when data were extracted from the travel diary. Detailed socio-demographics and some land use characteristics are also available in the 2009 NHTS dataset.

From travel diary data, 464 of 729 children were driven to school on their survey day, 229 walked or biked, and 36 used transit. Moreover, 57 % of children who went to school by car on their survey day were chauffeured by their parent who was surveyed; only 4 % of children who walked or biked to school were escorted by their parent who was surveyed, and no child who used transit to school was accompanied by their parent who was surveyed. These numbers show a very low parental escort rate for non-automobile trips. Although children who were not escorted by their parent surveyed might have been accompanied to school by other household members, friends, or neighbors, we focus on school chauffeuring out of concern for the robustness of our results.

For brevity, Table 2 only lists the definition of explanatory variables considered in our models; descriptive statistics for all dependent and explanatory variables are available in the electronic supplementary material. Of the four issues related to children's walking and biking to school, parents are more worried about traffic characteristics (volume and speed),

Table 2 continued

	Variable	Meaning
See Table S1 in the Electronic Supplementary Material for summary statistics <i>mi</i> mile, <i>mi</i> ² square mile, <i>k</i> 1,000, <i>m</i> million ^a Continuous or count variable; all others are binary variables ^b Measured at the census block group level	resdn2 ^b	Housing density/mi ² : 500–10,000
	resdn3 ^b	Housing density/mi ² : >10,000
	renter1 ^b	Renter-occupied housing: 0–15 %
	renter2 ^b	Renter-occupied housing: 15–35 %
	renter3 ^b	Renter-occupied housing: 35–55 %
	renter4 ^b	Renter-occupied housing: 55–75 %
	renter5 ^b	Renter-occupied housing: 75–100 %
	walkscore ^a	Home location walkscore (0–100)

while distance to school and crime are less of a concern. Most children travel to school by car, 32 % by active mode, and 5 % by public transit (including school bus). The situation is similar for returning home from school, although fewer children are driven home. On their survey day, 58 % of children who went to school by car were chauffeured by their parent who was surveyed.

In our dataset, most households include two adults, live in urban areas, have a higher income, and own two or more cars. Moreover, 62 % of the respondents who completed the safe routes to school questions for their children are female, which may suggest that mothers are the main caregivers for their children.

Walk score data

In addition to NHTS data, we collected walk scores from walkscore.com for each respondent's home location after obtaining home location information from Caltrans. The walk score of a residence, which ranges from 0 to 100 (where higher values denote higher walkability), is based on distance to amenities (such as stores, restaurants, schools, and parks) and the design of surrounding streets (such as length of street blocks and density of street intersections). For more details, see www2.walkscore.com/pdf/WalkScoreMethodology.pdf. The walk scores of home locations in our sample, shown in the electronic supplementary material, suggest that we cover communities with a wide range of walkability levels.

Methodology

In the following, \mathbf{X}_i is a $1 \times k$ vector of explanatory variables for child “ i ”. Before finalizing our results, we performed the relevant specification tests recommended in Long and Freese (2006), including checks that multicollinearity is not a problem here.

Binary logit model

To explore the factors associated with parental chauffeuring behavior, we relied on a binary logit model. Our dependent variable, which is denoted by y , equals 1 if child i was chauffeured to school by his/her parent who was surveyed, and 0 otherwise. The probability that child “ i ” was chauffeured to school by the parent surveyed is then given by (Greene 2008):

$$\Pr(y_i = 1 | \mathbf{X}_i) = \frac{\exp(\beta_0 + \mathbf{X}_i \boldsymbol{\beta})}{1 + \exp(\beta_0 + \mathbf{X}_i \boldsymbol{\beta})}, \quad (1)$$

where $\boldsymbol{\beta}$ is a $k \times 1$ vector of unknown parameters. The odds of observing $y_i = 1$ versus $y_i = 0$ are

$$\Omega(\mathbf{X}_i) = \frac{\Pr(y_i = 1 | \mathbf{X}_i)}{\Pr(y_i = 0 | \mathbf{X}_i)} = \exp(\beta_0 + \mathbf{X}_i \boldsymbol{\beta}). \quad (2)$$

If we denote by $\Omega(\mathbf{X}_i, x_j + \delta)$ the odds obtained by adding $\delta > 0$ to explanatory variable x_j ($j \in \{1, \dots, k\}$) in (2), the odds ratio for variable x_j is given by

$$\frac{\Omega(\mathbf{X}_i, x_j + \delta)}{\Omega(\mathbf{X}_i)} = \exp(\delta \beta_j). \quad (3)$$

Hence, increasing x_j raises the likelihood that a student will be chauffeured by a parent if and only if $\exp(\delta \beta_j) > 1$, which holds provided $\beta_j > 0$; we thus report odds ratios (OR) $\exp(\beta_j)$, $1 \leq j \leq k$.

Multinomial logit model

To analyze factors associated with children's school travel mode, we estimated a multinomial logit model for our dependent variable y , which can take three values: active mode (walking or biking; A), car (C), or transit (including school bus; T). With this model, the probability of mode $m \in \{A, C, T\}$ compared to mode $n \in \{A, C, T\} \setminus \{m\}$ for child " i " is (Long and Freese 2006):

$$\Pr(y_i = m | \mathbf{X}_i) = \frac{\exp(\beta_{m|n,0} + \mathbf{X}_i \boldsymbol{\beta}_{m|n})}{1 + \sum_{q \in \{A, C, T\} \setminus \{n\}} \exp(\beta_{q|n,0} + \mathbf{X}_i \boldsymbol{\beta}_{q|n})}, \quad (4)$$

where the $\boldsymbol{\beta}_{q|n}$ s are $k \times 1$ vectors of unknown parameters and the $\beta_{q|n,0}$ s are unknown parameters. Thus, the odds of mode $m \in \{A, C, T\}$ versus mode $n \in \{A, C, T\} \setminus \{m\}$ for child " i " are

$$\Omega_{m|n}(\mathbf{X}_i) = \frac{\Pr(y_i = m | \mathbf{X}_i)}{\Pr(y_i = n | \mathbf{X}_i)} = \exp(\beta_{m|n,0} + \mathbf{X}_i \boldsymbol{\beta}_{m|n}). \quad (5)$$

As a result, if $\Omega_{m|n}(\mathbf{X}_i, x_j + \delta)$ denotes the odds obtained by adding $\delta > 0$ to explanatory variable x_j ($j \in \{1, \dots, k\}$) in (5), the odds ratio of mode m relative to mode n for variable x_j is

$$\frac{\Omega_{m|n}(\mathbf{X}_i, x_j + \delta)}{\Omega_{m|n}(\mathbf{X}_i)} = \exp(\delta \beta_{m|n,j}). \quad (6)$$

Hence, an increase in x_j increases the likelihood that a respondent will use mode m relative to mode n if $\exp(\delta \beta_{m|n,j}) > 1$, which holds if and only if $\beta_{m|n,j} > 0$, and it decreases this likelihood otherwise. We thus report odds ratios (OR_{m|n}) $\exp(\beta_{m|n,j})$, $1 \leq j \leq k$.

One implication of Eq. (5), which is important for model specification, is that the odds of a paired comparison do not depend on other alternatives (independence of irrelevant alternatives, or IIA), which we assessed using Hausman and Small-Hsiao tests (Greene 2008).

Generalized ordered model

We estimated generalized ordered models to analyze factors associated with parental attitudes toward children’s walking and biking to school. Parental attitudes originally collected via a 5-point Likert scale were recoded into three ordinal outcomes captured by a dependent variable y to obtain better balanced categories and to simplify our analysis: “not an issue” and “a little bit of an issue” were merged into “1 = low concern”; “somewhat of an issue” was relabeled “2 = medium concern”; and “very much an issue” was merged with “a serious issue” into “3 = high concern”.

The generalized ordered model for choice $q \in \{1, 2, 3\}$, can be written (Williams 2006):

$$\Pr(y_i = q) = \begin{cases} 1 - F(\tau_1 + \mathbf{X}_i\boldsymbol{\beta}_1), & \text{if } q = 1, \\ F(\tau_1 + \mathbf{X}_i\boldsymbol{\beta}_1) - F(\tau_2 + \mathbf{X}_i\boldsymbol{\beta}_2), & \text{if } q = 2, \\ F(\tau_2 + \mathbf{X}_i\boldsymbol{\beta}_2), & \text{if } q = 3, \end{cases} \quad (7)$$

where $\boldsymbol{\beta}_1$ and $\boldsymbol{\beta}_2$ are $k \times 1$ vectors of unknown parameters to be estimated jointly with unknown “cutpoint” coefficients τ_1 and τ_2 ; and the link function F is a cumulative distribution function; assuming that $F \sim \text{logistic}(0, \pi^2/3)$ gives the generalized ordered logit model. Since allowing parameter values to differ for all categories is cumbersome, Stata (a statistics package) performs Wald tests (Greene 2008) to keep equal coefficients of variables that do not differ statistically across equations.

Following Williams (2006), we explored different link functions for our generalized ordered logit models. Based on the AIC and BIC information criteria (Greene 2008), but also to simplify the discussion of our results when AIC and BIC differences between models were under 3, we selected logit link functions. In that case, the odds that $y > q$ versus $y \leq q$ for $q \in \{1, 2\}$ is given by

$$\Omega_{>q|\leq q}(\mathbf{X}_i) = \frac{\Pr(y_i > q|\mathbf{X}_i)}{\Pr(y_i \leq q|\mathbf{X}_i)} = \exp(\tau_q + \mathbf{X}_i\boldsymbol{\beta}_q). \quad (8)$$

Hence, if $\Omega_{>q|\leq q}(\mathbf{X}_i, x_j + \delta)$ denotes the odds that $y > q$ versus $y \leq q$ obtained by adding $\delta > 0$ to x_j ($j \in \{1, \dots, k\}$) in (8), the odds ratio of choices $> q \in \{1, 2\}$ versus choices $\leq q$ for variable x_j is

$$\frac{\Omega_{>q|\leq q}(\mathbf{X}_i, x_j + \delta)}{\Omega_{>q|\leq q}(\mathbf{X}_i)} = \exp(\delta\beta_{qj}). \quad (9)$$

Equation (9) implies that increasing x_j augments the likelihood that a respondent will find an issue more of concern than she does now if $\exp(\delta\beta_{qj}) > 1$ (which holds provided $\beta_{qj} > 1$), and decreases this likelihood otherwise; we thus report odds ratios ($\text{OR}_{>q|\leq q}$) $\exp(\beta_{qj})$, $1 \leq j \leq k$.

Results

Results, estimated using Stata, are presented in Tables 3, 4, 5 and discussed below. For brevity, we report and discuss only OR [see the text below Eqs. (3), (6), and (9)] of statistically significant explanatory variables (at 10 % of significance or less). Variables with OR farther from 1.0 have more sway in changing the probability of an outcome than variables with OR closer to 1.0.

Parental attitudes: effects of parental gender and other factors

We hypothesized that mothers have greater concerns for their children's active commuting to school; results in Table 3 partially confirm this hypothesis. Of the four issues pertaining to children's walking and biking to school, mothers are statistically more likely than fathers to have higher concerns about traffic volume (OR = 1.32), but they do not seem to have different attitudes toward distance to school, traffic speed, and crime when living within 2 miles from school.

Seraj et al. (2012) used the same dataset to analyze these parental attitudes focusing on a smaller area of Southern California. Although our attitudinal models might look similar, they do not discuss how parental gender affects parental attitudes. In addition, we went further to explore how parental gender and attitudes interact to affect children's school travel mode and parental chauffeuring behavior (see [“Children's school travel mode: effects of parental attitudes and other factors”](#) and [“Parental chauffeuring behavior: interaction of parental gender and attitudes”](#) sections).

A number of other parental characteristics also matter for explaining parental attitudes toward children's walking and biking to school. Compared with parents aged 30–44, both younger and older parents are less concerned about traffic characteristics (OR 0.46–0.79) or crime (OR = 0.41). Asian and Hispanic parents, parents who were born in the U.S., and parents who were interviewed in English all show higher concerns for at least one of the four questions considered (OR 1.42–2.20). Moreover, parents with a high school degree, some college, or a bachelor's degree worry less about distance to school and traffic volume than parents with less education or than highly educated ones (OR 0.61–0.69), while parents who work full-time worry more about crime (OR = 1.44) and less about traffic volume (OR = 0.78) than those who don't.

Parental use of active transportation or transit is statistically associated with parental attitudes. Parents who walk or bike more often are less concerned about school distance for their children (OR 0.47–0.77), but parents who use transit more often worry more about traffic volume (OR = 1.35).

A few household characteristics also influence parental attitudes: households with more children are less concerned about traffic and crime (OR 0.81–0.89); households with an annual income under \$10 K worry less about traffic volume (OR = 0.52); and households with a low to medium annual income (\$10–\$50 K) show higher concerns about crime (OR 1.43–1.73).

Somewhat surprisingly, parents show no attitudinal differences when they consider letting a daughter or a son walk or bike to school, but parents have greater concerns about traffic characteristics (OR 1.31–1.33) for younger children (5–10 years old). However, our results suggest, as expected, that the most important factor here is the distance between home and school: when it is shorter, parents are less concerned about school distance and traffic characteristics (OR 0.31–0.73). This implies that attending a nearby school could reduce parental concerns and encourage children to walk or bike to school. We also note that parents of children who attend public schools are more concerned about distance to school (OR = 1.58).

Of the land use variables we considered, parents worry less about crime when the population density and the percentage of renter-occupied housing is lower (OR 0.19–0.56). A lower percentage of renter-occupied housing also helps reduce parental concerns about traffic volume (OR 0.60–0.66), but residing in cities over 1 million with subway or heavy rail increases this concern (OR = 1.52),

Table 3 continued

Odds ratios	Distance		Traffic volume		Traffic speed		Crime	
	OR _{>1 ≤1}	OR _{>2 ≤2}	OR _{>1 ≤1}	OR _{>2 ≤2}	OR _{>1 ≤1}	OR _{>2 ≤2}	OR _{>1 ≤1}	OR _{>2 ≤2}
walkscore	–	–	0.99**	0.99**	–	–	–	–

Only statistically significant coefficients are reported for brevity. For a full list of model variables, please consult Table S1 in the Electronic Supplementary Material

OR_{>1|≤1} for an explanatory variable is the odds ratio for a unit increase in that explanatory variable that a parent shows medium or high concerns versus low concerns for distance to school, traffic volume, traffic speed, or crime; OR_{>2|≤2} is similar except for high concerns versus medium or low concerns; see Eq. (9) and the text below

Models in this table were estimated using 1,391 observations; pseudo R^2 values are respectively 0.0547, 0.0514, 0.0391, and 0.0662 for the distance, traffic volume, traffic speed, and crime models

*, **, *** denote statistical significance respectively at the 10, 5, and 1 % levels

We supplemented the indirect land use measures above with walkability data from walkscore.com. Consistent with previous research (e.g., Kerr et al. 2006; Napier et al. 2011), parents in more walkable communities worry less, but the corresponding practical impact is very small and significant only for traffic volume (OR = 0.99). One possible explanation is that the walkscore component that account for local amenities does not matter here since the destination of a school trip is fixed.

Children's school travel mode: effects of parental attitudes and other factors

Table 4 presents results from two models that explain children's usual travel mode to and from school. As in previous studies (e.g., Hume et al. 2009; Panter et al. 2010; Napier et al. 2011), parental attitudes significantly influence children's school travel mode. When parents are more concerned with school distance, traffic volume, and crime, their children are less likely to walk or bike to and from school (OR 0.38–0.73). Interestingly, children whose parents worry more about traffic speed are more likely to use transit than cars (OR = 2.25), possibly because these parents' perceived risk reduces their willingness to drive their children from school.

As expected, parental gender is not statistically significantly associated with children's school travel mode. This makes sense since only one parent per household was surveyed, so the gender of the participating parent should not be correlated with the child's travel mode to school, assuming parents reached a joint agreement on that choice. However, since parental attitudes significantly affect children's school travel mode and since parental gender affects parental attitudes, parental gender may still play an indirect role in deciding children's school travel mode, but understanding this link will require surveying both parents in the household.

Several other parental characteristics matter. Younger parents (18–29 years old) are more likely to let their children travel to school actively (OR = 2.03), while Asian parents are less likely to do so (OR = 0.57). Moreover, parents who have at most some college education are less likely to let their children actively commute to and from school (OR 0.14–0.69) compared to parents with more education.

Parental participation in active or transit transportation impacts children's school travel mode. When parents take more walk or bike trips, their children are more likely to actively

Table 4 continued

Odds ratios	To school travel mode			From school travel mode		
	OR _{A C}	OR _{T C}	OR _{A T}	OR _{A C}	OR _{T C}	OR _{A T}
renter3	–	–	–	–	0.43*	–
renter4	–	–	–	–	0.35*	–
walkscore	–	0.98**	1.02**	–	0.97***	1.03***

Only statistically significant results are reported for brevity. For a full list of model variables, please consult Table S1 in the Electronic Supplementary Material

OR_{m|n} for an explanatory variable is the odds ratio for a unit increase in that explanatory variable of mode $m \in \{A, C, T\}$ versus mode $n \in \{A, C, T\} \setminus \{m\}$, where A active mode (walking/biking), C car, and T transit (including school buses); see Eq. (6) and the text below

These models were estimated using 1,362 observations; pseudo R^2 values are respectively 0.2338 and 0.2481 for the “To school travel mode” and “From school travel mode” models

*, **, *** denote statistical significance respectively at the 10, 5, and 1 % levels

Table 5 OR in binary logit models for parental chauffeuring behavior

Odds ratios	Restricted model OR	Unrestricted model OR
Parental attitudes		
schtraf3	(not included in model)	2.15**
Gender of parent surveyed		
pa_female	2.79***	2.99***
Other parental socio-demographic characteristics		
pa_1829	0.22**	0.23**
pa_ethaf	–	0.29*
pa_ftworker	0.35**	0.39**
Household characteristics		
sigadlt	11.69***	12.51***
twoadlt	2.21*	2.61*
hhinc3050	3.52**	3.59**

Only statistically significant results are reported for brevity. For a full list of model variables, please consult Table S1 in the Electronic Supplementary Material

OR for an explanatory variable is the odds ratio that a child is chauffeured to school by his/her parent who was surveyed for a unit increase in that explanatory; see Eq. (3) and the text below

Parental attitudinal variables were not included in the restricted model

These models were estimated using 334 observations; pseudo R^2 values are respectively 0.2134 and 0.2274 for the restricted and unrestricted models

*, **, *** denote statistical significance respectively at the 10, 5, and 1 % levels

commute to and from school (OR 1.44–6.03). Likewise, children of parents who use transit are more likely to take transit to school (OR = 2.13).

Results for household characteristics suggest that children are more likely to walk or bike from school when they have more siblings (OR = 1.51) or when their households have a lower income (\$10–\$30 K, OR = 1.91). Moreover, children are less likely to take

transit to and from school when there are more cars than drivers in the household (OR = 0.42), but they are more likely to do so in households with medium to higher income (\$50–\$100 K, OR 2.51–3.59).

As expected, child characteristics correlate with their school travel mode. Girls, younger children (5–10 years old), and children who attend before and/or after school care are less likely to walk, bike, or use transit to and from school (OR 0.13–0.79).

Again, the actual distance from home to school seems to have by far the greatest impact on children's school travel mode. The shorter that distance is, the more likely children are to walk or bike to and from school (OR ≥ 2.44). We also note that children who attend public school are more likely to actively commute or use transit for their school travel (OR 2.22–6.88).

Finally, our models show that living in non-urban areas reduces the likelihood of active commuting from school by children (OR = 0.56). In addition, living in neighborhoods with a lower population density increases children's transit use to and from school (OR = 5.09–8.27), while living in neighborhoods with a lower percentage of renter-occupied housing reduces such use (OR 0.14–0.43).

Parental chauffeuring behavior: interaction of parental gender and attitudes

We also explored the role that attitudinal differences may play in the gender gap for chauffeuring children to school; results are presented in Table 5. We estimated a restricted model (which does not include parental attitudes) and an unrestricted model (which includes parental attitudes) in order to gauge the impacts of parental attitudes on the results.

Note that the sample of both models contains only respondents whose children went to school by car on their survey day because, as explained in the “[NHTS data](#)” section, we found an extremely low parental escort rate for children who walked, biked, or took transit to school. To obtain more robust results, we focused on parental chauffeuring behavior instead. In other words, all children in both models were driven to school on their survey day by either parents surveyed or by other household or non-household members. Our goal here is to compare whether parental gender or attitudes are more important in deciding parental chauffeuring behavior.

Our results suggest that gender and attitudes are intertwined in influencing parental chauffeuring behavior. Parental attitudes significantly affect parental chauffeuring behavior: parents are more likely to chauffeur their children to school when they have high concerns about traffic volume (OR = 2.15, in the unrestricted model). However, the extent to which attitudinal differences can explain the gender chauffeuring gap is limited: the odds ratio of mothers chauffeuring their children to school compared with fathers is even slightly higher in the unrestricted model (OR = 2.99) than in the restricted model (OR = 2.79) after adjusting for parental attitudes. This suggests that, when holding equal concerns, mothers are still more likely than fathers to chauffeur their children to school, which confirms that the division of household chauffeuring duties is gendered.

As expected, parents' characteristics affect their chauffeuring behavior. Younger parents (18–29 years old, OR = 0.22–0.23) as well as African-American parents (OR = 0.29, only in the unrestricted model) are less likely to chauffeur their children to school, and so do parents who work full-time (OR 0.35–0.39) compared to those who do not.

Few household characteristics were found to be significant. In single parent (OR 11.69–12.51) and two-adult households (OR 2.21–2.61), the parent surveyed is much more likely to be chauffeuring his/her child to school, but this was expected since these families

are more constrained than families with more adults in sharing chauffeuring duties (recall that all children in the sample used to estimate this model were driven to school on the survey day). Moreover, income matters: parents in households with an annual income between \$30 and \$50 K are more likely to chauffeur their children to school (OR 3.52–3.59).

Whereas actual distance to school was paramount in explaining parental attitudes and children's school travel mode, it has no impact on parental chauffeuring behavior. One explanation is that children's school travel mode is jointly decided with parental chauffeuring behavior, making the decision to select a parent or an adult household member for the chauffeuring task irrelevant to school distance. Likewise, child and land use characteristics do not seem to affect parental chauffeuring behavior.

Conclusions

In this paper, we examined whether parental gender affects parental attitudes toward letting their children actively commute to school, and how parental gender and attitudes interact to influence children's school travel mode and parental chauffeuring behavior. Our results show that mothers usually have higher concerns about traffic volume, which in turn reduces the likelihood that their children will walk or bike to school. Moreover, although parents are more likely to chauffeur their children to school when they have higher concerns about traffic volume, mothers are still more likely than fathers to do so even when mothers and fathers have equal concerns. Based on these results, we conclude that maternal attitudes might matter more for children's active commuting to school.

These findings are relevant for two current programs that aim at increasing the number of children who actively commute to school: the Safe Routes to School program, and the Walking School Bus program. For the former, a national project that focuses on infrastructure improvements such as traffic signals and sidewalks, our results suggest measures that can effectively reduce mothers' perceptions of risk related to traffic volume. For the Walking School Bus program, which seeks adults to volunteer walking a group of neighborhood children to and from school, our results suggest targeting mothers when recruiting volunteers and trying to address their concerns.

Fostering active commuting to school by children is equally important to mothers. According to a recent OECD report (2012), household chores, childcare, and looking after aging parents are the main barriers to gender equality in employment. Our results provide support for this viewpoint by showing that mothers bear most of the chauffeuring burden not because they worry more but because chauffeuring children still appears to be more a woman's responsibility. The high level of space and time rigidity of such activities partly explains why women are more likely to work part-time and work closer to home, which in turn reduces their economic opportunities and does not allow them to take full advantage of their education (OECD 2012).

Lastly, our results have some implications for future research. In this paper, we estimated three sets of models to explain the relationships between parental gender, parental attitudes, children's school travel mode, and parental chauffeuring behavior. These links have been ignored in the literature mainly because all current research (including ours) relies on surveys that collect information only from one parent in each household (see the "[Children's school travel mode: effects of parental attitudes and other factors](#)" section for more details). As a result, the parental decision-making process regarding how children commute to school and who is responsible for chauffeuring them cannot be elicited. To