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A walking mode choice analysis of school trips across morning and afternoon period students in Rasht, Iran: Does it matter?

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Abstract

There is evidence that walking as a mode of transportation has many benefits for children and therefore, studying factors influencing walking mode choice in school trips have captured significant attention in recent years. However, research on this topic remains limited in countries like Iran. This study focused on the city of Rasht in which some students go to school in the morning and some other in the afternoon and therefore, the effect of various factors could be different on shaping their likelihood to choose walking. Results show that regardless of the time going to school, girls are less motivated to walk to school relative to boys. Furthermore, individual that has a car in his/her household is less motivates to walk to school. Among various environmental factors examined, morning trips were found to be more affected than the afternoon trips to school. Finally, a finding in this study was that students are sensitive to distances higher that 0.25miles (400 meters) in the morning period but they do not mind walking up to 0.5 mile (800 meters) in the afternoon period.

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Keywords: Walking Trips, School Periods, Choice Model, Iranian City

1. Introduction

The number of overweight children has been increasing across many countries in recent years and therefore, there has been growing concern over childhood obesity in recent years. According to the World Health Organization (WHO) report in 2012, 10% of children under the age of 18 years were estimated to be overweight or obese worldwide (Prioritizing Areas for Action in the Field of Population-Based 2012). The values are even higher in countries like United States where in 2009–2010, 17% of US children and adolescents aged 2–19 years were reported as obese (Ogden, et al. 2012). In the meantime, there is evidence that walking as a mode of transportation can reduce the risk of being overweight and its associated health consequences ((e.g., (Sahlqvist, Song and Ogilvie

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2012, Roth, Millett and Mindell 2012)). However, despite the many advantages associated with walking to school, there have been well-documented declines in walking to school across the globe in recent years. Therefore, studying walking mode choice behavior in school trips has captured significant attention in recent years. These studies have tried to understanding factors that influence active transportation in order to support interventions that increase rates of walking to school, and in turn might promote children's physical activity. However, a review of previous studies shows that 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, 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. In line with previous studies in Rasht (e.g., (Hatamzadeh, Habibian and Khodaii 2017, Hatamzadeh, Habibian and Khodaii 2017)) and in order to gain a deeper understanding of the opportunities for walking in trips to school, this study aims to analyze how various factors affect walking mode choice to school across two groups of students (children 7 to 18 years old in this study). It is worth noting that some schools in Rasht have more than one period; usually one period in the morning and another period in the afternoon. In other words, some students go to school in the morning and some other in the afternoon. Therefore, the first group in this study contains the morning period students (MPS) who usually start at 7:30 AM and the second group refers to the afternoon period students (APS) who usually start at 12:30 PM. Hypothetically, decision to choose walking as a mode of transportation to school may vary by the time of making trip and this was the main motivation for this study.

The remaining of this paper starts with a review of the literature and is followed by a description of the data and the methodology used in this paper. Model estimation results are then presented. The paper concludes with a summary of the main findings and a discussion of the implications for transportation policy and planning practice.

2. Literature Review

Previous studies have reported a wide range of factors to affect children's decision to walk to school. Some of these studies are briefly reviewed in this section in two parts containing environmental characteristics and individual/household characteristics.

2.1. Environmental characteristics

Travel distance has been reported as the most important factor which negatively affects the probability of choosing walking to school (McMillan 2007, McDonald 2008, Cervero and Duncan 2003). It has been found in other studies that students who live less than 1.6 kilometers 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). Numerous studies have also examined the effect of many environment factors which could influence the choice of non-motorized travel to school. It is beyond the scope of this study to point out to review many of these studies but some of them are mentioned in the following.

In a study, variables such as higher population density, greater school size, higher number of intersections (a measure of street network connectivity) were found with positive effect on walking or biking to school (Braza, Shoemaker and Seeley 2004). In another study, mixed land use in a neighborhood was found to positively affect the likelihood of walking and bicycling to school (McMillan 2007). Manaugh and El-Geneidy (Manaugh and El-Geneidy 2011) examined the correlation of different indices of walkability (including the walkability index (Frank, et al. 2005), the walk opportunities index (Kuzmyak, Baber and Savory 2005) and a measure using the pedshed method (Porta and Renne 2005)) with travel behavior to school and suggested that the simple pedshed method was found to be the best walkability index when it comes to explaining the odds of walking to school. Lacks of adequate sidewalks and unsafe road crossings have been identified as barriers for increasing non-motorized travel to school (Ewing, Schroeer and Greene 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).

2.2. Individual/household characteristics

Among individual characteristics, age and gender are found to be the most correlated characteristics with walking travel behavior. Prior researches on the effect of age have found that the probability of choosing active modes of transportation increases as children get older (Yeung, Scott and Andrew 2008, Pabayo, Gauvin and Barnett 2011, Su, et al. 2013). In contrast with these finding, a study indicated that the likelihood of walking declines during high school but with insignificant effect (McDonald 2008). Many studies on trips to school have found that girls are less likely to walk than boys (McDonald 2008, McMillan, Day, et al. 2006, Marten and Olds 2004, Johnson, et al. 2010). However, there are also some studies which do not confirm that boys are more likely to walk to school than girls (Wilson, et al. 2010, Bopp, T.Kaczynski and Besenyi 2012). In another study it was found that rates of walking were generally higher for older boys (in high school) and their parents were infrequently home after school (Evenson, et al. 2003).

Household characteristics have also been found to influence the mode choice of students in trips to school. For example, results in a study showed that the more frequently parents engage in walking activity, the more likely a child chooses an active mode of travel for the school trip (Park, Noland and Lachapelle 2013). In a study it was found that when mother commute to work, the probability of younger children choosing an active decreases (McDonald 2008). Results in this study showed that those whom their mothers did not leave for work in the mornings did not experience a statistically significant effect on their active travel. Students in lower income level households have also been found to be more likely to choose walking relative to higher income level households (McMillan 2007, Spallek, et al. 2006, Pabayo, Gauvin and Barnett 2011). Many studies also indicate that having access to private cars in households, negatively affects walking to school (Wilson, et al. 2010, Copperman and Bhat 2007, Park, Noland and Lachapelle 2013, Mackett 2011).

3. Data and Methodology

3.1. Data

The research objective was to assess the travel behavior of students travelling to school inside the urban areas of Rasht which is the largest city on Iran's Caspian Sea coast (Figure 1) with a population of 680,000 according to the 2016 national census (Statistical Center of Iran, Population and Housing Censuses Census 2016). A complete introduction about the spatial structure of the city is provided in the previous articles published by the same author (for example see, (Hatamzadeh, Habibian and Khodaii 2017, Hatamzadeh, Habibian and Khodaii 2017)).

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

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 distributed among

more than 5000 households who reside in the urban area of Rasht. The questionnaire provided information about every trip taken by each member of the participating household such as the mode of travel, starting and ending time of the trip and the trip purpose for a specific day. In addition, household information including number of vehicles owned and household size, as well as individual socio-demographic information such as age, gender and job status were also collected. According to the survey, automobile and taxi are the most favorable modes of transportation in daily trips and no mass transit has been provided yet. The city also suffers from a poor bus system which is not exciting for people.

3.2. Analysis

For the purpose of this study, two separate models were developed for the morning period students, and the afternoon period students including 3252 trips (76.9%) and 977 trips (23.1%) respectively. A binary logit model was applied to find out relationships between walking mod choice (as a dichotomous variable) and various variables, including environmental factors such as travel distance, land use mix and network connectivity measures while controlling for individual/household characteristics. Explanatory variables used in this study are introduced in Table 1. Other than individual and household characteristics which were used as control variables, other variables were included in the final model if they were significant at 10% level or there was a reasonable reason for keeping them (e.g., variables representing distance categories).

Table 1. Description of examined variables.

Category Name	Variable Name	Definition	
Individual/ Household Characteristics			
	Female	1:if student is female;	0: otherwise
	Elementary/middle	1:if student is aged 7 to 14 years old;	0: otherwise
	High	1:if student is aged 15 to 18 years old;	0: otherwise
	HHSize	Number of people in household	0: otherwise
	Veh_Car	1:if there is at least one automobile in household;	0: otherwise
Environmental Characteristics			
Travel distance	Dist_r (ref. level)	1:if trip distance is less than 0.25 miles ;	0: otherwise
	Dist_0.25-0.50	1:if trip distance is between 0.25 to 0.5 miles ;	0: otherwise
	Dist_0.50-0.75	1:if trip distance is between 0.5 to 0.75 miles ;	0: otherwise
	Dist_0.75-1.00	1:if trip distance is between 0.75 to 1.0 miles ;	0: otherwise
	Dist_1.00-1.50	1:if trip distance is between 1.0 to 1.50 miles ;	0: otherwise
	Dist_1.50-2.00	1:if trip distance is between 1.50 to 2.0 miles ;	0: otherwise
	Dist_Ov2.00	1:if trip distance is over 2.0 miles;	0: otherwise
(Land Use mix measures)			
Entropy	ENT_O	Value of entropy index for origin zone	
job population balance	Jobpop_O	Value of job population balance index for origin	
(Connectivity mesaures)			
Link connectivity	DnsLink_O	Density of links for origin zone (number of links/area)	
	SPBH_O	Ratio of minor links to major links for origin zone	
Node connectivity	CNR_O	Ratio of intersection per all of nodes for origin zone	
	P4int_O	Percentage of four way intersections for origin zone	
Network Pattern	Netp_Giridon/ Fragmented	1:if the pattern of origin zone is Giridon;	0: otherwise
	Netp_Loops_Lollipops	1:if the pattern of origin zone is like a Loops_Lollipops;	0: otherwise

In the absence of individual distance, the distance between the TAZ centroids of origin and destination of the trip was taken as the trip distance. Seven intervals were defined for trip distance taking trips less than 0.25 miles as the reference level (Table 1). The connectivity and land use mix variables were drawn for all TAZ's in the study area based on GIS database by means of Arc GIS 9.3. Entropy is a variable which is used as an indicator for land use and is defined as equality between different land uses in an area and is calculated using Equation (1) in which p_i is the percentage of i-th land use and *n* is the number of different land uses (Frank, Andresen and Schmid 2004). This index varies between 0 and 1 in which 0 indicates one land use type and 1 indicates the equal distribution of different types of land use 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. This index evaluates the balance between jobs and inhabitant population of an area and is calculated by Equation (2) in which *Job* shows the employment opportunities of a zone and *Pop* is the population of that zone (Ewing, et al. 2014). This index also varies between 0 and 1 in which values between zero and one shows areas with unbalanced residential and employment land uses.

$$\text{Job-pop balance} = -\left|\frac{\text{Job-}0.2\times\text{Pop}}{\text{Job+}0.2\times\text{Pop}}\right| \tag{2}$$

4. Results

As discussed in the previous section, separate binary logit models were developed for the morning period students (MPS), and the afternoon period students (APS). Final models are summarized in Table 2. Marginal effects were also calculated to determine the effect of a one unit change in the independent variable (or change for binary variables) on the probability of walking. In this study, marginal effects of the probability of choosing walking were estimated maintaining all other variables at their means. Marginal effects for variables such as job population density and entropy were not calculated because according to the definition given, it has no practical sense. The rest of this section is devoted to the discussion of the findings.

4.1. Individual/household characteristics

Results show that beside some similarities, the effect of different factors on walking behavior of MPS and APS are different in trips to school. For example, girls were less likely to walk to school relative to boys in both periods. A reason for this finding may be relate to parents higher concerns about girls relative to boys. The marginal effects calculated shows that the probability of walking among girls decrease by 10.3% points in afternoon period while it only decreases by 3.9% points in the morning period.

According to the results, no significant differences were found between walking mode choice of high school students (child aged between 15 to18 years) and elementary/middle aged students (child aged between 7 to 14 years) in both morning and afternoon periods. However, according to the signs of the coefficients, in the morning period, high school students were more likely to walk to school but in the afternoon period, they were less likely to walk to school relative to the elementary/middle aged students.

Results also show that the household size has different effects on walking mode choice to school in the two periods. In the morning period, as household size goes up, the propensity to walk increases. However, in the afternoon period, the effect of household size is negative and also insignificant.

Another similar finding in both models was that regardless of time of trip, individual who has a car in his/her household is less motivated to walk to school both in morning and the afternoon period. The marginal effects show that the negative effect of having a car in household is more pronounced in the afternoon period.

Table 2. Binary logit models across morning period students (MPS) and the afternoon period students (APS).

	Morning period students (MPS)			Afternoon period students (APS)		
Variable	Coeff.	t-stat.	Marginal Effect	Coeff.	t-stat.	Marginal Effect
Constant	.397	1.05	-	1.740***	2.35	-
Female	-.342***	-3.86	-0.0390	-.473***	-2.80	-0.1032
High	.026	.28	0.0029	-.964	-.49	-0.1958
HHSize	.808*	1.71	0.0180	-.053	-.63	-0.0125
Veh_Car	-.256***	-2.95	-0.0281	-.290*	-1.75	-0.0643
Dist_0.25-0.50	-.772***	-3.40	-0.0164	-.872	-1.34	-0.1169
Dist_0.50-0.75	-1.416***	-6.09	-0.0427	-1.957***	-2.99	-0.3542
Dist_0.75-1.00	-2.434***	-9.83	-0.1294	-2.656***	-4.03	-0.5255
Dist_1.00-1.50	-3.148***	-13.03	-0.2410	-3.999***	-5.96	-0.7606
Dist_1.50-2.00	-3.852***	-13.64	-0.3952	-5.539***	-6.75	-0.8602
Dist_Ov2.00	-4.505***	-14.62	-0.5569	-5.366***	-6.80	-0.8546
Jobpop_O	.714***	3.37	-	1.572***	3.88	-
ENT_O	1.226***	3.85	-	-	-	-
DnsLink_O	.002**	2.28	0.0004	-	-	-
Netp_Loops_Lollipops	-.206**	-2.25	-0.0234	-	-	-
Number of observations	3252			977		
Log likelihood at zero	-1637.83542			-453.64788		
Log likelihood at convergence	-2173.74555			-671.33376		
McFadden Pseudo R-squared	.2465377			.3242588		

Note: *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.

4.2. Environmental characteristics

Travel distance was a variable which its effect was examined in six levels relative to distances under 0.25 mile. Results show that the travel distance diversely affects walking to school in all models. All distance categories are also significantly different with respect to the reference level (i.e., under 0.25 mile) except the first category (i.e., 0.25-0.5 mile) in the model developed for the APS. This issue implies that although students are sensitive to distances higher that 0.25miles in the morning period, they do not mind walking up to 0.5 mile (800 meter) in the afternoon period. However, the marginal effects calculated for the distance intervals show that the negative effect of travel distance on walking mode choice is much higher in the afternoon period. For example, for distances between 0.25 to 0.5 miles (i.e., the first distance level), while the probability of walking in the afternoon period decreases by 11.7% points, it decreases by only 1.6% points in the morning period, with respect to the reference level (i.e., less than 0.25 mile). The gap between the two periods even increases as the travel intervals go up.

Another finding in this study was that environmental factors were more affective in the morning trips than the afternoon trips to school. Results show that entropy and job population balance as measures of mixed land uses in this study, were found with significant and positive effect in the MPS model. However, in the APS model, only job population balance was significant on walking mode choice of students.

According to the findings in this study, connectivity measures were only significant on the MPS. Results show that more links in an area (as connectivity measures) tend to increase walking mode choice in school trips made in morning. Network pattern was only found with significant effect on walking mode choice of MPS. This means that

students living in areas which contain more cul-de-sacs and curvilinear links in comparison with perfect grid pattern are less likely to walk in the morning trips to school. These factors were not statistically significant in the afternoon trips to school.

5. Conclusion

In order to develop a better understanding of walking behavior, this research examined factors affecting the walking mode choice of students in city of Rasht, Iran in which some students go to school in the morning and some other in the afternoon. Despite limitations to this study, the effect of some environmental variables was examined in two behavioral models while controlling for the effect of individual and household characteristics.

Altogether, from results in this study it was concluded that the effects of variables across students going to school in morning and students going to school in afternoon were different. A reason behind differences found could be due to different travel conditions of other family members in the two school periods. Another set of analysis with a new data collection could more clearly find reasons behind different behaviors and relate the time of making the trip to school and its role on walking mode choice behavior. Findings in this study could be interesting and beneficial in evaluating candidate policies for promoting walking in school trips in the Iranian cities in which schools are separated in to more than one periods.

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References

Boarnet, M.G, C.L Anderson, K Day, T.E McMillan, and M Alfonzo. "Evaluation of the California safe routes to school legislation: urban form change and children's active transportation to school." *American Journal of Preventive Medicine* 28 (2S2) (2005): 134–140.

Bopp, Melissa, Andrew T.Kaczynski, and Gina Besenyi. "Active commuting influences among adults." *Preventive Medicine* 54 (2012): 237–241.

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

Cervero, R, and M Duncan. "Walking, bicycling, and urban landscapes: Evidence from the San Francisco Bay Area." *American Journal of Public Health* 93, no. 9 (2003): 1478-1483.

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

Evenson, K.R, S.L Huston, B.J Mcmillen, P Bors, and D.S Ward. "Statewide prevalence and correlates of walking and bicycling to school." *Archives of Pediatrics & Adolescent Medicine* 157 (2003): 887–892.

Ewing, R, et al. "Varying influences of the built environment on household travel in 15 diverse regions of the United States." *Urban Studies*, 2014: 2330-2348.

Ewing, R, W Schroeer, and W Greene. "School location and student travel analysis of factors affecting mode choice." *Transportation Research Record: Journal of the Transportation Research Board* 1895 (1) (2004): 55–63.

Frank, L.D, T.L Schmid, J.F Sallis, J Chapman, and B.E Saelens. "Linking objectively measured physical activity with objectively measured urban form – findings from Smartraq." *American Journal of Preventive Medicine* 28, no. 2 (2005): 117–125.

Frank, L.D., M.A. Andresen, and T.L. Schmid. "Obesity relationships with community design, physical activity, and time spent in cars." *American journal of preventive medicine*, 2004: 87-96.

Hatamzadeh, Y, M Habibian, and A Khodaii. "Effective factors in walking mode choice of different age groups for school trips." *Transportation Research Procedia 25C*, 2017: 2302–2313.

Hatamzadeh, Yaser, Meeghat Habibian, and Ali Khodaii. "Walking behavior across genders in school trips, a case study of

Rasht, Iran." *Journal of Transport & Health* 5 (2017): 42-54.

Johnson, T.G, T.A Brusseau, P.W Darst, P.H Kulinna, and J White-Taylor. "Step counts of non-white minority children and youth by gender, grade level, race/ethnicity, and mode of school transportation." *Journal of Physical Activity & Health* 7 (2010): 730-736.

Kuzmyak, J.R, C Baber, and D Savory. "Use of walk opportunities index to quantify local accessibility." *Transportation Research Record: Journal of the Transportation Research Board 1977*, 2005: 145–153.

Mackett, R.L. "Letting children be free to walk." *WALK 21 12th Annual Conference.* Vancouver, Canada, 2011.

Manaugh, K, and A El-Geneidy. "Validating walkability indices: how do different households respond to the walkability of their neighbourhood?" *Transportation Research Part D* 16, no. 4 (2011): 309–315.

Marten, N, and T Olds. "Physical activity: patterns of active transport in 11–12 year old Australian children." *Australian and New Zealand Journal of Public Health* 28 (2004): 167–172.

McDonald, N.C. "Household interactions and children's school travel: the effect of parental work patterns on walking and biking to school." *Journal of Transport Geography* 16 (2008): 324–331.

McMillan, T. "The relative influence of urban form on a child's travel mode to school." *Transportation Research Part A—Policy and Practice* 41 (2007): 69–79.

McMillan, T, K Day, M Boarnet, M Alfonzo, and C Anderson. "Johnny walk s to school—Does Jane? Sex differences in children's active travel to school." *Children, Youth and Environments* 16 (2006): 75–89.

Ogden, C.L, M.D Carroll, B.K Kit, and K.M Flegal. "Prevalence of Obesity in the United States, 2009–2010." *NCHS Data Brief National Center for Health Statistics, Hyattsville, MD* 82 (2012).

Pabayo, R, L Gauvin, and T.A Barnett. "Longitudinal changes in active transportation to school in canadian youth aged 6 through 16 years." *Pediatrics* 128 (2011): E404–E413.

Park, Hyunsoo, Robert B Noland, and Ugo Lachapelle. "Active school trips: associations with caregiver walking frequency." *Transport Policy* 29 (September 2013): 23-28.

Porta, S, and J.L Renne. "Linking urban design to sustainability: formal indicators of social urban sustainability field research in Perth, Western Australia." *Urban Design International* 10 (2005): 51–64.

"Prioritizing Areas for Action in the Field of Population-Based." World Health Organisation, 2012.

"Rasht comprehensive transportation planning study." Final report (final edition), Municipality of Rasht (Andishkar consulting engineers), Rasht, 2011, 399.

Roth, M.A, C.J Millett, and J.S Mindell. "The contribution of active travel (walking and cycling) in children to overall physical activity levels: a national cross sectional study." *Preventive Medicine* 54 (2012): 134–139.

Sahlqvist, S, Y.N Song, and D Ogilvie. "Is active travel associated with greater physical activity? The contribution of commuting and non-commuting active travel to total physical activity in adults." *Preventive Medicine* 55 (2012): 206–211.

Spallek, M, C Turner, A Spinks, and C Bain. "Walking to school: distribution by age, sex and socio-economic status." *Health Promotion Journal of Australia* 17 (2006): 134–138.

"Statistical Center of Iran, Population and Housing Censuses." Census 2016.

Su, Jason G, et al. "Factors influencing whether children walk to school." *Health & Place* 22 (2013): 153–161.

Wilson, J Elizabeth, Julian Marshall, Ryan Wilson, and J Kevin Krizek. "By foot, bus or car: children's school travel and school choice policy." *Environment and Planning A* 42 (2010): 5 pages.

Yeung, Jennifer, Wearing Scott, and P. Hill Andrew. "Child transport practices and perceived barriers in active commuting to schoo." *Transportation Research Part A* 42, no. 6 (2008): 895–900.