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Transportation Research Procedia 00 (2018) 000–000

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

Toward a deeper understanding of elderly walking mode choice behavior: An analysis across genders in a case study of Iran

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Abstract

The world's elderly population has been dramatically growing during the last few decades and therefore, a big challenge for many societies will be to meet the future needs of this group especially their health problems. Promoting walking as an active mode of transportation in daily travel could have many benefits on the healthy lifestyle of the elderly. However, it has not received enough attention in the literature especially in developing countries. The main objective in this study was to understand the walking mode choice behavior of the elderly males (774 trips) and elderly females (299 trips) inside the urban areas of Rasht, the capital city of province Gilan, Iran which has the highest percentage of the elderly population among provinces in the whole country. Using a binary logit model, factors such as having a car in household, purpose of trip (work trips here), presence of small children in household, making trips on particular times of day, and higher ratio of minor roads to major roads were only found with significant effect on older males' likelihood to walk. However, factors such as land-use mix measures and travel distance were found with significant effect on the walking mode choice of both groups. Result showed that while older males' were sensitive to trips longer than 0.25 mile (400 meter); older females' do not mind walking up to 0.5 mile (800 meter) in daily trips.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: Walking Behavior, Elderly People, Gender Based Analysis, Developing Countries

1. Introduction

One of the most significant demographic changes in many societies is the aging of the population. According to a report by the World Health Organization (WHO), "the proportion of people age 60 and over is growing faster than any other age group. Between 1970 and 2025, a growth in older persons of some 694 million or 223 percent is

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expected. In 2025, there will be a total of about 1.2 billion people over the age of 60. By 2050 there will be 2 billion with 80 percent of them living in developing countries" (Active Ageing: A Policy Framework 2002). Because of the importance of the phenomenon of aging, the WHO has considered the increase in the elderly peoples' population as a demographic revolution in the world (Active Ageing: A Policy Framework 2002). Along with the world's elderly population growth, a big challenge will be to meet this group's future needs. Among various needs, health problems gain more importance. According to a report by the United Nations in 2013 "population ageing is associated with higher health expenditure, partly due to the increase in the proportion of older persons, which have higher prevalence of morbidity and demand for health care than younger adults" (World Population Ageing 2013, 2013). Therefore, identifying factors which can improve the elderly people's healthy lifestyle has become one of the concerns of policy makers and healthcare officials.

Daily travel to various purposes such as work and shopping is an important aspect of everyday life which could influence the elderly healthy lifestyle. Thus, improving transport for older people is increasingly important. In recent years and among various modes of transportation, promoting walking as an active mode of transportation in daily travel has received more attention due to its many benefits in terms of public health, economy, environment, transportation, etc. There is plenty of medical evidence suggesting that walking improve physical and mental health. Active transportation via walking and cycling could result in a positive contribution to overall physical activity which could itself reduce rates of coronary heart disease (Hu, et al. 2007), type-2 diabetes (Hu, et al. 2003), cancer and stroke (Cavill, et al. 2007) and all-cause mortality rates (Andersen, et al. 2000) in both men and women.

Numerous studies have investigated the effect of a wide range of factors on walking behavior for various trip purposes. However, to date, travel behavior of older people and especially their likelihood to choose walking in daily travel has received little attention especially in developing countries. This topic gains more importance in developing countries like Iran which has experienced a rapid increase in the number of elderly people in the past few decades and their health and welfare condition in the society have become an issue of concern. In the Islamic Republic of Iran in 2015, around 10% of the population is older than 60 years (World report on ageing and health 2015). In just 35 years' time, this will have increased to around 33% of the population. More specifically, the focus of this research is to understand walking behavior among older people (in this study, individuals' aged 60 or more) in the urban area of Rasht, the capital of Gilan province which is located in north of Iran. Figure 1 shows the proportion of population aged 60 or more by province in Iran. According to the Population and Housing Census report from the Statistical Center of Iran, the highest percentage of the elderly population in the whole country is seen in province of Gilan (Kousheshi, et al. 2014). Therefore, recognizing how various factors affect the walking behavior in daily travel of the citizens in Rasht becomes more important.

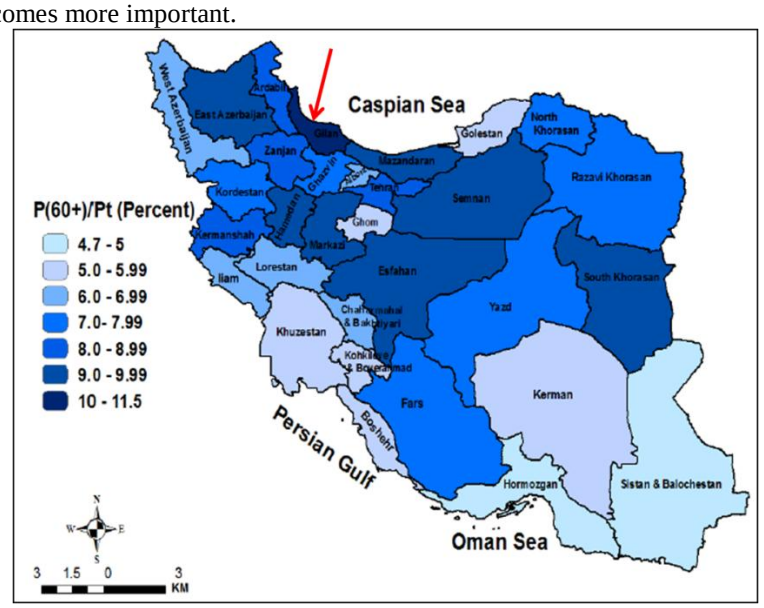

Fig. 1. Proportion of population aged 60+ by province, Iran, 2011

To gain a deeper understanding of the opportunities for walking choice in old age, this study investigated and compared walking behavior across genders. The main aim of the paper is to understand how various travel and environmental characteristics affect the walking mode choice behavior of males and females while controlling for their individual and household characteristics. Findings in this study can be beneficial in evaluating candidate policies for promoting walking as a mode of transportation which could lead to improvement in the elderly people's healthy lifestyle to a great extent.

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

The literature review shows that there are not enough studies on travel behavior of the elderly people. This section briefly reviews some of these studies in order to understand (1) differences between the walking behavior of the older people and other age groups, (2) differences between the travel behavior of the elderly men and women, and (3) different behavior of elderly people across developed and developing countries.

2.1. Travel behavior among older adults

The travel behaviors of older adults have some unique features that differ from other age groups. First, the distance which individuals travel in their daily life typically decrease as they get older (Barnes, et al. 2007) and this has made the neighborhood environment more important for them. For example, older people pay more attention to environmental characteristics in smaller buffers (e.g., 500m) around their residential locations relative to younger age group for which a buffer of 1– 1.6 km is typically used (Ding, et al. 2014). Second, the decision of older adults is less dependent to time constraints such as transporting children and strict work schedules. Third, some studies show older adults today travel more in comparison with previous cohort (Scott, et al. 2009), which may be associate with better health conditions in older adults nowadays. Finally, clearly discernible changes in other modes of transportation also affected the older adult’s decision, for example increasing older adults' crash rates in vehicle mile driven versus other age groups which may be a reason for them to be more willing to use other modes of transportation such as walking (Evans 2000).

Some studies indicate that the prevalence of walking among elderly in many countries is significantly low relative to other age groups (Keadle, et al. 2016, Laverty, et al. 2015). Wasfi el al. found that older adults walk for exercise less than other age groups (Wasfi, Steinmetz-Wood and Kestens 2017). According to the result of a survey in Norway, respondents show higher interest in driving since their health condition restrict them from walking (ECoMoTER 2000). A case study in Southwest England and Wales found that continue walking in old ages is a way to participate in social and community activities (Shergold, Parkhurst and Musselwhite 2012). In terms of factors which affect the walking behavior, some studies highlight the fact that older adults tend to walk in "activity friendly" environment in which ensure safe and easy access to services and recreational facilities (Wasfi, Steinmetz-Wood and Kestens 2017, Thielman, et al. 2015, Hirsch, et al. 2014). Some studies also focused on environmental aspect and found that higher density neighborhood results in higher frequency of walking among older adults (e.g., (Siren and Hakamies-Blomqvist 2004)). In a study in Seattle, all the environment variables were tested for different age groups and only positive relationship between older adults walking and proximity to parks and open spaces were found significant (ShigematsuShigematsu, et al. 2009).

2.2. Differences across elderly men and women

This part pays attention to gender differences in travel behavior of the elderly people. Some studies compare travel behavior of the elderly men and women based on their ability to drive. In a study it has been mentioned that the proportion of women who own driving license is lower than men (Hjorthol, Levin and Sirén 2010) and in another study it has been found that women also stop driving in younger ages (Siren and Hakamies-Blomqvist 2004).

In terms of the amount of walking, previous studies have come to different results across genders. For example, according to a case study in Canada elder women walk more than elder men in both utilitarian purposes and walk for exercise (Wasfi, Steinmetz-Wood and Kestens 2017); however, in contrast, some other studies have found that men relatively tend to walk more than women (Clark and Scott 2013, Owen, et al. 2007). Some case studies in Asia have also reported different walking behavior among elderly males and females. In a case study in Japan, Inoue et al. found positive association between total walking of elderly women (aged 65 years and over) and shop/ commercial destinations/ parks/ recreational and open spaces (Inoue, et al. 2011). They also found that total walking of elderly men is related to the pedestrian-friendly features and presence of pleasing sceneries. In another study in Hong Kong, Cerin et al. found that land use mix and sitting facilities positively affect within neighborhood walking of adults age over 65 only (Cerin, et al. 2014). They also found that crime and personal safety have negative impact on walking amount of women only.

2.3. Findings in developed and developing countries

Studies on older adults' travel behavior in developing countries have come to different results relative to developed countries which may be due to differences in life style in these countries. For example, although in the developed countries the labor force participation in older adults is decreasing, this rate in developing countries has a surging trend and many older adults still need to continue working even in older ages regarding their financial needs (World Population Ageing 2013 2013). While some studies in developed countries have reported that most of the trips are made by privet cars (e.g., Netherland (Tacken 1998)), some other studies in developing part of the world have found contradictory result. For example, Hu et al. in a case study of Changchun, China found that about half of the elderly travel on foot (Hu, Wang and Wang 2013). Previous studies have found that the elderly daily trips significantly changes after retirements (Van den Berg, Arentze and Timmermans 2011, Siren and Haustein 2016). Regarding this point, previous studies have introduced different purposes as elderly most favorable activities in different settings such as traveling for goods and services in Canada (Newbold, et al. 2005), going to religious places in Nigeria (Olawole and Aloba 2014) and shopping in China (Hu, Wang and Wang 2013).

3. Data and Methodology

3.1. Data

The research objective was to assess the travel behavior of elderly travelling inside the urban areas of Rasht which is the largest city on Iran's Caspian Sea coast with a population of 680,000 according to the 2016 national census (Statistical Center of Iran, Population and Housing Censuses Census 2016). Data for the analysis comes from Rasht comprehensive transportation planning study in 2007 (Rasht comprehensive transportation planning study 2011). According to that study, the urban area of Rasht was divided in to 112 traffic analysis zones, TAZs (see Figure 2).

Some TAZs are identified as main areas of business. Furthermore, 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 traditional bazaar is situated and acts as the main retail center in the core of the city. As a part of that study, a questionnaire was distributed among more than 5000 households who reside in the 112 TAZs. 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.

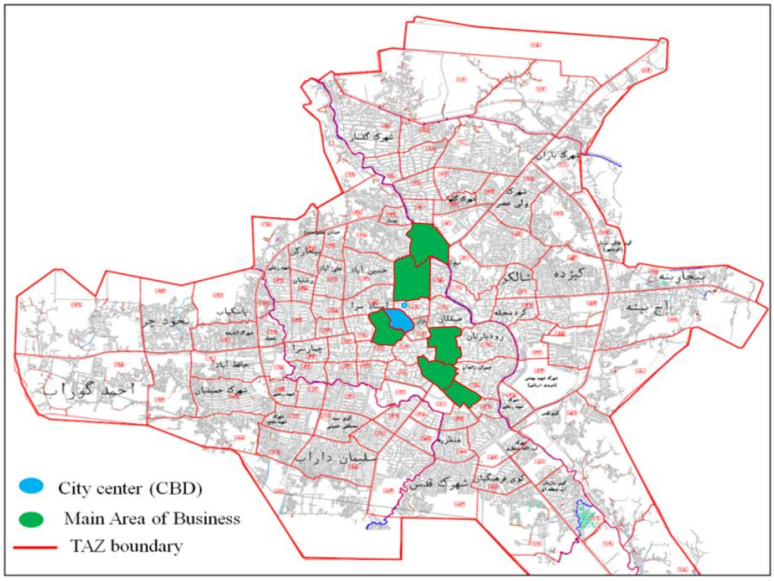

Fig. 2. The urban area of Rasht

3.2. Analysis

Two separate models were developed for elderly males (774 trips) and elderly females (299 trips) using the data from Rasht household travel survey in 2007. The decision to make a trip by foot was modeled as a dichotomous variable in a binary logit model. Explanatory variables are divided into three main categories: individual/household characteristics, travel characteristics, and environmental factors. Coding definitions, specifically developed for each of the variables are given in Table 1 and some of them are more described in this section.

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). As introduced in Table 1, built environment factors used in this study were divided into three main categories of connectivity measures, land use mix measures and traveling to areas of main business. 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.

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

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			
	Age	Individuals' age	0: otherwise
Household Structure	Child_711	1:if there is a 7-11 years child (i.e., elementary school age) in household;	0: otherwise
Vehicle Ownership	Veh_Car	1:if there is at least one automobile in household;	0: otherwise
Travel 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
Time of travel	Time_AM Peak	1:if trip is made between 7 to 8 AM (the peak hour of morning traffic);	0: otherwise
	Time_PM Park	1:if trip is made between 5 to 7 PM (the peak hour for car parking demand);	0: otherwise
	Time_8-10 AM	1:if trip is made between 8 to 10 AM;	0: otherwise
Trip purpose	Purpose_work	1:if purpose of trip is work;	0: otherwise
	Purpose_shopping	1:if purpose of trip is shopping;	0: otherwise
Environmental Characteristics ***(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	
Destination zone	Bazaar	1:if trip destination is to the traditional Bazaar in the CBD;	0: otherwise
	Business area	1:if trip destination is to a main area of business;	0: otherwise

4. Results

As discussed in the previous section, separate binary logit models were developed for elderly males and elderly females. Final models are summarized in Table 2. 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 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

Among individual characteristics, a finding is that the effect of age is significant but different on the two studied groups. According to Table 2, as age goes up among elderly males, the likelihood to walk increase but in contrast, as age goes up among elderly females, their likelihood to walk decrease.

Results show that regardless of gender, having a car in household has a negative effect on walking mode choice in both models. However, the effect of this variable is only significant on walking behavior of elderly males and it has no significant effect on elderly females. Generally, a reason for the negative effect of this variable is that individuals having a car in household are probably more motivated to choose this mode of transportation than those who do not have such an option in their choice set. Base on the marginal effects calculated, the rate of decline in the probability of walking for males is 7.4% points while it is almost nothing for females. It has been argued in some studies that the husband has the first choice in families with only one car (e.g., (Hjorthol 2000)) and this (i.e., lower car access which reduces their number of choices) could be a reason for the finding in this study.

Results show that the effect of having an elementary school age children in household (i.e., child aged between 7 to 11 years old) is completely different across the two elderly groups studied both in terms of the statistical significance and the magnitude of coefficient. According to Table 2, this variable has a negative and significant effect on walking mode choice of elderly males. One possible reason for the negative effect of the variable is that young children are relatively more dependent on their parents than older children and they still need care which would make parents more time limited and therefore, decreases the opportunity to walk. Interestingly, among elderly females, the effect of the variable is positive although it is not statistically significant. This finding means that accompanying young children to school could motivate older women to walk more.

Table 2. Binary logit models for elderly males and females.

	Males			Females		
Variable	Coeff.	t-stat.	Marginal Effect	Coeff.	t-stat.	Marginal Effect
Constant	-1.847	-1.50	-	8.025***	3.57	-
Age	0.039**	2.37	0.0076	-0.093***	-3.07	-0.0013
Child_711	-0.715**	-2.46	-0.1213	0.158	0.33	0.0022
Veh_Car	-0.379**	-1.97	-0.0741	-0.446	-1.13	-0.0057
Time_8-10 AM	0.763**	2.56	0.1657	-	-	-
Purpose_Work	-0.529**	-2.16	-0.0958	-	-	-
Dist_0.25-0.50	-0.781**	-2.06	-0.1440	-0.917	-0.84	-0.0630
Dist_0.50-0.75	-2.093***	-5.10	-0.4603	-2.738**	-2.49	-0.3861
Dist_0.75-1.00	-1.384***	-3.15	-0.2869	-3.384***	-2.84	-0.5461
Dist_1.00-1.50	-4.642***	-8.31	-0.7780	-5.103***	-4.41	-0.8434
Dist_1.50-2.00	-3.389***	-7.27	-0.6868	-6.211***	-4.77	-0.9139
Dist_Ov2.00	-5.677***	-7.00	-0.8047	-35.417	0.00	-0.9529
ENT_O	1.869***	3.23	-	2.062*	1.80	-
Jobpop_O	0.769**	2.00	-	1.265*	1.74	-
SPBH_O	0.004**	2.08	0.0009	-	-	-
Bazaar	-	-		-1.610*	-1.83	-0.0117
Number of observations	774			299		
Log likelihood at zero	-337.28032			-100.24862		
Log likelihood at convergence	-512.43152			-206.87459		
McFadden Pseudo R-squared	.3418041			.5154136		

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

4.2. Travel characteristics

As a travel characteristic, the effect of trip purpose was examined in this study. According to Table 2, trip purpose has no significant effect on walking behavior of elderly females and therefore, it was excluded from the final model. However, among elderly males, making a trip for the purpose of work significantly reduces the likelihood of walking relative to other trip purposes. A reason for this finding could be related to the limitation of being on time at the workplace. According to the marginal effects calculated the probability of walking for elderly males decrease by 9.6% points in trips to work. Results also show that making a trip in particular times of day has no significant effect on elderly females. However, making a trip between 8 to 10 AM by elderly males motivates them to choose walking relative to other travel times. None of the other time periods have a significant effect on walking mode choice of the elderly.

Travel distance was a variable which its effect was examined in six levels relative to distances under 0.25 mile. Results show that all estimated coefficients have negative signs in the models developed which means that the probability to choose walking decreases as the travel distance increase. All distance intervals are also significantly different from the reference level (i.e., under 0.25 mile) except the first interval (i.e., 0.25-0.5 mile) in the females model according to which, one can conclude that while older males were sensitive to trips longer than 0.25 mile; older females do not mind walking up to 0.5 mile (i.e., 800 meters) relative to distances less than 0.25 mile. A possible reason for this finding could be that females relative to males, perceive walking to various destinations as a recreational trip and even as an opportunity to socialize.

The marginal effects calculated for the distance intervals show that the negative effect of travel distance on walking mode choice is higher for elderly males than females for distances up to 0.75 mile. According to Table 2, for distances between 0.25 to 0.5 miles (i.e., the first distance level), the probability of walking decreases by 14.4% points and 6.3% points for elderly males and females, respectively, with respect to the reference level (i.e., less than 0.25 mile). For the second interval (i.e., distance between 0.5 to 0.75 miles) the probability of walking decreases by 46.0% for males but with 38.6% for females. For all distances intervals over 0.75 miles, the theorem is the opposite and the negative effect of travel distance on walking mode choice is more pronounced among elderly females than males. For example for distances between 0.75 to 1 mile, the probability of walking decreases by 54.6% points for elderly females but with 28.7% points for elderly males with respect to the reference level.

4.3. Environmental characteristics

Among environmental factors, entropy and job population balance of the trips origin zone (as measures of mixed land uses) were found with positive significant effect on both elderly males and females. This finding indicates that TAZs with higher level of mixed land uses increase the opportunity to walk among elderly people. Results also show that despite concerns about the connectivity measures, only the ratio of minor roads to major roads was significant among elderly males and not females. This finding implicates that planners should consider the higher ratio of minor links to major links as minor roads in contrasting with major roads provide lower levels of motorized traffic hazards and also less speed of vehicles which seems to be more important for elderly people relative to other age groups. Another finding was that making trips to the traditional Bazzar has significant and negative effect on elderly females walking behavior which could be due to difficulties of carrying heavy goods as shopping trips made to this area are usually for major and extensive purchases.

5. Conclusion

This study managed to provide an insight into the case of elderly walking behavior across genders and more specifically in a developing country such as Iran, which has not been well addressed in previous research despite experiencing a rapid increase in the number of elderly people in the past few decades. The study also focused on the city of Rasht, the capital of the province Gilan which has the highest percentage of the elderly population among provinces in the whole country.

Overall, beside some similarities, the effect of different factors on walking behavior of older males and females were different which suggests that gender differences also need to be addressed in walking mode choice analysis of

the elderly people. A finding in this study was that age has a significant but different effect on the two studied groups in terms of the sign of the coefficient (with negative effect on elderly females but with positive effect on elderly males). Considering age intervals in future research by using dummy coding for age may better describe the walking behavior of different age groups of the elderly. For example, age groups could be sub-stratified to determine behavioral differences between, for instance, individuals age 60–74 years, 75–84 years, and 85 or more years which are namely representing the "young old", ''older old'' and the ''oldest old'' respectively. Separate models for each of the mentioned groups could also be considered. This was not possible in the current study due to the sample size.

From findings in this study, it was concluded that the elderly females do not mind walking up to 0.5 mile (800 meter), however, elderly males were sensitive to distances over 0.25 mile (400 meter). Another conclusion from the results found in this study was that among various environmental characteristics, the factor of mixed-use is more important than connectivity measures for the elderly. Accordingly, one of the policies that can be used for increasing the probability of choosing walking as a mode of transportation among elderly people is to plan for higher mixed-use developments as variable used for measuring this factor were significant among both groups. Higher mixed-use zones could provide more accessibility for the elderly and make the place more exciting for them which could itself increase the propensity to walk. However, it should be borne in mind that although the effect of some built environmental variables were examined in this study, they are limited and various other attributes of the environment including the built environment (such as average incline, presence of sidewalks, the traffic safety, the elevation difference and etc.) and the social environment (such as trusting people in the neighborhood) could be helpful in reflecting some key factors influencing the elderly peoples walking mode choice.

Overall, because data on travel behavior in developing countries like Iran is minimal, this study should be viewed as a preliminary study on walking behavior of the elderly in Iran and as an exploratory effort to test the effect of various factors on their walking mode choice. Despite some explanations presented for the walking behavior of the elderly males and females, future research should further deepen the analysis by including many other variables as an active life results from the interaction of a myriad of factors, both at the individual (such as age and gender) and social (such as income and cultural beliefs) level which are also influenced by environmental factors, such as urban design and transport infrastructure in the vicinity of an individual's route, and by natural factors, such as topography and weather.

Acknowledgements

The authors would like to acknowledge the municipality of Rasht for providing the data. However, it had no role in this study design; analysis and interpretation of data; writing the paper; or the decision to submit the paper for publication. We also would like to thank Mrs. Sara Mahmoodi for her useful assistance.

References

Active Ageing: A Policy Framework. Noncommunicable Diseases and Mental Health Cluster, Noncommunicable Disease Prevention and Health Promotion Department, World Health Organization , 2002.

Andersen, LB, P Schnohr, M Schroll, and HO Hein. "All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work." *Archives of Internal Medicine* 160, no. 11 (2000): 1621– 8.

Barnes, LL, et al. "Correlates of life space in a volunteer cohort of older adults." *Experimental aging research* 33, no. 1 (2007): 77-93.

Ben-Akiva, M, and S Lerman. *Discrete choice analysis: theory and application to travel demand.* The MIT Press, Cambridge, Massachusetts, 1985.

Cavill, N, S Kahlmeier, H Rutter, F Racioppi, and P Oja. "Economic assessment of transport infrastructure and policies methodological guidance on the economic appraisal of health effects related to walking and cycling." *Copenhagen: World Health Organization, Regional office for Europe*, 2007.

Cerin, E, CH Sit, A Barnett, JM Johnston, M-C Cheung, and W-M Chan. "Ageing in an ultra-dense metropolis: perceived neighbourhood characteristics and utilitarian walking in Hong Kong elders." *Public health nutrition* 17, no. 1 (2014): 225-232.

Clark, AF, and DM Scott. "Does the social environment influence active travel? An investigation of walking in Hamilton, Canada." *Journal of Transport Geography* 31 (2013): 278-285.

Ding, D, et al. "Neighborhood environment and physical activity among older adults: do the relationships differ by driving status? ." *Journal of aging and physical activity* 22, no. 3 (2014): 421-431.

ECoMoTER. "Transport and Ageing of the Population." Organization for Economic, 2000.

Evans, L. "Risks older drivers face themselves and threats they pose to other road users." *International journal of epidemiology* 29, no. 2 (2000): 315-322.

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.

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.

Hirsch, JA, AV Diez Roux, KA Moore, KR Evenson, and DA Rodriguez. "Change in walking and body mass index following residential relocation: the multi-ethnic study of atherosclerosis." *American journal of public health* 104, no. 3 (2014): e49-e56.

Hjorthol, R.J. "Same city—different options: an analysis of the work trips of married couples in the metropolitan area of Oslo." *J. Transp. Geogr* 8, no. 3 (2000): 213–220.

Hjorthol, RJ, L Levin, and A Sirén. "Mobility in different generations of older persons: The development of daily travel in different cohorts in Denmark, Norway and Sweden." *Journal of Transport Geography* 18, no. 5 (2010): 624-633.

Hu, G, et al. "Occupational, commuting and leisure-time physical activity in relation to coronary heart disease among middle-aged Finnish men and women." *Atherosclerosi* 194, no. 2 (2007): 490- 497.

Hu, G, et al. "Occupational, commuting, and leisure-time physical activity in relation to risk for type2 diabetes in middle-aged Finnish men and women." *Diabetologia* 36, no. 3 (2003).

Hu, X, J Wang, and L Wang. "Understanding the travel behavior of elderly people in the developing country: a case study of Changchun, China." *Procedia-Social and Behavioral Sciences* 96 (2013): 873-880.

Inoue, S, et al. "Perceived neighborhood environment and walking for specific purposes among elderly Japanese." *Journal of epidemiology* 21, no. 6 (2011): 481-490.

Keadle, SK, R McKinnon, BI Graubard, and RP Troiano. "Prevalence and trends in physical activity among older adults in the United States: a comparison across three national surveys." *Preventive medicine* 89 (2016): 37-43.

Kousheshi, Majid, Ardeshir Khosravi, Mahtab Alizadeh, Mohammad Torkashavnd, and Nazanin Aghaei. "Population Ageing in I.R.Iran: Socio-economic, Demographic and Health characteristics of the elderly, 2014,." University of Tehran, 2014.

Laverty, AA, R Palladino, JT Lee, and C Millett. "Associations between active travel and weight, blood pressure and diabetes in six middle income countries: a cross-sectional study in older adults." *International Journal of Behavioral Nutrition and Physical Activity* 12, no. 1 (2015): 65.

Newbold, KB, DM Scott, JE Spinney, P Kanaroglou, and A Páez. "Travel behavior within Canada's older population: a cohort analysis." *Journal of Transport Geography* 13, no. 4 (2005): 340-351.

Olawole, MO, and O Aloba. "Mobility characteristics of the elderly and their associated level of satisfaction with transport services in Osogbo, Southwestern Nigeria." *Transport Policy* 35 (2014): 105-116.

Owen, N, et al. "Neighborhood walkability and the walking behavior of Australian adults." *American journal of preventive medicine* 33, no. 5 (2007): 387-395.

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

Scott, DM, KB Newbold, JE Spinney, R Mercado, A Páez, and PS Kanaroglou. "New insights into senior travel behavior: the Canadian experience." *Growth and change* 40, no. 1 (2009): 140-168.

Shergold, I, G Parkhurst, and C Musselwhite. "Rural car dependence: an emerging barrier to community activity for older people." *Transportation Planning and Technology* 35, no. 1 (2012): 69-85.

ShigematsuShigematsu, R, et al. "Age differences in the relation of perceived neighborhood environment to walking." *Medicine & Science in Sports & Exercise* 41, no. 2 (2009): 314-321.

Siren, A, and L Hakamies-Blomqvist. "Private car as the grand equaliser? Demographic factors and mobility in Finnish men and women aged 65+." *Transportation Research Part F: Traffic Psychology and Behaviour* 7, no. 2 (2004): 107-118.

Siren, A, and S Haustein. "How do baby boomers' mobility patterns change with retirement?" *Ageing & Society* 36, no. 5 (2016): 988-1007.

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

Tacken, M. "Mobility of the elderly in time and space in the Netherlands: An analysis of the Dutch National Travel Survey." *Transportation* 25, no. 4 (1998): 379-393.

Thielman, J, L Rosella, R Copes, M Lebenbaum, and H Manson. "Neighborhood walkability: differential associations with self-reported transport walking and leisure-time physical activity in Canadian towns and cities of all sizes." *Preventive medicine* 77 (2015): 174-180.

Van den Berg, P, T Arentze, and H Timmermans. "Estimating social travel demand of senior citizens in the Netherlands." *Journal of Transport Geography* 19, no. 2 (2011): 323-331.

Wasfi, R, M Steinmetz-Wood, and Y Kestens. "Place matters: A longitudinal analysis measuring the association between neighbourhood walkability and walking by age group and population center size in Canada." *PloS one* 12, no. 12 (2017): e0189472.

World Population Ageing 2013. New York: United Nations, Department of Economic and Social Affairs, Population Division , 2013.

"World report on ageing and health." World Health Organization, 2015.