Case Study

Students' Tendency to Walk to School: Case Study of Tehran

Amir Samimi[1] and Alireza Ermagun[2]

Abstract: The recent decrease in physical activity among youth, which has resulted in increasing obesity and in overweight individuals, has attracted global attention and a renewed sense of investigation in both public and academic circles. However, using active modes of transportation (AMT) to and from school can serve as a bulwark against inactivity and the increase in cases of obesity and excess weight. In an attempt to study and counteract this growing phenomenon, more than 4,700 questionnaires were distributed in 92 schools throughout Tehran in a random stratified sampling method according to location and gender differences, and 3,441 responses were received (72% response rate). Significant factors affecting each gender's propensity to choose active modes of transportation to and from school were separated and identified. Among females, 45% chose an AMT to school, and 52% did so for return trips home, both of which are higher than the males' propensity to choose AMT. Among males, 39% chose an AMT to school, and 46% did so for the way back. Female tolerance in active modes of transportation also proved to be greater than that of males such that with an increase in costly factors (e.g., increases in travel time), economic considerations (e.g., household car ownership), and tougher topography, females substituted away from AMT less than males.
DOI: 10.1061/(ASCE)UP.1943-5444.0000141.

CE Database subject headings: Students; Case studies; Iran; Schools; Urban development; Pedestrians.

Author keywords: Physical activity; School trip; Gender effect; Logit model.

Introduction

Physical inactivity is drawing the attention of policy makers and researchers in different disciplines. A wide range of physical problems, including obesity, is rapidly increasing, especially in developing countries (Maes et al. 1997; Samimi et al. 2009). This is increasingly endemic in many societies, and the prevention of this crisis is considered a health priority [World Health Organization (WHO) 1998; Keil 2005]. In recent years, because of a parallel increasing importance being placed on world health, there has been an increase in the amount of studies examining this phenomenon in various countries throughout the world (Booth et al. 2003; Freedman et al. 1997; Hedley et al. 2004; Troiano and Flegal 1998; Wedderkopp 2004; Samimi and Mohammadian 2010). These studies have shown that overweight children have a greater likelihood of developing type 2 diabetes, hypertension, hyperlipidemia, atherosclerosis, sleep apnea, and asthma (Ebbeling et al. 2002).

Students' inactivity is specifically the subject of many studies not only in health-related disciplines but also in transportation and urban planning arena that could arguably contribute to a more active lifestyle. It has been found that active modes of transportation (AMT) (i.e., walking and cycling) to and from school have been associated with increased physical activity (Alexander et al. 2005; Cooper et al. 2005; Sirard et al. 2005; Metcalf et al. 2004), and thus with lower body mass index (Rosenberg et al. 2006) and higher levels of energy expenditure (Tudor-Locke et al. 2003). As 60 min of moderate physical activity and exercise per day for children and adolescents to prevent the surfacing of health problems has been recommended (Cavill et al. 2001), walking and cycling to and from school can appropriately fulfill this recommended daily physical activity for schoolchildren (WHO 2008). Many professionals are trying to make a reasonable amount of physical activity part of students' daily routine, and thereby establish a healthy lifestyle and ease the burden of public health expenditure (Heckman 2012).

The statistics regarding overweight and obese individuals are not readily available in Iran. There has only been one study in Iran examining the increase in cases of obesity among schoolchildren, which found that 21.3% of K-12 (kindergarten through grade 12) students in Tehran can be categorized as overweight or obese (Mohammadpour et al. 2004). In the United States, approximately one of every five individuals is overweight (Ogden et al. 2006). This study is an attempt to fill a gap in Iran, which has not paid adequate attention to this issue on an academic and public policy level. Moreover, travel behaviors are different among male and female students, which is partly attributed to Middle Eastern culture. This motivated the authors to investigate active school-commuting behaviors, with a special focus on gender differences. Demographic, socioeconomic, and environmental factors of 3,441 middle and high school students (ages 12–17) were collected in Tehran, the capital city of Iran. These factors were used to investigate how schoolchildren make decisions regarding active modes of transportation to and from school and were examined and weighed appropriately relative to their overall effect.

Background

Considerable effort has been put into possible ways of promoting an active lifestyle in different societies. In previous decades, many

[1]Assistant Professor, Civil Engineering Dept., Sharif Univ. of Technology, Azadi Ave., Tehran 11365-8639, Iran (corresponding author). E-mail: asamimi@sharif.edu

[2]Graduate Student, Civil and Environmental Engineering Dept., Amirkabir Univ. of Technology, 424 Hafez Ave., Tehran 15875-4413, Iran. E-mail: ermaguna@aut.ac.ir

Note. This manuscript was submitted on February 16, 2012; approved on November 8, 2012; published online on November 10, 2012. Discussion period open until November 1, 2013; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Urban Planning and Development***, Vol. 139, No. 2, June 1, 2013. © ASCE, ISSN 0733-9488/2013/2-144-152/$25.00.

researchers have struggled to develop policies and strategies for promoting physical activity among schoolchildren and preventing obesity. Demographic, socioeconomic, and built-environment characteristics are found to have a significant association with the childhood obesity epidemic. These are discussed in more details in this section.

Demographic Characteristics

Age is an important demographic characteristic that has been given a priority in many studies. Some studies found that with an increase in age, the propensity to select active modes of transportation decreases (Fulton et al. 2005; McDonald 2008b; McMillan et al. 2006; Wilson et al. 2010), whereas others claimed the opposite (Salmon et al. 2007; Yeung et al. 2008; Rodriguez and Vogt 2009). In some studies, no correlation was found between age and propensity to choose AMT (Dellinger and Staunton 2002; Kerr et al. 2006; Merom et al. 2006).

These differences can be indicative of each study's different sample selection. For example, difference in age ranges and subsequently the researcher's definition of "older" for case studies have shown that some researchers are working with different age definitions such as 10–12 (Wilson et al. 2010) and 14–18 (McDonald 2007). However, even in cases where there was no difference in definition, contradictory conclusions were still found (McDonald 2008b; Kerr et al. 2006). These differences can be indicative of socioeconomic or environmental factors. For example, in some countries, youths are granted the right to driving licenses from the age of 16, such as in the United States, whereas in other countries, such as Belgium or Iran, individuals must be at least 18 years old. This difference in minimum driving ages could be a reason for an increase in AMT for countries with higher age requirement. Finally, methodological differences could be a possible reason for these contradictory findings. Most of the studies have assumed a similar effect of age on the propensity to choose AMT for families with different demographic, socioeconomic, and environmental characteristics.

Gender is another demographic variable, the effect of which has been widely investigated in previous studies. Many researchers have shown that males have a higher propensity for walking and cycling to and from school (McDonald 2007; Bungum et al. 2009; Larsen et al. 2009; Nelson et al. 2008; Hume et al. 2009). Nonetheless, some studies do not confirm this finding (Wilson et al. 2010; Salmon et al. 2007; Kerr et al. 2006; Martin et al. 2007). The reasons behind male-female differences in AMT have not been well established, and very few studies have provided possible explanation for this difference. For instance, Bungum et al. (2009) argued that girls may worry that wearing a bike helmet will mess up their hair and are thus less likely to ride bikes to school.

Socioeconomic Characteristics

Socioeconomic factors such as car ownership and income have been shown to affect mode choice in school trips (DiGuiseppi et al. 1998; Bradshaw and Atkins 1996). Some studies have found that students from higher household incomes (McDonald 2008b; Wilson et al. 2010; Martin et al. 2007; Spallek et al. 2006; McMillan 2007) and those with more household cars (Wilson et al. 2010; McMillan 2007; Yelavich et al. 2008; Copperman and Bhat 2007) are less likely to use AMT for school trips. Larsen et al. (2009), on the contrary, found that there is negative correlation between AMT and household income but only for return trips to home. Other studies reported nonsignificant associations between household income and AMT (Martin et al. 2007; Ewing et al. 2004), and household car ownership and AMT for school trips (Martin et al. 2007; Timperio et al. 2004).

There is negative correlation between the level of parents' education and AMT in school trips in some studies (Evenson et al. 2003; Shi et al. 2006; Mota et al. 2007) and nonsignificant association in others (Spallek et al. 2006; Carlin et al. 1997). The reason behind this negative correlation may be that most of the individuals with higher education also have higher income and are thus less dispensed toward AMT.

In terms of whether students live in single-parent homes or with both parents, correlation has been found to be nonsignificant (Merom et al. 2006; Martin et al. 2007; Timperio et al. 2006), and only very few studies have stated that students in single-family homes are more likely to use AMT (Fulton et al. 2005).

Built-Environment Characteristics

The distance between the students' home and school is one of the most significant environmental factors affecting the use of AMT. All studies regarding this subject have found negative correlation between distance and AMT (McDonald 2008b; McMillan et al. 2006; Wilson et al. 2010; Salmon et al. 2007; McDonald 2007; Larsen et al. 2009; Ewing et al. 2004; Aultman-Hall et al. 1997). Specifically, students who live less than 1.6 km from their school have a much higher probability of using AMT than those who live farther (McMillan 2007). Schlossberg et al. (2006) have shown that in Oregon, 52% of those who live less than 1.6 km from their school walk to school. This drops to 36% when the distance between home and school increases to 2.4 km. Another study in Belgium has identified that 83.5% of students walk to and from school when they live less than 2 km from school (Dyck et al. 2010).

Few studies have considered the effects of environmental factors such as parks, play areas, and number of trees on school trips, but none has found a negative correlation (Timperio et al. 2004; Mota et al. 2007; Kerr et al. 2007; Evenson et al. 2006; Alton et al. 2007). Some studies (Kerr et al. 2006; Nelson et al. 2008; Braza et al. 2004) found a higher propensity for students to use AMT for their school trips in areas with high population density.

Data

The city of Tehran is 700 km^2 with 22 municipalities and more than 600 traffic analysis zones. The population of this city is approximately 7.5 million, with an average monthly family income of approximately 136 million Iranian rials (Municipality of Tehran 2011). Tehran ranks as the sixteenth most population-dense city in the world (City Mayors 2011), with approximately 7.5 million trips per day, of which 27% are educational. The average duration and speed of each daily trip in Tehran is 24.6 min and 23.3 km/h, respectively.

In 2010, there were 1,119,571 K-12 students in Tehran and 5,352 schools (Municipality of Tehran 2011). Almost 70% of schoolchildren are in either middle school or high school, and the number of female students is almost 3% more than that of males. Two types of data are required to investigate active school trips with regard to the demographic, socioeconomic, and built-environment factors. First, aggregate zonal data are collected and summarized in Table 1. This includes demographic, socioeconomic, and built-environment data for each of the 22 municipalities of Tehran. Then, disaggregate data of 3,441 students were collected in a mail survey to help unravel possible reasons behind different propensities for choosing AMT in school trips among male and female students.

J. Urban Plann. Dev., 2013, 139(2): 144-152

Aggregate Zonal Data

Aggregate zonal data have two applications in this study. First, built-environment characteristics were shown in the literature to have a substantial effect on active commuting to school. Therefore, variables such as number of parks in a neighborhood, road density, population density, walkability, public-transit accessibility, and green space per capita could have a significant association with the possibility of choosing a green mode of transportation to and from school. Table 1 summarizes some of such aggregate information from the 2006 Tehran census (Municipality of Tehran 2011) and was used in developing the models.

Another set of aggregate data was required for conducting the survey. The total number of male and female students in each zone and grade was required to develop a sampling strategy for the survey. The sample is stratified by gender and grade, so overrepresentation of a specific gender or grade does not bias the modeling results.

Survey

A pilot survey was conducted in December 2010 to evaluate a questionnaire that was designed for collecting information on socioeconomic and demographic details along with the school trip characteristics of students. Five hundred students from two middle schools and two high schools in Tehran were targeted, among which 341 completed questionnaires were received. An envelope with an invitation letter on the Amirkabir University of Technology letterhead, together with the questionnaire, was given to each student. The questionnaires were completed by the students' parents and were returned to the school. This method has been used predominantly by other researchers in this field as well (McMillan 2007; Timperio et al. 2004; Kerr et al. 2007). Whereas multiple-choice questions were responded to very well, those requiring written explanation were not received well by parents. Therefore, some questions were revised accordingly. The questionnaire was finalized after reviewing the responses and resolving ambiguities that were detected in some questions.

The final questionnaire was distributed to more than 4,700 middle and high school students (ages 12–17) in Tehran in a randomly selected stratified sampling method in relation to municipality (geographic sector in Tehran) and gender. To cover a wider range of schools and to increase the variety of the distribution, only one class was randomly selected from each grade in each school so that 92 schools (46 male schools and 46 female schools) were covered. In Iran, K-12 schools are segregated by sex. A total of 3,441 questionnaires (from the same amount of distinct families) were returned, resulting in a response rate of 72%. From the returned questionnaires, 1,387 (40%) were from male students and 2,054 (60%) were from female students. Middle school students constituted 60% of all questionnaires returned.

The final questionnaire consisted of 19 questions, with one section on socioeconomic and demographic details and another section on the school trip characteristics of students. The first section consisted of questions such as the number of children, level of education of students, household car ownership details, number of driver licenses, level of education of parents, parental occupation, and monthly household income. The second section consisted of questions such as the modes of transportation selected by students throughout the week, the reasons behind selecting those modes of transportation, and the costs of transportation, all of which

Table 1. Description of Variables

Variable	Description	Average	Standard deviation
AREA	Area in each municipality (km^2)	30.16	19.54
POPULATION	Population in each municipality	35,948.05	211909.33
NWORKERS	Number of workers in each municipality	36,613.95	39386.77
AUTOOWNER	Car ownership in each municipality (car/household)	0.23	0.09
NPARKS	Number of parks in each municipality	35.09	23.53
RDLENGTH	Road length in each municipality (km)	110.41	54.16
POPDENS	Population density in each municipality (person/km^2)	17,200.6	7777.63
RDDENS	Road density in each municipality (km/km^2)	4.48	1.83
GRNPRCP	Green space per capita in each municipality (m^2/person)	13.93	19.6
D_HILL	1 = mountainous; 0 = flat/level	0.47	0.49
NSCHOOL	Number of schools in each municipality	281.68	138.71
NMSCHOOL	Number of male schools in each municipality	144.63	73.41
NFSCHOOL	Number of female schools in each municipality	137.05	66.16
NSTUDENTS	Number of students in each municipality	58,924.78	25162.62
NMSTUDENT	Number of male students in each municipality	29,793.84	12908.56
NFSTUDENT	Number of female students in each municipality	29,130.95	12344.71
D_AUTO2	1 = household owns two or more cars; 0 = otherwise	0.18	0.38
INCOME	1 = less than 5; 2 = 5–10; 3 = 10–15; 4 = 15–20; 5 = 20–25; 6 = more than 25 million rials[a] household income	2.11	1.23
D_WTBS	1 = less than 10 min of walking to bus stop; 0 = otherwise	0.82	0.39
WTS	1 = less than 10 min; 2 = 10–20 min; 3 = 20–30 min; 4 = 30–40; 5 = 40–50 min; 6 = more than 50 min of walking to school	2.67	1.55
WTS_LE	WTS for high school students; 0 = otherwise	1.21	1.79
LEVEL	1 = high school; 0 = middle school	0.41	0.49
D_WTS_LE	1 = high school students living less than 1.6 km from school; 0 = otherwise	0.22	0.41
AMT_TO	1 = students choose AMT to school; 0 = otherwise	0.44	0.49
AMT_FR	1 = students choose AMT from school; 0 = otherwise	0.50	0.50
LOWEDU	1 = parents with less than a high school diploma; 0 = otherwise	0.33	0.47
HIGHEDU	1 = parents with undergraduate degrees or higher; 0 = otherwise	0.25	0.43
NCHILD	Number of children in household	2.41	1.07
SAFETY	1 = children safety is primary concern of parents; 0 = otherwise	0.31	0.46

[a]11,800 rials = US$1 in May 2011.

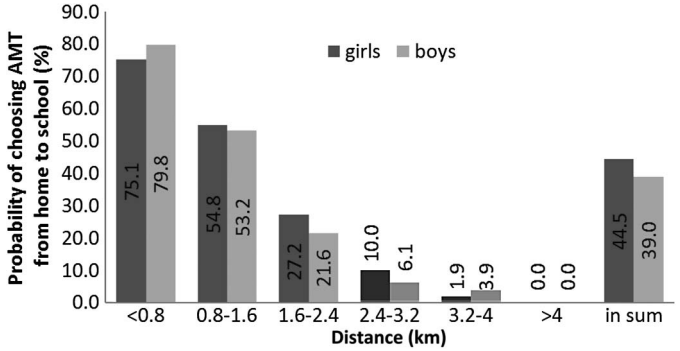

Fig. 1. Distribution of distance for AMT trips from home to school by gender

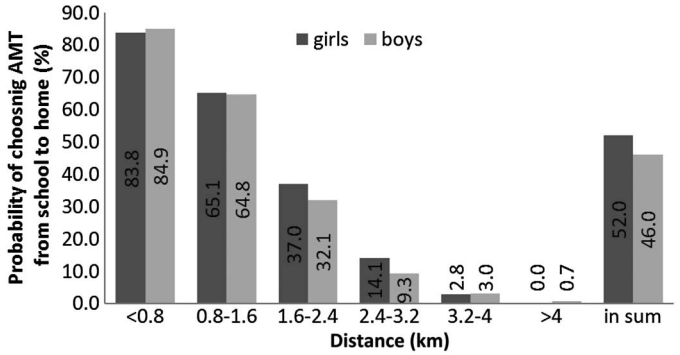

Fig. 2. Distribution of distance for AMT trips from school to home by gender

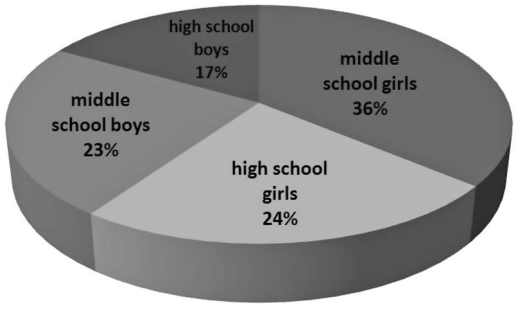

Fig. 3. Distribution of students' level of education by gender

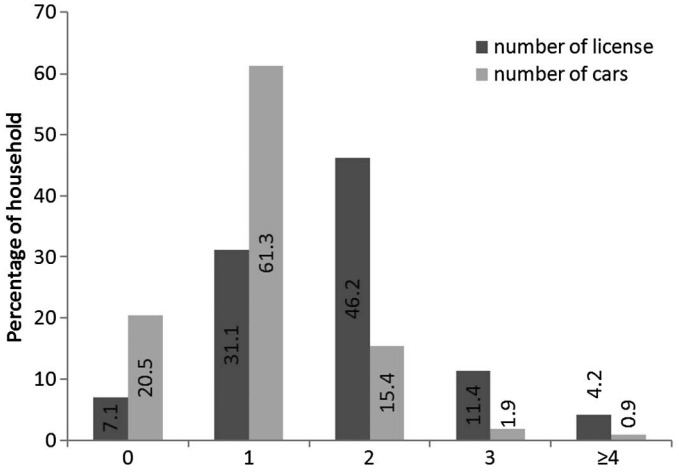

Fig. 4. Distribution of car ownership and number of licenses in households

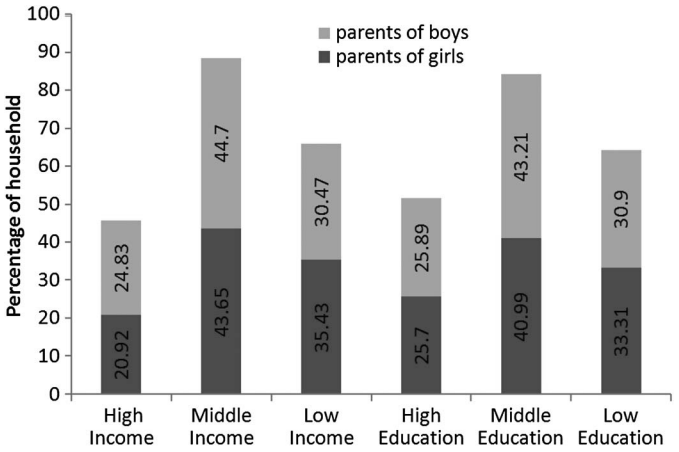

Fig. 5. Distribution of education and income by gender

are regarding transportation both to and from school. Because an average person may be unable to accurately predict distance, how much time (in increments of 10 min) it took for students to walk to and from school was asked instead; this method has also been adapted in previous studies (Ewing et al. 2004; McDonald 2007a).

Although it is out of the scope of this study to elaborate on the details of survey recruitment, design, and sampling, brief descriptive statistics are provided in Figs. 1–5 to further describe the environment of the study.

Models

The binary logit specification is used to construct AMT models for school trips in this study. Logit models have a closed-form formula for choice probability and thus provide results that are easy to interpret. Further explanation on this method may be found in Train (2010). One of the properties of this model is independence from irrelevant alternatives (IIA), which can be a limitation in some multivariate models (Train 2010). In binary logit models, however, IIA property is not restrictive because the choices are limited to only two options. Hensher et al. (2005) and Train (2010) discussed the power and limitations of this specification in sufficient depth.

The models are calibrated by the collected data to estimate the probability of choosing an active mode of transportation in school trips. Active modes are usually defined in two categories as either walking or biking and other modes such as skateboard and scooters, which have been considered occasionally in previous studies (Nelson et al. 2008; Evenson et al. 2006). Only walking and biking were considered in our survey because other active modes of transportation are neither widespread in Iranian culture nor suitable for Tehran's streets or sidewalks. Moreover, only 1% of students within the sample size rode a bicycle to school and were thus excluded from the study because of their small size. The model parameters are calibrated by the maximum likelihood estimation method, in which the probability of occurrence of the observed events is maximized.

In the preliminary stage of model structuring, the effect of every parameter such as environmental, socioeconomic, and demographic in choosing AMT was considered independently. On the basis of previous experiences, different combinations of variables

J. Urban Plann. Dev., 2013, 139(2): 144-152

were considered as well. A forward selection method was used in the next stages, the correlation of these parameters was analyzed for AMT, and the parameters which proved to have the most explanatory power were used in the following stages of this study. The statistical t-test was used to reject the null hypothesis that a specific variable does not affect the probability of choosing an active mode of transport in school trips. For the overall goodness of fit of each model, likelihood ratio test was undertaken. Likelihood ratio index, or the McFadden value, has a similar interpretation as R^2 in the linear regression models. The McFadden value fluctuates between 0 and 1; for the comparison of models, assuming the data are standardized and there is a same set of alternatives, however closer the McFadden value is to 1, the estimated parameters more perfectly predict the choices of the sample (Train 2010).

With the emergence of significant interaction variables and the construction of various models, and the comparison of these factors, the model that had the best fit relative to the data was chosen. To shed light on the effects of gender, four models of boys' and girls' active commute to and from school are presented. The final models are shown in Tables 2–3 and are further discussed in the following section.

Table 2. Gender-Specific Binary Logit Models for Home-to-School ATM Selection

	Male		Female	
Variables	Coefficient	t-statistic	Coefficient	t-statistic
CONSTANT	3.92[a]	8.87	3.38[a]	10.37
D_AUTO2	−0.48[a]	−2.07	−0.65[a]	−3.25
D_WTBS	−0.51[a]	−1.96	−0.57[a]	−3.49
POPDENS	0.28E-04[b]	2.47	0.36E-04[a]	3.47
WTS	−1.54[a]	−12.99	−1.15[a]	−13.92
INCOME	−0.14[c]	−1.75	−0.30[a]	−4.22
WTS_LE	0.21[a]	2.78	0.08	1.43
D_HILL	−0.52[b]	−2.90	−0.28[a]	−2.15
SAFETY	−1.66[a]	−7.69	−1.65[a]	−11.27
Chi square	622.88		847.48	
Significance level	0.00		0.00	
McFadden pseudo R^2	0.40		0.35	
Number of valid observations	1,359		2,017	

[a]Significance level at 1%.
[b]Significance level at 5%.
[c]Significance level at 10%.

Table 3. Gender-Specific Binary Logit Models for School-to-Home ATM Selection

	Male		Female	
Variables	Coefficient	t-statistic	Coefficient	t-statistic
CONSTANT	4.46[a]	9.85	3.53[a]	10.93
D_AUTO2	−0.31	−1.40	−0.41[b]	−2.14
D_WTBS	−0.68[b]	−2.54	−0.34[b]	−2.08
POPDENS	0.18E-04	1.55	0.38E-04[a]	3.64
WTS	−1.34[a]	−13.17	−1.09[a]	−14.27
INCOME	−0.15[c]	−1.93	−0.37[a]	−5.35
WTS_LE	0.07	1.05	0.08	1.47
D_HILL	−0.52[a]	−2.92	−0.41[a]	−3.08
SAFETY	−1.94[a]	−8.89	−1.52[a]	−10.44
Chi square	664.66		886.10	
Significance level	0.00		0.00	
McFadden pseudo R^2	0.42		0.36	
Number of valid observations	1,359		2,017	

[a]Significance level at 1%.
[b]Significance level at 5%.
[c]Significance level at 10%.

Discussion

On the way to school, 43% of the sample chose an AMT, and 49% did so on their way back home. This finding shows that school children in Tehran choose an active mode of transportation, on average according to our sample, more than do those in California (21%) (Copperman and Bhat 2007) and Georgia (14.1%) (Kerr et al. 2007) but less than do those in Portugal (52.6%) (Mota et al. 2007) and China (87.7%) (Shi et al. 2006). Differences in demographics, socioeconomics, culture, and infrastructure could explain these differences (Dyck et al. 2010).

The rest of this section is devoted to the discussion of the findings and possible explanations for the results. Demographic and socioeconomic variables are discussed first, followed by a discussion on built-environment and transportation variables. Finally, other factors that could not be included in the final models but was considered in the study are discussed exclusively. For each variable, possible explanations for the observed association, agreement or disagreement with other studies, and differences between male and female models are discussed. This section is expected to help the city officials to consider factors that may contribute to a healthier lifestyle, especially for schoolchildren, not only in the city of Tehran but in any community with similar cultural, economic, and geographic characteristics.

Demographic and Socioeconomic Factors

The propensity of females in choosing AMT to and from schools is more than that of males: 45% of females choose AMT from home to school, and 52% do so from school to home, whereas 39% of males choose AMT to school, and 46% do so from school to home (Fig. 1). This propensity within the subset of girls is higher in trips back home than in trips to school.

In accordance with some previous studies (Martin et al. 2007; Spallek et al. 2006; McMillan 2007), low-income families are found to be more likely to choose an active mode of transportation to and from school simply because they cannot afford other modes of transportation. From a policy perspective, it is critical to know that such families could easily change their preference about active commuting as their financial reservations are resolved. Comparing the male and female models, one can observe that having a higher income level does not promote a male student to use an active mode. For a female student, however, this is not the case. Parents with a high level of income are less motivated to use an active mode of transportation for their daughter than for their son. This type of behavior has been observed in other studies (Salmon et al. 2007; Alton et al. 2007) and has been attributed to the fact that parents are more concerned about their daughter's safety. Other explanations (e.g., cultural effects) should be investigated in eastern cultures. The urban safety issue is identified as a key factor for using AMT (Timperio et al. 2004). However, safety is not easy to quantify in Tehran because reliable measures are not available. Instead, a dummy variable was entered for the parents who are primarily concerned about transportation safety of their kids. This variable turned out to have a significant negative impact on the use of AMT. Policymakers can promote the use of AMT in school trips with specific policies that improve traffic urban safety.

The number of cars in a household is another significant variable, showing that children of families with two or more cars are less motivated to use an AMT in school trips. A similar conclusion

has been reached in other studies (Kerr et al. 2007). This negative impact that car ownership has on the use of AMT should be noted by policymakers because car ownership per capita has faced an increasing rate in recent years, from 0.2 in 2005 to approximately 0.3 in 2011 (Municipality of Tehran 2011). Furthermore, the decrease in using AMT is more pronounced on the trip to school compared with the trip back because of two primary reasons: (1) the concern of getting to school on time; and (2) the school may be on the way of a parent's workplace in the morning. An interesting observation in the models is that the decline in the girls' probability of active commuting to and from school is less than this amount for the boys'. This finding is particularly unique because, to the best of the authors' knowledge, no previous studies have reached this finding. This may be because females, especially during their school years, are faced with more limitations regarding physical activity and social interaction compared with males in Iranian society. Iranian families tend to be more culturally conservative in allowing their females to be as freely present socially as the males, at least during the formative school years. Thus, females in Iran may view active modes of transportation to and from school as a prime opportunity to socialize with friends and take advantage of the fact that they are unconstrained for a short while. This becomes more prevalent on the way back home because students are not faced with the same time constraint as they would on the way to school. Therefore, they may view the walk back home as a particular opportunity to socialize and spend time with their friends, although their families have an easy access to cars.

Built-Environment and Transportation Factors

Walking time or distance from home to school has been found to have an indispensable effect on the propensity to select active modes of transportation in school trips. For a better understanding of the role of distance, an average walking speed of 4.8 km/h for students (Sullivan and Morrall 1996; Jumsan et al. 2005; Väänänen et al. 2002) was used. Thus, the time it takes to walk to school was translated into distance. With further analysis, it was found that 63.8% of families with female students and 52.9% with male students live less than 1.6 km from their schools. Of this percentage, 62.7% of female and 64.3% of male students choose an AMT on their way to school, and 69.1% of female and 71.9% of male students do so on their return home. In the United States, only 31% of schoolchildren use AMT if they live 1.6 km or less from their schools (Dellinger and Staunton 2002; Nelson et al. 2008; Evenson et al. 2003).

Travel time, as expected, has a strong negative correlation with the use of active modes of transportation. That is, as the time it takes to walk to and from school increases, the less likely individuals are to choose active modes of transportation. This has also been verified in previous studies (Ewing et al. 2004; McDonald 2007a; Ham et al. 2008). This decrease in propensity for active modes of transportation is more pronounced in trips from home to school because individuals tend to be more concerned with time on the way to school as they do not want to be tardy; however, this is not the case on the way from school to home because they are not as time constrained. It was also found that the resistance of females to an increase in time is more than that of males; more precisely, females are less deterred from active modes of transportation than males when the time it takes to walk to and from school increases (Tables 2–3). The lower age of maturation for females relative to males and the female preference for taking advantage of available freedoms can be possible reasons for higher female tolerance. Unfortunately, no study thus far has examined these cultural and social factors behind the differences between male and female students in choosing AMT.

To examine the effect of the differences in educational level between male and female students, the interaction variable WTS_LE (high school student time to school) was used, which shows that the tolerance of high school students for increases in costs (whether in time, cost, or topographic difficulty) compared with middle school students is higher; this is similar to what previous studies have also shown (McDonald 2008c). Considering the coefficient of WTS_LE, the tolerance for increases in travel time to school is higher for high school boys than for high school girls (Tables 2–3).

The landscape variable is significant in affecting the probability to use AMT, as previous studies have also shown (Dyck et al. 2010). This study has found that the probability of using AMT for individuals living in hilly areas is less than for those living in flatter areas. However, the decrease is more pronounced for females than for males in return trips because females would get more exhausted on the way back compared with trips to school, as the female body tends to have less physical tolerance compared with the males'.

In line with the studies in Ireland (Nelson et al. 2008) and in Georgia (Kerr et al. 2007), which found a significant positive association between population density and active modes of transportation, this study also found that as population density increases, females are more likely to use AMT than males.

Any study that has looked into the association between the availability of public transportation and students' propensity to use AMT for school trips was not found. But some studies (Alshalalfah and Shalaby 2007) found that increasing the access time to the bus station has a negative impact on walking propensity in regular daily trips. Access time to the nearest public station from home was asked in questionnaire. A dummy variable D_WTBS (walk time to bus stop is less than 10 min) based on which students that live less than 10 min from a mode of public transportation are found to be much less likely to use AMT (Tables 2–3). However, for trips back home for females, the decrease in using AMT is not nearly as negatively affected by availability of public transportation may be because these female students are not as limited by time and also see the walk back home as an opportunity to socialize with friends.

Other Influential Factors

In accordance with previous studies (Dellinger and Staunton 2002; Kerr et al. 2006; Merom et al. 2006), the parameter of age was not found to be significant. However, considering interactive variable D_WTS_LE (walk time to school of high school students living less than 1.6 km from school), it was found that in distances less than 1.6 km, 67% of students on average use active modes of transportation for trips to and from school, and the parameter of the level of education is significant.

Students in high school (ages 15–17) have a higher propensity to use AMT compared with students in middle school (ages 12–14). Only one previous study found that as the level, or grade, in high school increases, a decrease is seen in the use of active modes of transportation to and from school compared with elementary and middle school. This could be attributed to the fact that as students enter higher grades, they are eligible to get driving licenses and are thus more likely to substitute away from active modes of transportation to and from school (McDonald 2008c). Conversely, this study found that as the grade level increases in high school, the propensity to choose AMT increases compared to middle school

J. Urban Plann. Dev., 2013, 139(2): 144-152

because the minimum driving age in Iran is 18, whereas that in the United States is 16 (McDonald 2008c).

In accordance with previous studies (Martin et al. 2007; Evenson et al. 2003; Mota et al. 2007) individuals with lower levels of education have a higher propensity to use active modes of transportation in travelling from home to school perhaps because those with lower education tend to have lower income. However, this was not the case for trips on the way back home from school and was not found significant.

Yelavich et al. (2008) found a positive correlation between the number of children in a household and the propensity of students to use active modes of transportation; that is, with an increase in the number of children in a household, there is a higher likelihood for students within that household to use active modes of transportation. Conversely, McDonald (2008c) found this variable insignificant for elementary and middle school students. This is in line with this study, in which a significant correlation between an increase in children in a household and an increase in the use of AMT was not found.

The number of parks or green spaces and road density within each municipal zone were specific environmental factors used in constructing the model. None of these, however, had a positive association with the active modes of transportation, but because they were not significant, they were not included in our study. Previous studies have also found similar results (Mota et al 2007; Kerr et al. 2007; Evenson et al. 2006). One reason for the insignificant coefficients is that the built-environment variables are aggregated in each of 22 municipal zones and their variability is highly bounded. This inflates the standard error of the estimated coefficients and makes them insignificant.

Conclusion

The study of factors that increase active transportation modes has in recent years been paid renewed attention because of the importance placed on health-related reasons connected to active transportation and an emphasis on enacting public policy (U.S. Dept. of Health and Human Services 2011).

The distribution of more than 4,700 questionnaires, based on a random stratified sampling method and in relation to gender and location in 92 middle and high schools throughout Tehran, has yielded a plethora of demographic, socioeconomic, and school-trip characteristics. Because of the lack of studies examining gender in relation to the level of education for choosing AMT, these two factors were examined for trips to and from school and incorporated in the model. Thus, the effects that gender had on the propensity to use AMT were independently examined.

The distance between home and school is the most important factor affecting the propensity to use active modes of transportation such that with an increase in distance between school and home, the propensity to use AMT decreases. Not only is the tolerance for females more than that of males when it comes to choosing AMT as time increases, but even with greater economic pressure, girls are still more tolerant to decreasing their use of AMT. Considering a positive association between distance and reluctance to use AMT, policy makers may consider neighborhood schools in promoting AMT.

Girls are more likely to use active modes of transportation to and from school compared with males, the reason behind which may be cultural and social differences in a traditional region such as the Middle East; however, not much has been written regarding this topic. In this study, it has been found that in societies with cultural, social, and security sensitivities, young adults, especially young females, have a less pronounced social presence. Thus, these young females see the chance to walk back home from school as an opportunity to bring about their desired social presence and as a chance for physical activity, as there is less time constraint than on the way to school. In general, improvements in the travel safety of students are expected to significantly increase the parents' willingness to let their kids walk to schools. This would have tremendous positive effects on children's general health; therefore, public health officials need to have a more effective collaboration with urban planners to promote an active lifestyle (Southworth 2005).

For future research, an interesting question is whether gender segregation in schools have any influence in using AMT. To answer this, one needs to observe the students' tendency to walk in both gender-segregated and mixed schools. This data could not be found in Iran, as all the schools are gender segregated.

Acknowledgments

The authors wish to thank Shahrbanu Khaniki for her kind assistance in data collection. We also would like to thank the assistance of three anonymous reviewers whose comments were helpful in revising the article.

References

Alexander, L. M., Inchley, J., Todd, J., Currie, D., Cooper, A. R., and Currie, C. (2005). "The broader impact of walking to school among adolescents: Seven day accelerometry based study." *BMJ*, 331(7524), 1061–1062.

Alshalalfah, B., and Shalaby, A. (2007). "Case study: Relationship of walk access distance to transit with service, travel, and personal characteristics." *J. Urban Plann. Dev.*, 133(2), 114–118.

Alton, D., Adab, P., Roberts, L., and Barrett, T. (2007). "Relationship between walking levels and perceptions of the local neighborhood environment." *Arch. Dis. Child.*, 92(1), 29–33.

Aultman-Hall, L., Roorda, M., and Baetz, B. W. (1997). "Using GIS for evaluation of neighborhood pedestrian accessibility." *J. Urban Plann. Dev.*, 123(1), 10–17.

Booth, M. L., et al. (2003). "Change in the prevalence of overweight and obesity among young Australians, 1969–1997." *Am. J. Clin. Nutr.*, 77(1), 29–36.

Bradshaw, R., and Atkins, S. (1996). "The use of public transport for school journeys in London." *Proc., Seminar F: Public Transport Planning and Operations*, Brunel Univ., England, 405.

Braza, M., Shoemaker, W., and Seeley, A. (2004). "Neighborhood design and rates of walking and biking to elementary school in 34 California communities." *Am. J. Health Promot.*, 19(2), 128–136.

Bungum, T. J., Lounsbery, M., Moonie, S., and Gast, J. (2009). "Prevalence and correlates of walking and biking to school among adolescents." *J. Community Health*, 34(2), 129–134.

Carlin, J., Stevenson, M., Roberts, I., Bennett, C., Gelman, A., and Nolan, T. (1997). "Walking to school and traffic exposure in Australian children." *Aust. N. Z. J. Public Health.*, 21(3), 286–292.

Cavill, N., Biddle, S., and Sallis, J. F. (2004). "Health enhancing physical activity and sedentary behaviour in children and adolescents." *J. Sports Sci.*, 22(8), 679–701.

City Mayors. (2011). "The largest cities in the world by land area, population and density." ⟨http://www.citymayors.com/statistics/largest-cities-density-125.html⟩ (Jul. 29, 2011).

Cooper, A. R., Andersen, L. B., Wedderkopp, N., Page, A. S., and Froberg, K. (2005). "Physical activity levels of children who walk, cycle, or are driven to school." *Am. J. Prev. Med.*, 29(3), 179–184.

Copperman, R., and Bhat, C. (2007). "An analysis of the determinants of children's weekend physical activity participation." *Transportation*, 34(1), 67–87.

Dellinger, A. M., and Staunton, C. E. (2002). "Barriers to children walking and biking to school—United States, 1999." *MMWR*, 51(32), 701–704.