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Walking behavior across genders in school trips, a case study of Rasht, Iran

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ABSTRACT

Although walking behavior in school trips has been the subject of debate in developed countries in recent years, much remains to be learned about this subject in developing countries. Moreover, despite exploring effects of various factors, research on walking mode choice behavior across genders remains quite limited. The main purpose of this study is to understand reasons behind male-female differences in choosing walking as a mode of transportation in trips to school in the city of Rasht, Iran. Separate binary logit models were developed for boys and girls in trips to school using the data from Rasht household travel survey in 2007. Results show that high school girls are less likely to walk relative to elementary and middle aged girls; but elementary and middle aged boys dislike walking to school relative to high school boys. Results show that regardless of gender, an individual who has a car in his/her household is less likely to walk to school. In this study, different distance intervals (increasing by 0.25 miles) were defined. Results show that both boys and girls are sensitive to trips longer than 0.25 miles in choosing walking. However, the decrease in likelihood of walking is greater among boys than girls. For example, if the distance is between 0.25 to 0.5 miles, the probability of walking to school decreases by 14.8% points for boys and 10.5% points for girls with respect to trips less than 0.25 miles. Altogether, our findings suggest that gender differences need to be addressed if policy makers hope to increase rates of walking in children's trips to school.

1. Introduction

An increase in motorized trips and a decline in individuals' physical activity have become a major concern for many communities. Recently, this issue has led many local and regional authorities to promote non-motorized travel including walking and bicycling in urban areas. Among different trip purposes, school trips have captured significant attention in both public and academic viewpoints. This attention is, understandably, due to the priority that societies and policy-makers, specifically, give to the children. Especially over the last two decades, there has been growing concern over childhood obesity. For example it was reported in 2009–2010 that 17% of US children and adolescents aged 2–19 years were obese (Ogden et al., 2012). Based on new evidence, active transportation to school reduces risk of childhood obesity (Sahlqvist et al., 2012; Cooper et al., 2012; Roth et al., 2012). Promoting active transportation to school has other advantages in terms of

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health, economic, environment, transportation and even social justice. Despite these advantages, there have been well-documented declines in walking to school across the globe in recent years (McDonald, 2007) and have led researchers to investigated the effect of a various factors on children's mode choice for the school trip.

While walking has become a critical research topic in developed countries, it has not received enough attention in developing countries such as Iran. This study tries to overcome the gap in the current literature by studying the walking behavior to school within a typical city in Iran, Rasht. According to Rasht household travel survey in 2007 (Rasht comprehensive transportation planning study, 2011), 13.48% of all daily trips made were school trips apart from trips for the purpose of returning to home which consisted 49% of all trips. Moreover, it seems likely that travel behaviors are different among male and female students. The reasons behind male-female differences in choosing walking as a mode of transportation have not been well established, and mainly some recent studies have addressed this issue (e.g., (McDonald, 2012; Hsu and Jean-Daniel, 2014; Guliani, 2015)). Previous research on gender differences in travel behavior has used various theories and assumptions to explain the empirical evidences. For example, theoretical perspectives could be broadly classified into clusters such as theories of internalized gender differences, theories of gendered structural contexts, and theories of socially constructed gender differences which are used to explain gender differences in travel behavior (Boarnet and Hsu, 2015). However, the main motivation of this study for focusing on genders categories is that in Iran, schools are segregated by sex and boys and girls go to separated schools. Hypothetically, decision to choose walking as a mode of transportation to school may vary by gender. Furthermore, gender differences in travel behaviors in Iran, are partly because of cultural specification. It is worth noting that although females in Iran, are not faced with any limitations and barriers regarding physical activity and social interaction, Iranian families may be more culturally conservative in allowing their girls to be as freely present socially as males, at least during the school years (Ermagun and Samimi, 2012; Hatamzadeh et al., 2014). Therefore, girls may view factors affecting walking to school differently relative to boys. These motivated us to investigate walking behaviors, with a special focus on gender differences. A comparison between covariates that are expected to influence walking mode choice tendencies across genders is beneficial in evaluating candidate policies for promoting walking as a mode of transportation.

2. Literature Review

Numerous studies have investigated the effect of a wide range of factors on children's mode choice for the school trip and suggested a range of policies to be considered by the policy-makers. Prior researches on the effect of individual's age on traveling to school by active-transport have come to different conclusions. While some studies found a negative sign for the age variable (McDonald, 2008; Wilson et al., 2010), others found that with an increase in age (as children get older), the propensity for choosing active modes of transportation increases (Yeung et al., 2008; Pabayo et al., 2011; Su et al., 2013). There are also some studies which found no significant relation between age and choosing active modes in trips to school (Ermagun and Samimi, 2012). In another study among US youth, it was indicated that the likelihood of walking declines during high school but with insignificant effect (McDonald, 2008). This study shows that the effect of age was only significant for children between 5 and 14 years (elementary and middle school).

Walking behaviors are also affected by individual's gender. Many studies on trips to school have found that girls are less likely to walk than boys (McDonald, 2008; McMillan et al., 2006; Marten and Olds, 2004; Johnson et al., 2010). Cooper et.al in a study on five urban primary schools in Bristol, England suggested that gender played an important role in the likelihood that youth would walk to school, with boys being more likely to walk to school and also engage in physical activity after school (Cooper et al., 2003). Also, in a study by Evenson et.al in North Carolina it was found that rates of walking were generally higher for older boys (in high school) who were non-white, had a lower body mass index, and had parents that were infrequently home after school (Evenson et al., 2003). Despite the mentioned studies, there are some studies which do not confirm that boys are more likely to walk to school than girls (Ermagun and Samimi, 2012; Wilson et al., 2010; Bopp et al., 2012). Furthermore, several studies, have not found any association between gender and children's walking to school (e.g. Su et al., (2013; Carlin et al., 1997). It is worth noting that the two latter studies are on children who are quite young (at elementary school level in southern California and two cities in Australia respectively) and Su et al. has mentioned that gender differences at this age may not yet be large enough to be significant in influencing the rate of children's walking to school (Su et al., 2013).

Previous studies indicate that household characteristics including household structure influence travel behavior. It has been reported in some studies that household interactions are important in the decision to walk to school (McDonald, 2008; Yarlagadda and Srinivasan, 2007; Park et al., 2013). The relationship between walking or bicycling to school and the walking habits of parents or caregivers was examined in a study using a statewide pedestrian survey of New Jersey residents. It was found that the more frequently parents engage in walking activity, the more likely a child engages in active travel for the school trip (Park et al., 2013). McDonald found that the probability of younger children walking or bicycling to school decreases when their mother commuted to work in the morning. However, this had no statistically significant effect on high school students' likelihood to use active modes (McDonald, 2008). Furthermore, McDonald found that the work and travel behavior of fathers had a less significant impact on students' use of active modes for school.

The effects of opportunities or constraints on household transportation options and household income on walking mode choice of students have also been investigated previously. These studies mostly indicate that children of parents with lower income level are more likely to choose walking and bicycling in school trips than those with higher incomes (Ermagun and Samimi, 2012; Pabayo et al., 2011; McMillan, 2007; Spallek et al., 2006). The effect of transportation options have also been studied previously. While in many studies households access to private cars has been reported with a negative effect on walking and bicycling to school (Park et al., 2013; Copperman and Bhat, 2007; Wilson et al., 2010; Mackett, 2011), there are also studies which found that the number of cars per driver in the household had no effect on the travel mode choice to school (for example: a study among primary school students in North and South California (McMillan, 2007)).

Many studies have reported the trip distance as the most important factor in the probability of choosing active transportation. Most of the models of non-motorized travel to school showed that the probability of choosing active transportation decreased by an increase in trip distance (Ermagun and Samimi, 2012; McDonald, 2008; McMillan, 2007; Cervero and Duncan, 2003). In a study, due to lack of access to actual distance, public school density (the number of public schools per square mile) was used as a proxy for distance in the analysis. Results showed that as public school density increases, school children are more likely to walk to school (Park et al., 2013).

In general, research on walking behavior for different trip purposes show that a distance of 400 m (0.25 miles) which is about five-minutes' walk is often used as an acceptable walking distance (Krizek, 2003; McCormack. et al., 2008). However, research has also suggested that walking trips longer than 400 m may not be uncommon (McCormack. et al., 2008; Hoehner et al., 2005). A study has shown that in the U.S. state of Oregon, 52% of those who live less than 1.6 km from their school walk to school. This number drops to 36% when the distance between home and school increases to 2.4 km (Schlossberg et al., 2006). Another study in Belgium reported that 83.5% of students walk to and from school when they live less than 2 km from school (Dyck et al., 2010). McMillan studied the effect of home to school distance beside the influence of urban form and non-urban form factors on children's travel behavior and found that students who live less than 1.6 km from their school have a much higher probability of choosing active modes of transportation than those who live farther than 1.6 km from school (McMillan, 2007). She also concluded that other factors such as perceptions of neighborhood safety and traffic safety, household transportation options, and social/cultural norms were important.

There are many environmental factors which could influence non-motorized travel such as mixed uses of land, street connectivity, residential density, sidewalk continuity, sidewalk width, presence of cycling and walking paths, and the topography. While some previous studies have incorporated explicit measures of these attributes, others have developed composite factors for exploring the relation to active transportation behavior. For example, Braza et.al found positive correlations between higher population density, greater school size, higher number of intersections (a measure of street network connectivity), and increased rates of walking or biking to school in 34 California communities (Braza et al., 2004). Walking to school is also associated with urban form and land-use planning (Voorhees et al., 2010; Pucher et al., 2010). Mixed land use in a neighborhood positively affects the likelihood of walking and bicycling to school, while controlling other variables of influence (McMillan, 2007). Lack of adequate sidewalks and unsafe road crossings has been identified as barriers for increasing non-motorized travel to school in Alachua County, Florida (Ewing et al., 2004). Construction of sidewalks and street-crossings, and the installation of traffic control devices can also increase the proportion of children walking to school in areas where these changes are made (Boarnet et al., 2005). In a study, Frank et al. incorporated three factors including mixed uses of land, street connectivity and residential density into a single 'walkability index' and examined its relation with individual's physical activity (Frank et al., 2005). This index varies in its details and sub-index weightings in different studies.

As can be seen, previous studies have come to different results on walking behavior which could be a reason that this topic is very much related to the place and the society of the study area. According to the literature review, although some researchers have examined the walking behavior in school trips, none of them provide a discussion or empirical evidence across genders. It is worth noting that in Iran, schools are segregated by sex and boys and girls go to separated schools. Furthermore, as mentioned earlier, school trips constitute a relatively high proportion of daily trips in Rasht. Therefore, this study addresses two gaps in the current literature by focusing on gender differences in walking behavior to school, providing an insight into the case of walking to school in a developing country such as Iran, which has not been addressed in previous research. To address the mentioned gaps, the variables affecting the walking behavior to school were extracted from previous studies and then made for the study area in Rasht. Hypothetically, the effect of these variables on the decision to choose walking as a mode of transportation to school may vary across genders. Understanding these differences could be beneficial in evaluating candidate policies for promoting walking as a mode of transportation.

3. Method

3.1. Area of Study

The research objective was to assess the travel behavior of students travelling to school inside the urban areas of Rasht. Rasht is the largest city on Iran's Caspian Sea coast (Fig. 1) with a population of more than 550,000 according to the 2006 census. Automobile, taxi, motorcycle, mini-bus, bus, bicycle, and walking are the modes of transportation and no mass transit system has been provided yet. The increasing rate of vehicle ownership during the last decade and a poor transit system has made the automobile and taxi as the most favorable modes of transportation in daily trips.

Unplanned settlements with disordered pathways, low quality and condensed houses and weak infrastructure constitute

Fig. 1. Location of study area in north of Iran.

a major part of spatial structure of Rasht. Radiating streets from the city center in conjunction with ring roads shapes the main structure of street layout which gives a significant role to the city center where a traditional bazaar is located (Fig. 2) and as the main retail center in the core of the city, causes heavy congestion. Over the past decades, there has been a change in the spatial pattern of activities in Rasht. With the development of the city and limited space of the bazaar, some commercial activities have moved out from the city center and the traditional bazaar (Azimi, 2005).

3.2. Data

Data for the analysis comes from Rasht comprehensive transportation planning study in 2007 (Rasht comprehensive transportation planning study, 2011). As a part of that study, a questionnaire was designed and distributed among more than

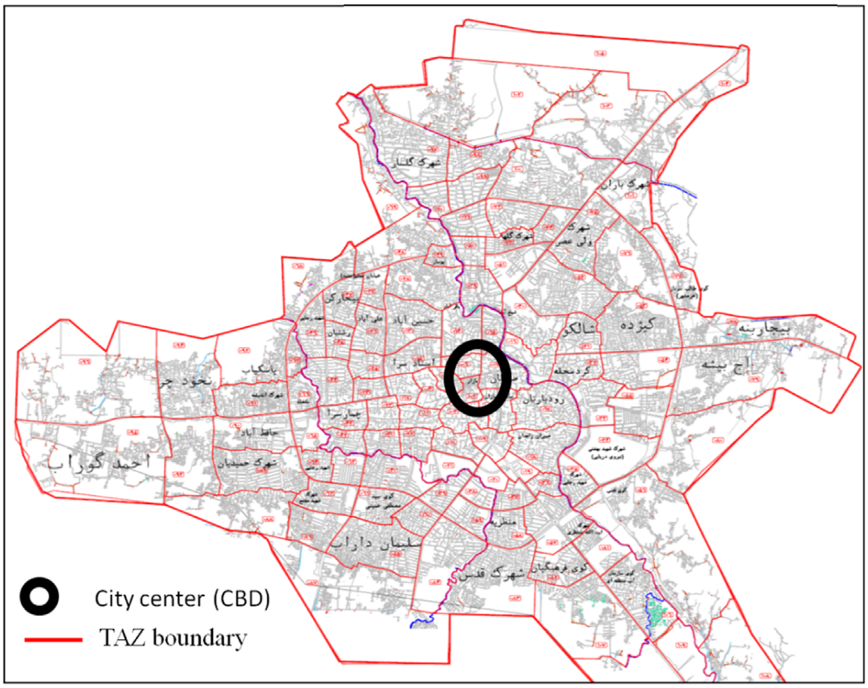


Fig. 2. City of Rasht containing 112 TAZs.

Table 1
Description of examined variables.

Category Name	Variable Name	Definition	
Individual Characteristics			
Age	Age_711Age_1214Age_1518	1:if age is between 7 and 11;1:if age is between 12 and 14;1:if age is between 15 and 18;	0: otherwise0: otherwise0: otherwise
Household Characteristics			
Structure	Child_U7Child_711Child_1218HSize	1:if there is a child under 7 years in household;1:if there is a 7- to 11-year old child in household;1:if there is a 12- to 18- year old child in household;Number of individual (s) in household	0: otherwise0: otherwise0: otherwise
Vehicle Ownership	Veh1_AutoVeh2_Motor	1:if there is one (or more) automobile(s) in household;Number of motorcycles in household	0: otherwise
Trip Characteristics Travel distance	Dist_r (ref. level)Dist_0.25-0.50Dist_0.50-0.75Dist_0.75-1.00Dist_1.00-1.50Dist_1.50-2.00Dist_Ov2.00	1:if trip distance is less than 0.25 miles;1:if trip distance is between 0.25 and 0.5 miles;1:if trip distance is between 0.5 and 0.75 miles;1:if trip distance is between 0.75 and 1.0 miles;1:if trip distance is between 1.0 and 1.50 miles;1:if trip distance is between 1.50 and 2.0 miles;1:if trip distance is over 2.0 miles;	0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise
Time of travel	Time	1:if trip is made in the afternoon;	0: otherwise
Environmental Characteristics(Land Use mix)			
Entropy	Entropy iEntropy j	Value of entropy index for origin zoneValue of entropy index for destination zone	
Job population balance	Job pop balance iJob pop balance j	Value of job population balance index for origin zoneValue of job population balance index for destination	
(Connectivity)			
Connectivity Factors	Factor1 iFactor1 jFactor2 iFactor2 j	Value of factor 1 for origin zone (based on Table 2);Value of factor 1 for destination (based on Table 2); Value of factor 2 for origin zone (based on Table 2);Value of factor 2 for destination (based on Table 2);	
Network patterns	Netp1 iNetp2 iNetp3 iNetp4 iNetp5 iNetp1 jNetp2 jNetp3 jNetp4 jNetp5 j	1:if the pattern of origin zone is like pattern 1 in Fig. 3;1:if the pattern of origin zone is like pattern 2 in Fig. 3;1:if the pattern of origin zone is like pattern 3 in Fig. 3;1:if the pattern of origin zone is like pattern 4 in Fig. 3;1:if the pattern of origin zone is like pattern 5 in Fig. 3;1:if the pattern of destination is like pattern 1 in Fig. 3;1:if the pattern of destination is like pattern 2 in Fig. 3;1:if the pattern of destination is like pattern 3 in Fig. 3;1:if the pattern of destination is like pattern 4 in Fig. 3;1:if the pattern of destination is like pattern 5 in Fig. 3;	0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise0: otherwise
(Other measures)			
Population density	OriginDenDestDen	Population per square kilometer of origin zonePopulation per square kilometer of destination zone	
Trip to CBD	CBD (Bazaar)	1:if trip destination is located in the CBD;	0: otherwise

5000 households who reside in 112 traffic analysis zones, TAZs (Fig. 2). Some TAZs are identified as main areas of business. The aim of the survey was to collect detailed information about every trip taken by all members of each participating household. Each person was asked to fill out a trip diary for a specific day including the mode of travel, starting and ending time of the trip and the trip purpose. In addition, household information including number of vehicles owned by type (e.g., car, motorcycle, and bicycle) and household size, as well as individual socio-demographic information such as age, gender and job status were also collected. Of all the trips made, 15.6% were for the purpose of study including trips to school and university. As the research objective was to assess the travel behavior of individuals to school, trips made from home to school were selected for the analysis. For the purpose of this study, trips which had origin-destination (O-D) outside the municipal boundaries of Rasht were excluded.

In the sample studied it was found that on the way to school 43.42% of boys choose walking as a mode of transportation while 37.16% of girls choose walking to school. This finding shows that school children in Rasht choose an active mode of transportation, on average according to our sample, more than school children in the U.S. states of California at 21% (Copperman and Bhat, 2007) and Georgia at 14.1% (Kerr et al., 2007), but less than the Portuguese at 52.6% (Mota et al., 2007) and Chinese at 87.7% (Shi et al., 2006) which could be due to differences in demographics, socioeconomics, culture, infrastructure and so on.

3.3. Analysis

Separate models were developed for boys' trips to school and girls' trips to school. The decision to make a trip by foot to school was modeled as a dichotomous variable in a binary logistic model. Explanatory variables are divided into four main categories: individual characteristics, household characteristics, travel characteristics, and environmental factors (Table 1).

In order to examine the effect of individual's age, different age groups were defined and tested in the models. Individual's aged between 7 and 18 were divided into three groups of 7-11, 12-14 and 15-18 in order to represent the elementary, middle and high school students, respectively. Household factors include characteristics of the trip-makers family such as number of persons in the family, vehicle ownership and number of children.

In order to examine the effect of travel distance, the distance on transportation network between the TAZ centroids of origin and destination of the trip was taken as the trip distance. Seven categories were defined for trip distance taking trips less than 0.25 miles as the reference level (Table 1). The aim was to find out the relative amount of disutility of distance intervals in different trip purposes.

Environmental factors used in this study were divided in to two main categories including: connectivity and land use. Each category contains several variables as indicators for the two categories which were extracted from the literature. In previous studies, several variables have been used as indicators of network connectivity. According to the literature, variables such as intersection density (Frank et al., 2005; Christian et al., 2011), percentage of four way intersections (Southworth and Owens, 1993; Dill, 2004), ratio of minor links to major links (Dill, 2004), Cul-de-sacs' density (Schlossberg and Brown, 2004), links' density (Dill, 2004), the ratio of intersection per all of nodes in network (including dead end or cul-de-sacs nodes) (Dill, 2004), the ratio of number of links to number of nodes (Ewing and DeAnna, 1996), gamma index (Kofi, 2010), and alpha index (Dill, 2004; Zhang and Kukadia, 2005) have been used as indicators of network connectivity. Those interested in more information about these variables are referred to the references mentioned. In this study, all of the nine connectivity variables mentioned were drawn for each of the 112 zones of the study area based on GIS database by means of Arc GIS 9.3. However, to eliminate multi-colinearity and comprising independent set of variables representing connectivity, a correlation test was performed to find out high correlated variables. Three variables had high correlation coefficients with other variables; thus were dropped from further analysis.

To identify conceptually meaningful connectivity factors out of the remaining connectivity variables, a principal component analysis (PCA) with varimax rotation (which assumes the factors are uncorrelated) was performed. Two clear factors emerged which could explain more than 70 percent of the variance. Table 2 shows variables which have factor loadings greater than 0.4. The variables "percentage of four way intersection" and "the ratio of intersections to nodes" loaded most highly on factor 1 labeled "node connectivity" and the variables "the ratio of minor roads to major roads" and "link density" loaded most highly on factor 2 labeled "link connectivity" (see Table 2). For further analysis, two new variables 'Factor1' and 'Factor2' were created using factor loadings. It worth noting that Kaiser-Meyer-Olkin test and Bartletts' test of sphericity confirmed the sample adequacy. More details about factor analysis process can be found in Field (Field, 2013).

Table 2
Principal component analysis of connectivity measures: factor loadings.

Variable indicating network connectivity	Factor 1 (Node connectivity)	Factor 2 (Link connectivity)
Percentage of four way intersection	0.817	
The ratio of intersections to nodes	0.817	
The ratio of minor roads to major roads		0.862
Link density		0.762

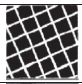
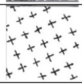
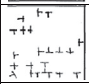
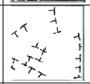
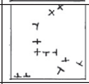
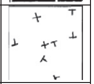
	Gridiron (c.1900)	Fragmented Parallel (c. 1950)	Warped Parallel (c. 1960)	Loops and Lollipops (c. 1970)	Lollipops on a Stick (c. 1980)
Street patterns					
Intersections					
Lineal Feet of Streets	20800	19000	16500	15300	15600
Number of Blocks	26	19	14	12	8
Number of Intersections	26	22	14	12	8
Number of Access Points	19	10	7	6	8
Number of Loops & Cul-de-Sacs	0	1	2	8	24
Variable Name	Netp1	Netp2	Netp3	Netp4	Net5

Fig. 3. Different types of network patterns (Southworth and Owens, 1993).

Beside the abovementioned variables, network pattern also reflects the visual form of network and tells us so much about the underlying effects of network on walkability. Southworth and Owens classified various patterns into five descriptive patterns as shown in Fig. 3 (Southworth and Owens, 1993). In walking through different patterns, there is a transferring from more connected areas to less ones which is caused by more auto oriented areas (Southworth and Owens, 1993). The grid network is an example of most connected network giving the pedestrian more alternative routes (Ewing and Cervero, 2010; Ewing et al., 2014). On the other hand, the cul-de-sac pattern has been more observed in sub urban areas and provides longer and wider roads accompanying by more houses which often ends in a circle for vehicles to turn around (Southworth and Owens, 1993). For the case of this study, one of the five network patterns in Fig. 3 was assigned to all 112 TAZs according to the reorganization made by experts. The frequency of the network patterns 1 to 5 in the study area is 2, 9, 18, 44 and 33 respectively.

Mixed land use is found to be one of the most correlated characteristics with walking travel behavior in previous studies. More mixed areas tend to create more propensities toward walking and therefore less relying on motorized transport (Frank and Pivo, 1994). A review by Maghelal and Capp in 2011 on the last two decades researches shows that mixed land uses criteria has the most influence on walking as 16 studies of 25 emphasize on the effect of mixed land uses (Maghelal and Capp., 2011). Previous researchers have used different land use indices. Entropy as a measurement of mixed land uses has been used in some walking studies (Frank et al., 2005; Ewing et al., 2014; Cervero and Kockelman, 1997; Frank et al., 2010). Entropy is defined as equality between different land uses in an area and is calculated using Eq. (1) in which p_i is the percentage of i-th land use and n is the number of different land uses (Frank et al., 2004). This index varies between 0 and 1 in which 0 indicates one land use and 1 indicates the equal distribution of different land uses in area.

$$Entropy = -\frac{\sum_{i=1}^{n} p_i log p_i}{log n} \tag{1}$$

Job-population balance is another variable which measures the level of mixed land uses and is introduced as an influential variable in examining walking. More balance between employment opportunities and population in the destination zone could provide more accessibility for workers which could itself give parents more chance to accompany children to school by foot. Ewing et al. used this variable beside the entropy to assess the mixed land uses (Ewing et al., 2014). This index evaluates the balance between jobs and inhabitant population of an area and is calculated by Eq. (2) in which *Job* shows the employment opportunities of a zone and *Pop* is the population of that zone. The value of 0.2 is suggested by Ewing et al. in order to maximize the explanation power of this index.

$$Job - popbalance = 1 - \left|\frac{Job - 0.\ 2 \times Pop}{Job + 0.\ 2 \times Pop}\right| \tag{2}$$

This index varies between 0 and 1 in which 0 is related to the areas which have either of residential or employment land use and 1 indicates the optimized ratio of jobs to inhabitants of an area (Ewing et al., 2014). Values between zero and one shows areas with unbalanced residential and employment land uses. According to Ewing et al. zones with just one land use (residential or nonresidential) has no attraction for pedestrians to make walking trips (Ewing et al., 2014).

The variables entropy and Job-population balance were calculated for the study area as indicators for land uses and are introduced in Table 1. Beside the mentioned variables used as indicators for connectivity and land use, the effect of other environmental variables such as population density of the origin/destination zone and the effect of making a trip to the CBD were also examined (see Table 1). Coding definitions, specifically developed for each of the variables are given in Table 1. Variables were included in the final model if they were significant at 90% level. The best specifications for the two models were obtained after systematically eliminating the statistically insignificant variables.

Table 3
Gender-specific binary logit models for school trips.

Variable Name	Boys Model			Girls Model		
	Coefficient	t-stat.	Marginal Effects	Coefficient	t-stat.	Marginal Effects
Constant	1.04**	2.48	–	–.03	–	–
Age_711	–0.31**	–2.32	–0.07305	–	–	–
Age_1214	–0.27**	–2.15	–0.06438	–	–	–
Age_1518	–	–	–	–0.30**	–2.25	–0.06181
Veh1_Auto	–0.30***	–3.01	–0.07234	–0.24*	–1.96	–0.04968
Hsize	–	–	–	0.12*	1.87	0.02563
Dist_0.25-0.50	–1.12***	–3.64	–0.1480	–0.54*	–1.72	–0.1046
Dist_0.50-0.75	–1.93***	–6.16	–0.3243	–1.27***	–3.95	–0.2762
Dist_0.75-1.00	–2.79***	–8.57	–0.5358	–2.25***	–6.59	–0.5061
Dist_1.00-1.50	–3.57***	–11.2	–0.6933	–3.17***	–9.19	–0.6529
Dist_1.50-2.00	–4.57***	–12.4	–0.8151	–3.54***	–8.79	–0.6910
Dist_Ov2.00	–4.80***	–13.1	–0.8323	–5.03***	–9.2	–0.7644
Time	0.43***	2.79	0.10582	–	–	–
DestDen	–0.01*	–1.79	–0.00045	–	–	–
Entropy i[a]	1.07***	3.09	–	–	–	–
Entropy j[a]	0.88**	2.47	–	1.45***	3.68	–
Job pop balance i[a]	0.42*	1.67	–	0.85***	2.91	–
Job pop balance j[a]	1.50***	7.2	–	–	–	–
Factor2 i	0.19***	2.91	0.0686	–	–	–
Factor2 j	–	–	–	0.19**	2.4	0.03968
Netp4 i	–0.26**	–2.4	–0.07730	–	–	–
Netp3 j	0.32**	2.45	0.06080	–	–	–
Number of observations		2547			1682	
Log likelihood at zero		–1238.26802			–816.55367	
Log likelihood at convergence		–1743.35108			–1109.77013	
McFadden Pseudo R-squared		0.2897197			0.2642137	

Notes:
*** Significant at 1% level;
** Significant at 5% level;
* Significant at 10% level.
[a] For these variables, as it is mentioned in Section 4.3, marginal effect do not make much sense; consequently, they were not calculated.

4. Results and discussion

Separate binary logit models were developed for boys' trips to school and girls' trips to school. Results show that beside some similarities, the effect of various factors on walking behavior of boys' and girls' are different in trips to school. Final models are summarized in Table 3 and are further discussed in this section.

4.1. Individual and socioeconomic characteristics

The model developed for females shows that high school girls (i.e., child aged between 15 to 18) are less likely to walk to school relative to elementary and middle aged girls (i.e., child aged between 7 to 11 and 12 to 14, respectively). However, in the model developed for males, the probability of choosing walking to school is less in elementary and middle aged boys relative to high school boys. Our finding is in contrast with a study on school trips which found that girls are less likely to walk than boys with the difference being more significant at younger ages (McMillan, 2007) but also confirms findings in another study which found that rates of walking were generally higher for high school boys (Evenson et al., 2003).

Our analysis suggests that the presence of children in a household has no significant effect on the likelihood of walking neither for models developed for boys nor girls which is consistent with a study by Ermagun and Samimi in 2012 (Ermagun and Samimi, 2012) but is also in contrast with a study in the New Zealand by Yelavich et.al who found positive correlation between the number of children in a household and the propensity of students to utilize active modes of transportation (Yelavich et al., 2008). However, the variable used in these studies was the number of children in a household while the variable used in our study was the presence of school aged children in household. As indicated in Table 3, results show that regardless of gender, an individual who has a car in his/her household is less motivated to walk to school which is consistent with results found in many previous studies (Wilson et al., 2010; Park et al., 2013; Copperman and Bhat, 2007; Mackett, 2011). The reason behind this may be due to the interaction between children's trip to school and the parent's trip to workplace which may lead families to choose motorized transportation modes (usually driving) for accompanying children and then attainment to their workplaces. These findings were also reported in the literature (McDonald, 2008; Yarlagadda and Srinivasan, 2007). Unfortunately, there was no information on the number of licensed drivers in a household for this study. However, the variable defined for the number of motorcycles in a household was found to be statistically insignificant in both models and was eliminated from the final model presented.

4.2. Travel and environmental characteristics

Making trips on particular times of day was found with different effects on walking behavior of males and females. Some schools in Rasht have more than one period (usually one period in the morning and another period in the afternoon). The results show that time of day has no statistically significant effect on girls' tendency to walk; but it has a significant and positive effect on the walking mode choice of boys when the trips are made in the afternoon. The less likely to walk in the morning may be due to the sensitivity on getting to school on time, and the fact that the children's school may be on the way to the parent's workplace in the morning as mentioned above.

Another significant factor is the travel distance which was categorized in six levels (increasing by 0.25 miles) relative to a base category (i.e., distances less than 0.25 miles) to show the variation of distance effect across genders. Therefore, it is logical to find the estimated coefficients with negative signs in the models. Results show that the travel distance negatively affects walking in all models which is consistent with other studies showing that an increase in trip distance decreases the likelihood of walking (Ermagun and Samimi, 2012; McDonald, 2008; McMillan, 2007; Cervero and Duncan, 2003). All distance categories are also significantly different with respect to the reference level. This finding implies that boys' and girls' are sensitive to trips longer than 0.25 mile in choosing walking to school. As shown in Table 3, different coefficient values are determined for the assumed distance intervals. This finding confirms the appropriateness of assuming the distance variable in several intervals.

Assessing environmental factors showed that in line with previous studies (e.g. Frank et al., 2005; Ewing et al., 2014; Cervero and Kockelman 1997; Frank et al., 2010), land use features both in origin and destination zones of a trip are directly related to walking choice probability. It was found that travel zones with higher level of mixed land uses have a positive significant effect on the propensity to walk.

Among connectivity measures, the variable *Factor1* which mostly reflects the characteristics of nodes in the network was not significant in any model. However, the variable *Factor2* that more represents the characteristics of links in the network was found with positive effect on walking behavior. Results showed that more links in an area, specifically higher ratio of minor roads to major roads tend to increase walking mode choice in school trips. Moreover, according to the results found in this study, network pattern has no significant effect on walking mode choice of girls in trips to school but it significantly affects boys walking behavior. Our findings show that boys living in areas which look like the fourth pattern in Fig. 3 (i.e., pattern which contains more cul-de-sacs and curvilinear links in comparison with perfect grid pattern) are less likely to walk to school. On the other hand, schools located in areas which are more similar to perfect grid pattern, increase the probability of walking among boys. Moreover, results showed that increase in population density of the trip destination zone (the zone where the school is located in), decreases the likelihood of walking for boys.

4.3. Policy implications

As the coefficients and the levels of significance only highlight associations and do not provide much insight for planning, marginal effects were calculated to determine the effect of a one unit change in the independent variable (or change for binary variables) on the probability of walking (Ben-Akiva and Lerman, 1985). In this study marginal effects are computed at the individual-level and weighted by the individual's associated choice probability (i.e., probability weighted sample enumeration- PWSE). Finally, an average of the PWSE over the sample is reported as the marginal effect of each variable. It is worth noting that calculating marginal effects for variables which have values between zero and one have no practical sense. Therefore, for the land uses indices which have values between zero and one, marginal effects were not calculated. Many factors (like age) are beyond the control of policymakers; therefore, the main focus of the proposed policies was on the travel and environmental characteristics.

Results show that distance is one of the most important factors on the propensity to walk to school. As mentioned earlier, all distance intervals were significantly different with respect to the reference level which implies that both boys and girls are sensitive to trips longer than 0.25 mile (400 m) in choosing walking to school. According to Fig. 4, variation of distance coefficients for both boys and girls is about linear until 1.5 mile but in longer distances, some non-linear effect can be seen especially among boys. The marginal effects calculated for distance intervals show that, the decrease in likelihood of walking is greater among boys than girls. For example, if the distance is between 0.25 to 0.5 miles (i.e., the first interval), the probability of walking to school decreases by 14.8% points for boys and 10.5% points for girls with respect to the reference interval (i.e., less than 0.25 miles). Our findings suggest that gender differences need to be addressed if policy makers hope to increase rates of walking in children's trips to school. For example, due to demographic changes and reduction in the number of students during recent years in Iran, a number of schools are closing. Therefore, a school integration policy is under consideration in the Ministry of Education in Iran. According to results obtained in this study and in order to achieve sustainable development it is recommended to distribute schools in a way that leads to higher density of boys' schools in an area than girls' schools. This could provide more accessibility to school for boys and shorter distances which could itself increase the propensity to walk to school. The marginal effects estimated throughout this work are helpful for planners, policymakers, and the public, in understanding to what extent behaviorally-based models predict shifts toward and away from making trips by foot.

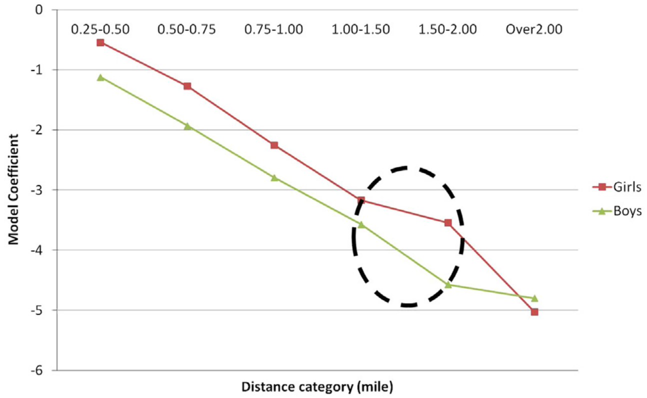


Fig. 4. Effects of distance on propensity to walk across genders for school trips.

Network connectivity measures also give some implications. For example the significant effect of the variable Factor2 shows that planners should consider the higher ratio of minor links to major links which could provide better network for pedestrians. Minor roads in contrasting with major roads are considered as advocators of walking which is a result of lower levels of motorized traffic hazards and also less speed of vehicles in these roads. Overall, designing local roadways to decrease automobile speeds could have an important role in increasing walking to school. Moving toward network patterns which have more resemblance to grid network patterns could also be effective especially in areas which have higher school density for boys. Areas with higher cul-de-sacs' density are deterrent to walking. Furthermore, increasing connectivity of pedestrian infrastructure (e.g., fill network gaps with sidewalks, multi-use trails, and roadway crossing facilities) should be considered in future programs.

One of the policies that can be suggested based on the results found is to plan for higher mixed-use developments. The significant effect of the variable (Jobpop_D) implies that a more balance between employment opportunities and population in the destination zone could provide more accessibility for workers which could itself increase the propensity to walk for adults. Accordingly, this could give parents more chance to accompany children to school by foot. However, according to Table 3, the magnitude of effect for the variable car ownership in household is high in both models which suggests that improving walking infrastructure can be enhanced by transportation demand management push policies (i.e., policies discourage car usage) to encourage people to walk more.

4.4. Study limitations

It should be borne in mind that data on travel behavior in developing countries like Iran is minimal. This is especially true for the city of Rasht. Therefore, some limitations are important to point out. A major limitation to this research was the lack of information about the actual distance traveled which should be considered in future research. Furthermore, due to lack of information in the data used, more explanations about the effect of household characteristics on children's walking to school (for example, interactions between children's trip to school and parent's trip to workplace) were not possible and is proposed to be explored in future studies. Also, while some environmental variables were controlled in this study, they are limited. Various path attributes such as average incline, adjacent traffic volumes, and presence (and width) of sidewalks, and the elevation difference could be helpful in reflecting some key factors influencing walking mode choice in school trips.

5. Summary and conclusion

Walking behavior and its relationship to various factors has been the subject of debate in developed countries. However, much remains to be learned about this topic in developing countries. This study addresses two gaps in the current literature by focusing on gender differences in walking behavior to school which has not been well established in previous research, providing an insight into the case of walking to school in a developing country such as Iran and particularly in the city of Rasht in which school trips constitute a relatively high proportion of daily trips. Especially, in Iran, schools are segregated by sex and boys and girls go to separated schools. Moreover, as mentioned earlier, Iranian families may be more culturally conservative in allowing their girls to be as freely present socially as males, at least during the school years. Therefore, decision to choose walking as a mode of transportation to school may vary by gender. Understanding differences between boys and girls could be beneficial in evaluating candidate policies for promoting walking as a mode of transportation in school trips.

Despite limitations to this study, many variables were created and examined in two behavioral models. The models were developed for boys and girls and comparisons were presented to provide useful insights about traveler's behavior. Results show that among girls, high school students are less likely to walk relative to elementary and middle aged students but among boys, elementary and middle aged boys are less likely to walk to school relative to high school boys. Analysis also suggests that the presence of children in household has no significant effect on the likelihood of walking neither for males nor for females. Results show that regardless of gender, an individual who has a car in his/her household is less likely to walk to school. Another finding is that time of day has no statistically significant effect on girls' tendency toward walking; but it has a significant and positive effect on the walking mode choice of boys when the trips are made in the afternoon. Some schools in Rasht have more than one period (usually one period in the morning and another period in the afternoon).

In this study different distance intervals (increasing by 0.25 miles) were defined and their effect was evaluated relative to a reference category (i.e., distances less than 0.25 miles). The results showed that all distance categories have negative effect and are significantly different from the reference level (i.e., under 0.25 mile) which means that students are sensitive to trips longer than 0.25 mile in choosing walking to school. This finding should be considered in locating new schools in future planning. Our findings also show that the decrease in probability of walking is greater among boys than girls. Therefore, higher density of boys' schools in an area could have higher priority than girls' schools in Rasht. It is valuable to have in mind that environmental feature of an area also important. Examining environmental factors in this study suggests higher-mixed-use developments and higher ratio of minor links to major links which provide better network for pedestrians. Moving toward network patterns which have more resemblance to grid network patterns could be effective in increasing the propensity to walk in school trips, especially among boys. The marginal effects estimated throughout this work are helpful, when communities seek to reduce reliance on motorized travel by defining new built-environment environment contexts and pursuing distinctive policies.

Altogether, our findings show that beside some similarities, the effect of various factors on walking behavior of boy's and girl's are different in trips to school which suggests that gender differences need to be addressed if policy makers hope to increase rates of walking in children's trips to school. However, despite some reasons presented for differences between boys and girls in choosing walking in school trips, this subject is still interesting and open for future studies. Additional research examining the reciprocal influence between individual walking behaviors across genders can further clarify the relationships detected in this study. For example it would be interesting to find out how improving the infrastructure for walking could encourage boys and girls to choose walking as a mode of transportation to school considering cultural and social norms and family concerns.

Disclosure Statement

The authors have no conflict of interest.

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