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Attitudes to urban walking in Tehran

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Abstract. There is a growing interest in increasing walking in urban areas, partly to reduce pollution and other problems related to transportation by cars, and partly to improve public health (through reasonable exercise such as walking). In this study several factors that influence the amount of pedestrian movement in Tehran (Iran) are explored. Data were collected through questionnaires and interviews, and included sociodemographic indicators, people's perceptions of the neighborhoods where they live or work, and daily walking time in District 6 of the City of Tehran. The results of the study show that security, street connectivity, public health education, and sociodemographic indicators such as age and education influence pedestrian movement in residential areas. Local sociocultural behavior and indicators such as age and education were found to be the most influential in the commercial areas in the study. On the other hand, the respondents' behavior showed that there is a surprisingly low tendency in the City of Tehran to walk out of choice. Almost all pedestrian movement appears to be in response to a need or an obligation to walk, such as for business or essential shopping.

Keywords: walking, walkability, built environment, pedestrians, urban transportation, walking attitude, Tehran

Introduction

Walking is the oldest form of human movement. However, after World War II cities were designed and transformed for the benefit of cars. The decline of the pedestrian share in the transportation system has led to ever-increasing congestion, pollution, and a lack of vitality in neighborhoods in city centers and beyond. Now, particularly in advanced countries, new attention is being paid to pedestrian movement in order to preserve or redirect neighborhoods towards sustainability. In the developing world, however, such attention has so far been very limited and marginal. In this paper, walking is defined as pedestrian movement toward a destination regardless of motive or intention and 'Tehran' and 'city' refer to the Regional Municipality of Tehran, which consists of twenty-two districts.

The rapidly increasing use of private cars and the absence of public transport, coupled with overpowering commercial and sociological pressures exerted by the automobile industry, have resulted in the total neglect of meaningful planning for pedestrian movement. Tehran like all other large cities needs to review and improve its pedestrian networks. Rapid population growth in recent decades has caused the expansion of the city and subsequently its transportation networks. Iranians are very sociable and like to walk to see friends and places, and spend their time on the street. However, pedestrian movement is greatly hampered in Tehran due to the increase in travel distance between work and home, lack of attention to the necessary infrastructure, and the appeal that the automobile has for families. The problem is also exacerbated by an inadequate public transport system. Together, these factors have meant that both city officials and city dwellers have neglected issues related to walking. In the absence of serious academic research on this subject, particular attention is now required to

restore the balance between a rapidly growing metropolitan center and the need for planning that will make Tehran a walkable city.

During the 1930s urban planners and decision makers in Tehran used Haussmann's 19th-century plan for Paris as a model. Hausmann had made sweeping changes to Paris by building wide 'boulevards' in place of previously narrow streets. Tehran's planners also used as a model the wide street designs of Daniel Burnham's 1909 Plan of Chicago. In Tehran, following such models, the Naseri walls around the city, which had been used as fortification for almost 150 years, were demolished during the second half of the 19th century. This was followed by the laying out of straight and wide streets which severed tight-knit neighborhoods. Overall, Tehran began to lose its Middle Eastern identity for the sake of easier vehicle movement. Pedestrian walkways only considered when all other land uses had been decided upon, that is, using leftover segments (Moeini, 2009).

Many streets have changed in the last two decades due to revitalization. In many parts of the city the pavement width has actually been reduced to facilitate vehicular traffic use. This also results in a reduction of pedestrian capacity, but does not always produce a commensurate increase in vehicle capacity of roads. Indeed, for people who are not car owners, a combination of walking and public transport is the main way of getting around the city. Possibly the basic concern of the pedestrian in the city is traffic safety. Reduction of the pedestrian–vehicle conflict is essential. Pedestrian convenience and comfort is another issue that may affect walking. Among the other important factors that pedestrians are facing in Tehran is that pedestrians are not often encouraged to choose walking over other modes of transport.

As Robertson Kent (1993) indicated, it is factors such as the narrowing of pavements, the insensitive design of buildings, lack of safety, and the isolation of urban areas that result in a decline of walking. This study was carried out to assess the most important variables that influence peoples' walking choices in Tehran. While such studies are common for major cities in Europe and North America, very few studies of this nature are to be found for large cities in the developing world. In this context, the aim of this study is to investigate pedestrian movements in a particular part of Tehran (District 6), with the following objectives:

(1) To investigate and identify the relative influence of selected variables on pedestrian movement in Tehran.

(2) To assess, through the use of statistical analysis, the most important variables influencing walking in Tehran.

Research background

The existing literature demonstrates theoretically that the quality of the urban environment has significant influence on people's use of urban spaces (Gehl, 1987). The behavior of large numbers of people is influenced by the physical environment (McCormack et al, 2004). Research by Rapoport (1987) and Desylles et al (2003) lists many cultural and physical factors that influence people's decisions to select walking as their mode of movement. Studies have identified many possible characteristics of the built environment that may impact walking convenience and safety. Multiple indicators of the built environment, including land-use patterns, transportation systems, planning, and design features have been positively associated with increasing levels of physical activity, such as walking and cycling (Handy et al, 2002; Saelens et al, 2003). The built or physical environment can be defined in three ways: as land-use patterns (the distribution across space of activities and the buildings that house them); transportation systems (the physical infrastructure of roads, pavements, and bike paths, as well as the services this system provides); and design features (providing aesthetic, physical, and

functional qualities of the built environment, such as the design of buildings and streetscapes, and relating to both land-use patterns and the transportation system) (Saelens and Handy, 2008; Transportation Research Board, 2005). Walking for different purposes such as recreation or transportation may depend upon different characteristics of the built environment (Handy et al, 2002). Alfonzo (2005, page 811), however, "posits a hierarchy of walking needs, modelled after Maslow's hierarchy of human needs. In his model some aspects of built environment matter more fundamentally than others in influencing walking." Earlier studies did not incorporate demographic and other individual characteristics that are associated with the tendency to walk, such as race, custom, and age (Saelens et al, 2003). These could raise concerns over interpreting the findings. Alfonzo et al (2008) address this concern by using regression analysis, which models individual sociodemographic characteristics. Frank et al (2006) and Leslie et al (2007) examined the association between walking and built environment features such as mixed land uses, street connectivity, net residential density (dwelling density), and retail floor-area ratio. Furthermore, Alfonzo et al (2008) used multiple regression analysis and linear equations to examine the relationship between different dependent variables (total walking, destination walking, and recreation walking) and an individual's sociodemographic indicators, plus urban design indices (variables). In addition to sociodemographic indicators, they used four urban design variables for walkability as independent variables: accessibility, safety, pleasure, and comfort.

In this research an innovative approach was used, by applying two different land uses and including local social behavior in the survey. The causal relationship between some environmental variables and walking duration was examined, while taking into account the role of attitudes, including walking attitudes in relation to study-area characteristics.

Study area: District 6 of the Regional Municipality of Tehran

Tehran is Iran's economic and political capital. It lies to the south of the awesome Alborz Mountains which line up as if they are a wall, peaking to over 5000 m above sea level. According to the 2005 National Census, the city is home to over 7.6 million people, with about 146 people per ha in the built-up area, in twenty-two districts covering a total of 700 km^2 (figure 1). It ranks closely with cities such as Los Angeles in terms of size, sprawl, population, levels of service, sophistication, and even smog (Nourian, 2002).

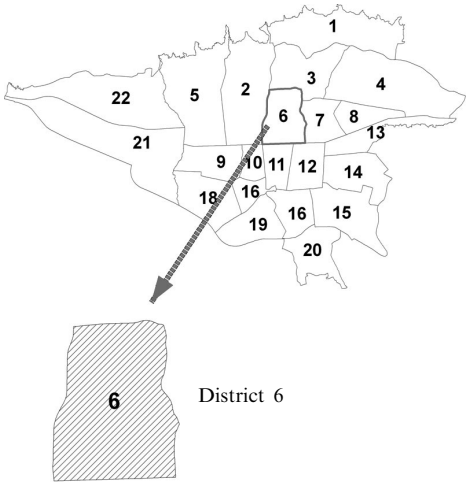


Figure 1. Tehran's twenty-two administrative districts.

Like many other exploding megalopolises, Tehran's planning schemes have long been influenced and dominated by the motor car. As a consequence, acute traffic density and pollution are typical problems and are rampant. Tehran has had three comprehensive master plans (two in the past thirty-five years and the last just recently issued). None of these master plans paid much attention to pedestrian movement in the city.

The study area was limited to one of the twenty-two districts. Municipal District 6 was selected. It covers only a part of the city center and forms part of the present-day central business district,[(1)] an area for which data availability was better than most and that is of mixed land usage relevant to the study.

According to the Tehran Geographic Information Center (TGIC, 2007), the study area has a land area of 2144 ha and a population of 213 000. This gives an average population density of 108 per ha, accounting for 3.1% of the city's population in 3.2% of the city's land area. District 6 has six subdistricts, 18 neighborhoods, and 1505 city blocks made up of about 28 000 parcels, of which 20 789 are residential and 5460 are commercial. According to the latest studies of Tehran's districts, District 6 has the highest level of employment, accommodating 322 623 workshops, businesses, and various commercial activities (Habibi and Houcadi, 2005). As shown in figure 2, employment is highly concentrated in District 6.

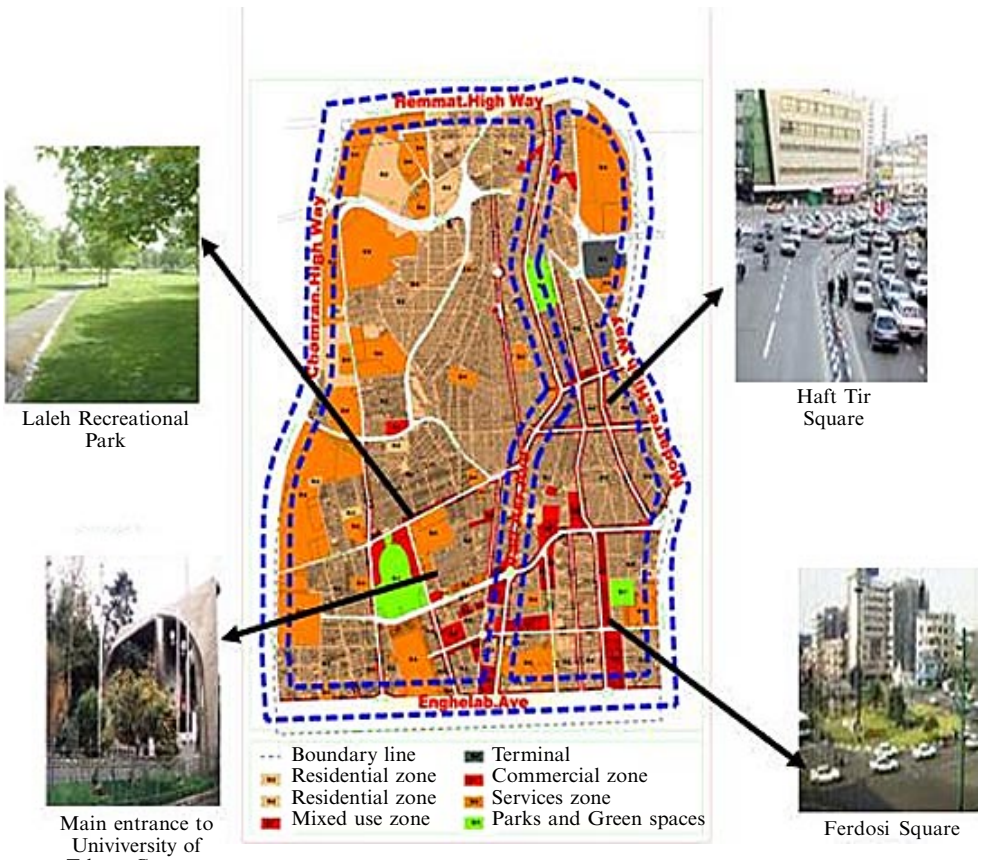


Figure 2. [In color online.] A sample of major sites within District 6 (source: TGIC, 2007).

[(1)] Although Tehran is multicentral, this study does not focus on the main or oldest center which is District 12 but a center with more mixed land usage, District 6.

Methodology

The objectives of this study were, first, to investigate and identify the relative influence of selected variables on pedestrian movement, and second, to assess through the use of statistical analysis the most important variables influencing walking in the study area. The walkability (environmental) variables were selected from the results of earlier theoretical and empirical studies. Table 1 shows the list of selected walkability variables, which were grouped into C1 – C10, used to analyse and measure walking attitudes. These ten variables have been quantified through the selection of thirty-four measurement factors, plus the four sociodemographic indicators of age, gender, job, and education level (which might also correspond to income level). Factors such as the quality of construction, physical obstacles, crossing designations, lighting levels, signage, and traffic calming devices, pertain to 'safety'. The quality and quantity of street furniture,

Table 1. Summary of walkability variables identified in previous studies.

Selected variables	Definition	Studies
C1: Safety	Road crossings and other safety features such as lighting and the presence of pavements	Alfonzo et al, 2008; Appleyard, 1981; Humpel et al, 2004; Lee and Vernez Moudon, 2004; Martin, 2006; Pikora et al, 2002
C2: Pleasantness/ attractiveness/ amenity/aesthetic perception/ convenience	Street/pavement furniture, pavement quality, comfort, presence and condition of pavements, topography, physical obstacles, pavement infrastructure, and calmness	Alfonzo et al, 2008; Cervero and Kockelman, 1997; Giles-Corti and Donovan, 2003; Humpel et al, 2002; 2004; Pikora et al, 2003
C3: Transportation choice	Facilities and the availability of different transport methods, expense, and travel time	Bovy and Stern, 1990; Hill, 1982; Hoogendoom and Bovy, 2002; Saelens et al, 2003
C4: Accessibility/mobility (access to open space)	Mobility of movement, mobility substitutes, and access to transit points	Alfonzo et al, 2008; Giles-Corti and Donovan, 2003; Handy, 2005; Humpel et al, 2002; 2004; McCormack et al, 2004; Owen et al, 2004; Pikora et al, 2006
C5: Public health education	Promotion of public health through public knowledge and encouragement of programs about the use of traffic-calming devices, signage, pedestrian crossings, the encouragement of walking, and pavement cleanliness; reduction in the use of private motor vehicles which leads to a decrease of air pollution and less consumption of fossil fuel	Gozar-e-Rah Engineering Consultants, 1994; Schilling and Linton, 2005
C6: Street connectivity	Geometry of the grid network, origin to destination connection, work and house connection, amenity, and facilities	Cervero and Kockelman, 1997; Kulash et al, 1990; Leslie et al, 2006; Saelens et al, 2003; Sallis et al, 2004
C7: Environment sustainability	Existence and level of equity of access to the network for all pedestrians, use of durable material and maintenance of the pedestrian infrastructure	Appleyard, 1981; Schilling and Linton, 2005
C8: Link between land use and transportation	Level of access to jobs and services, mixed land use, existence of street networks, and links between public transport stops	Cervero and Kockelman, 1997; Ewing and Cervero, 2001; Handy et al, 2006; Lee and Vernez Moudon, 2004; Leslie et al, 2006; Owen et al, 2004; Saelens et al, 2003
C9: Local sociocultural behavior	Features related to walking in Tehran based on local sociocultural attitude/ behavior, such as being unaccustomed to walking (especially women), unease or discomfort at being observed in public spaces, restriction in choice of clothing, fear of possible harassment	Appleyard, 1981
C10: Security	Levels of crime, and public surveillance such as neighborhood surveillance or police presence	Appleyard, 1981; Humpel et al, 2004

topography, pedestrian infrastructures (such as street width, pavement width, and the presence of pavement buffers) relate to 'pleasantness and comfort' in walking. Therefore the composite variables might be perceived as 'safe' or 'pleasant' in terms of traffic, and consequently influence a person's decision to walk. In other words, the presence of one of these variables alone may be less significant in influencing a person's walking attitude, compared with the sum of these various features.

Table 2 shows the list of factors related to each environmental variable. To be able to quantify these environmental variables, the literature was reviewed, municipal experts were consulted, and local factors were investigated. In-depth interviews were held with three experts within District 6. As a result of this work, a questionnaire containing fifty-four questions was designed in order to explore how the perception of a neighborhood's environment impacts walking choices and distances.

Table 2. Factors related to selected variables.

Selected variables	Factors related to selected variables
C1: Safety	Traffic condition/crossing designation, quality of construction and presence of lighting, signage/traffic calming devices
C2: Pleasantness/attractiveness/amenity/aesthetic perception/convenience	Street furniture/comfort, presence of amenities, pedestrian infrastructure, physical obstacles, comfort, topography
C3: Transportation choices	Facilities/modes of travel; expense, calmness
C4: Accessibility/mobility	Ease of movement, access to open space, mobility substitutes, time
C5: Public health education	Pedestrian crossings, incentives to walk, pavement cleanliness; decrease in pollution/fossil fuel
C6: Street connectivity	Geometry of grid network; origin/destination connection; works to house connection, existence of facilities' connection
C7: Environment sustainability	Use of durable material and maintenance of the pedestrian infrastructure; equity of access
C8: Link between land use and transportation	Access to jobs and services, mixed use, continuous road network, links with public transport stops
C9: Local sociocultural behavior	Unaccustomed to walking (especially women), fear of possible street harassments; uneasiness to be seen in public spaces, lack of freedom in choice of clothing
C10: Security	Social/public surveillance, crime levels

The questionnaire included questions about respondents' gender, age, current job, and education. Respondents were asked about their perceptions concerning the neighborhoods where they live or work, and about how much time they spent daily walking in the neighborhood.

The question "How many minutes per day do you usually walk in your neighborhood?" was used to determine walking time (duration) for any purpose as a dependent variable. In this study, the focus was on the walking time (minutes per day spent walking near the house, close to the work place, sport centers, or on pedestrian routes). Questions were also asked to discover the perceived relationship between a neighborhood's environment and time spent walking. This included categories on traffic safety, pleasantness, travel choice, accessibility, street connectivity, public health education, environmental sustainability (including equity of access and durability of pavement construction), mixed land use, local sociocultural behavior, and personal safety. The responses for perception of neighborhood characteristics were selected using a Likert

scale of 1 – 5. Only the descriptions "I strongly disagree" for scale value 1 and "I strongly agree" for 5 were added to the questionnaire. The higher the score, the more positive was the perception of the neighborhood. Figure 3 shows the relationship between variables, factors, and questionnaires.

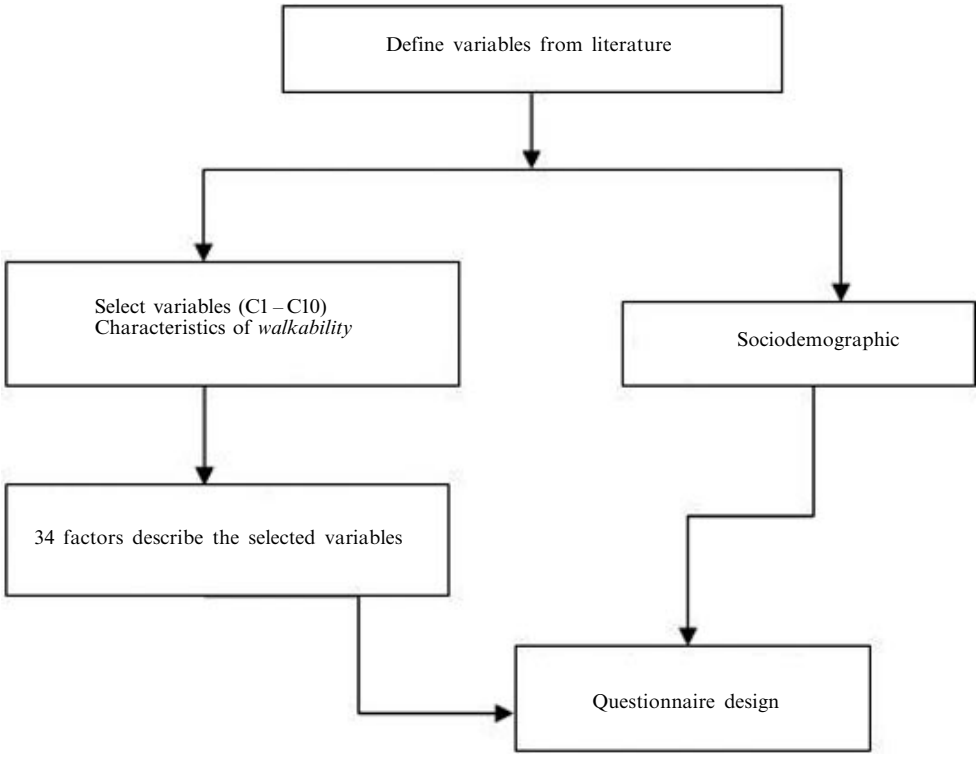
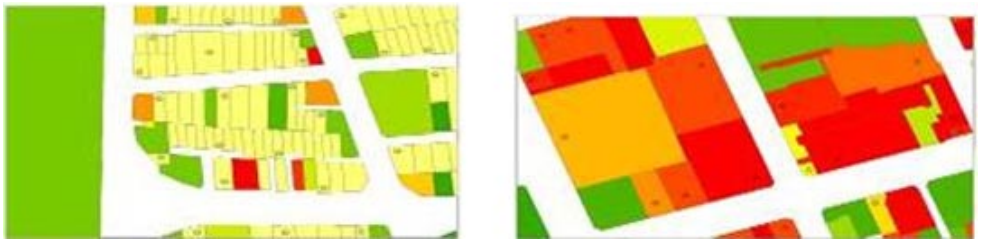


Figure 3. Variables, factors, and question design relations.

Survey and sampling

A multistage stratified sampling technique (Baker, 1982; Mueller et al, 1970) was employed to identify the district's blocks and their respective residential and commercial parcel layers. The purposive aspect of this process was then invoked, resulting in the identification and selection of specific residential and commercial parcels in the various blocks. This process ensured that all households had approximately the same likelihood of being selected. The selection was based on predefined factors, such as the distance between street intersections (ie, junctions), variations in the width of the pavement or street, and proximity to locations such as cinemas, shopping centers, and workshops.

A comprehensive sample coverage from each block was chosen by considering the type, size, and location of each block, as well as the arrangement of parcels within each block. A household in each parcel was selected by systematic random sampling, and then a person who could choose to walk unaccompanied whenever he or she chose was selected from each chosen household. Figure 4 shows the location of samples and their distribution in the study area for both residential and mixed use. In order to collect field data from the intended respondent accurately, sample locations were georeferenced and located in a 1:2000 parcel-based map of the study area.



(a) (b)

Figure 4. [In color online.] Sample selection scheme. (a) Residential; (b) commercial. The shades of grey (color) indicate different land uses.

A total of 536 questionnaires were distributed. The overall response rate for the survey was 84.5%. Of the 423 questionnaires completed 252 came from residential areas and 171 from commercial or mixed areas. Repeat visits were made until the target interviews were completed. The interviews were urban planning undergraduates from the University of Tehran. They were briefed on how to conduct the interviews, including practicing the completion of a pilot survey. Approximately 35 min were allocated for the completion of each questionnaire. The questionnaires were filled out by the interviewers during the interviews, which were held between 9 am and 7 pm. The questionnaires were followed-up with an onsite survey that assessed the participant's walking behavior, and their perceptions about the adequacy of routes for their needs and wants, and for their daily walking habits, regardless of purpose.

Results

For residential areas, people aged 18 – 50+ were interviewed, with a mean age of 31.11 years (SD = 2.75; VAR = 7.58). The 118 men interviewed had a mean age of 31.11 years, and comprised 46.7% of the respondents; 134 women were interviewed, comprising 53.5% of the respondents. The response rate was 86% (table 3).

Table 3. Sample size, gender, and percentage of responses from survey result.

Response group	Sample size	Gender (%)		Percentage response rate	Standard deviation of age (years)	Variance of age (years)
Residential area	252	men	118 (46.7)	86	2.75	7.58
		women	134 (53.3)			
Commercial area	171	men	129 (75.5)	83	3.12	9.77
		women	42 (24.5)			
Total	423			83.5		

For commercial areas, people aged 18 – 50+ were interviewed, with a mean age of 33.55 years (SD = 3.12; VAR = 9.77). The 129 men interviewed had a mean age of 48.1 years, and comprised 75.5% of the respondents; 42 women were interviewed, comprising 24.5% of respondents. The response rate was 83% (table 3).

Descriptive statistics for the walkability and sociodemographic variables are reported in tables 4 and 5, respectively, for residential and commercial areas.

Table 4. Descriptive statistics for residential area of study ($N = 252$).

Variables	Minimum	Maximum	Mean	Standard error	Standard deviation
Gender	1	2	1.57	0.029	0.496
Age	13	85	44.61	0.988	16.916
Job	1	7	4.51	0.100	1.713
Education	1	4	2.11	0.044	0.761
C1: Safety	8.041	27.902	17.94369	0.203624	3.485476
C2: Pleasantness/attractiveness amenity	5.123	21.382	12.75234	0.166455	2.849247
C3: Transportation choice	3.644	14.190	9.52789	0.115934	1.984468
C4: Accessibility/mobility	3.352	13.778	7.81053	0.111045	1.900780
C5: Public health education	2.521	12.605	8.05250	0.114897	1.966712
C6: Street connectivity	5.484	16.909	12.08706	0.133969	2.293174
C7: Environment sustainability	1	5	2.74	0.074	1.267
C8: Link between land use/ transportation	1.799	8.995	6.06994	0.084682	1.449519
C9: Local sociocultural behavior	2.9	28.2	8.611	0.1323	2.2644
C10: Security	1.46	7.28	4.7705	0.08013	1.37154
Duration (walking time in mins)	7.5	40.0	17.517	0.5058	8.6578
Duration (in logarithmic form)	2.01	3.68	2.75	0.027	0.47

Table 5. Descriptive statistics for commercial area of study ($N = 171$).

Variables	Minimum	Maximum	Mean	Standard error	Standard deviation
Gender	1	2	1.16	0.028	0.371
Age	19	70	37.54	0.814	10.644
Job	1	3	2.37	0.056	0.736
Education	1	4	2.16	0.049	0.645
C1: Safety	11.29	25.73	17.3985	0.24459	3.19847
C3: Pleasantness/attractiveness/ amenity	7.73	18.57	12.7176	0.21079	2.75640
C3: Transportation choice	4.438	13.735	9.12865	0.141364	1.848577
C4: Accessibility/mobility	3.428	11.501	7.45752	0.132195	1.728677
C5: Public health education	3.337	12.452	7.78939	0.156101	2.041288
C6: Street connectivity	5.332	15.410	11.54533	0.163356	2.136155
C7: Environment sustainability	1	5	2.82	0.094	1.230
C8: Link between land use/ transportation	2.540	8.867	6.37036	0.109109	1.426783
C9: Local sociocultural behavior	3.493	11.867	8.34249	0.136948	1.790834
C10: Security	1.496	7.480	4.85106	0.103327	1.351175
Duration (walking time in mins)	7.5	40.0	15.219	0.4519	5.9089
Duration (in logarithmic form)	2.01	3.68	2.64	0.0316	0.41

Following Alfonzo et al (2008), the regression model was developed based on walking time, which is a dependent variable measured against the independent variables of four sociodemographic indicators and ten built-environment characteristics related to attitudes to walking. In this model, various built-environment variables probably work together in impacting the decision to walk. Compared with focusing on only on variable, regardless of its individual importance, the interaction of all these variables can be meaningfully significant in the analysis of factors influencing people

to walk, following the format shown below:

$$\begin{aligned}\text{Walking time (duration)} = {} & \alpha_0 + \alpha_1 \text{Safety Var} + \alpha_2 \text{Amenity Var} + \alpha_3 \text{Transportation choice Var} \\ & + \alpha_4 \text{Accessibility Var} + \alpha_5 \text{Public health education Var} \\ & + \alpha_6 \text{Connectivity Var} + \alpha_7 \text{Sustainability Var} + \alpha_8 \text{Landuse Var} \\ & + \alpha_9 \text{Localbehavior Var} + \alpha_{10} \text{Security Var} + \beta_1 \text{Age} + \beta_2 \text{Gender} + \beta_3 \text{Job} \\ & + \beta_4 \text{Education} \ .\end{aligned}$$

In the above regression model, ten variables related to the built environment characteristics are shown by name, with four individual sociodemographic indicators. The coefficients, α_0, $\alpha_1, \ldots, \alpha_{10}$, and β_1, β_2, β_3, β_4 are estimated for a regression model to obtain the best fit for the dependent variable. Due to having only four intervals for walking time,[2] a multinomial logistic method was used to estimate regression. This model controls some of the individual and group-level factors; interpolations only come from coefficients that are statistically significant at the 10% level or better. The significance level (p-values) of $\leqslant 0.1$ indicates the possibility of association between a corresponding variable and walking duration.

Regression results are reported in tables 6 and 7. To interpret these results, note that the sign of the coefficients indicates whether there is a positive or negative association between the right-hand side (or independent) variable and the walking time. For example, in table 6, the coefficients show how changes in the sociodemographic indicators and the built-environment characteristics are associated with walking time.

In the residential areas, the statistical results extracted from the regression model show that three variables, together with the two demographic indicators (age and education), are the most significant for walking duration: C6 (street connectivity $p < 0.001$), C10 (security $p = 0.0016$), and C5 (public health education[3] $p = 0.0420$) (table 6).

The computed F-value statistic for this table is 11.13 and the associated probability (p-value) or significance level is <0.0001 which indicates that the model is reliable. The t-value (computed by dividing the estimated value of the β coefficient by its standard error) is a measure of the likelihood that the actual value of the parameter $\neq 0$. The larger the absolute value of t, the less likely that the actual value of the parameter could be zero.

Street connectivity is positively and significantly associated with walking duration. People who live where the security variable is higher walk more when walking is measured as time spent walking. When the connectivity variable is entered into the regression along with security, both variables are statistically significant and positively associated. This result shows that when other variables are entered in the regression, they are not statistically significant (p-values > 0.1). Age ($p = 0.0001$) and education ($p = 0.0001$) are also associated with walking duration. Simultaneously the education indicator correlates with C5 (public health education). The analysis presented here suggests that the physical, cultural, and sociodemographic variables such as security, street connectivity, and public health education are associated with walking duration in residential neighborhoods.

[2] What amount of time do you daily spend walking? (<15 min, 15 – 30 min, 30 – 50 min, or >50 min).

[3] Promoting public health through public knowledge and encouraging programs about the use of traffic calming devices, signage, pedestrian crossings, the encouragement of walking, and pavement cleanliness. Also, promoting a reduction in the use of private motor vehicles leads to a decrease in air pollution and a lower consumption of fossil fuel.

Table 6. Regression results for walking duration in residential areas.

Parameter	Estimate (β coefficient)	t-value
Intercept	2.250	4.04
C6: Street connectivity	−0.040	−4.74
C10: Security	0.048	3.20
C5: Public health education	0.181	2.49
Age	−0.010	−4.47
Education 1	1.660	2.95
Education 2	0.490	0.90
Education 3	0.850	1.49
Education 4	0.000	
C5 × Education 1	−0.270	−3.63
C5 × Education 2	−0.120	−1.66
C5 × Education 3	−0.160	−2.13
C5 × Education 4	0.000	

Notes: $R^2 = 0.313$; adjusted $R^2 = 0.285$, Pr > $F(0.0001)$, mean square = 1.01, and $F = 11.13$.

Table 7. Regression results for walking duration in commercial areas.

Parameter	Estimate (β coefficient)	t-value
Intercept	2.09	2.80
C9: Local sociocultural behavior	0.08	1.77
Job 1	−0.81	−2.11
Job 2	0.58	1.81
Job 3	0.00	
Education 1	−1.17	−1.36
Education 2	0.71	0.92
Education 3	−0.20	−0.25
Education 4	0.00	
C9 × Job 1	0.11	2.26
C9 × Job 2	−0.09	−2.51
C9 × Job 3	0.00	
C9 × Education 1	0.12	1.09
C9 × Education 2	−0.08	−0.76
C9 × Education 3	−0.00	−0.01

Notes: $R^2 = 0.293$; adjusted $R^2 = 0.244$, Pr > $F(0.0001)$, mean square = 0.775, and $F = 6.01$.

This result also shows that the effect of C5 on walkability varies depending on different levels of education. All these associations are significant at the 90% level or higher. The comparatively low values of R^2 obtained in the model (0.313) can be attributed to the limited intervals designated in the design stage.

The statistical significance of parameters concerning walking duration in the commercial areas is presented in table 7. The table shows the β values and the socio-demographic indicators used in the model. In the commercial areas the statistical results extracted from the regression model indicate that the most significant variable with respect to the walking duration is C9 (local sociocultural behavior [4] $p = 0.584$) in conjunction with job and education variables. All these associations are significant

[4] Features related to walking in Tehran based on local sociocultural attitude and behavior, such as being unaccustomed to walking (especially in women), uneasy or discomforted at being observed in public spaces, restricted in choice of clothing, or fearful of possible harassment.

at the 90% level or higher. One can conclude from table 7 that criterion C9, together with the job status and education indicators, is a factor directly affecting walking in the commercial areas. Also, the correlation of job and education factors can be detected as a submodel.

An increase in the value of C9 will increase walking duration if the other variables stay constant. One can observe a meaningful relationship between job and level of education. The predicted value for walking duration increases or decreases, moving up or down, respectively, with the level of education or job status. The regression analysis also shows that the intercept value for walking duration when all variables are zero is 2.091. The walking duration computed by the cologarithm of the same value is 10.88 min in this case. The value of R^2 in the obtained model is 0.294.

Although variable C9 (local sociocultural behavior) was not seen as a significant factor in people's attitudes in walking decisions, the result shows that this factor is the most significant variable in walking in the commercial areas. It seems that the attitudes of people who work in this area are not similar to their behavior.

Discussion

The general result of both response groups/areas in this survey showed that on average, men walked more than women (54.6% for men compared with 45.4% for women). Although the difference is not very large, it can be explained generally by the fact that in Iranian society men spend more time than women outside the home.

Interestingly, comparing residential users in the same adult age group, where it was common for both women and men in their 30s to walk for essential daily shopping, on average women walked more than men (men: 46.7%; women: 53.3%). In the commercial area men walked more than women (men: 75.5%; women: 24.5%), particularly to get to work or in transit. This can be interpreted in terms of the lack of safety, or uneasiness, felt by women about walking in places other than where they live.

In the commercial areas, the C9 (local sociocultural behavior) variable was revealed to be related to various types of job and different levels of education. This means that the C9 coefficient differs in the job combinations with different levels of education. These results confirm that the lowest and the highest level of education will increase the C9 coefficient, while the middle level of education in comparison with the highest level will decrease the C9 coefficient. The intercept value has a meaningful relation to job status and education level. When moving towards lower levels of education, while the condition of the job remains constant the value of the intercept increases, with the exception of the lowest level of education, which increases this value.

This could be explained by influences on people's habits and attitudes in different urban environments. In this research, particular attention has been paid to factors such as dress codes (particularly for women), fear of possible threats in the form of street harassment, women's subservient status to the authority of their husbands and fathers, discomfort based on local tradition, and stress felt in commercial spaces due to official notices at entrance gates warning women not to be lax about observing the dress code.

Overall, the analyses presented here suggest that some aspects of the built environment are associated with higher levels of walking time. This study has demonstrated that physical safety and security are the most important requirements for pedestrians in residential areas. Although the speed of vehicles is not the only contributing factor to the safety of pedestrians, traffic safety does appear to be inversely associated with the high speed of traffic, because the speed limit of 30 km/h in residential areas is not respected. In addition, there are not enough pavements, safe crossings, traffic lights,

(a)

(b)

Figure 5. [In color online.] (a) Pedestrian collision with vehicles; (b) an unsafe crossing (Tehran, Iran).

accessible pedestrian signals, or pedestrian overpasses anywhere. Safe and secure streets encourage walking by reducing pedestrians' anxieties about crossing streets (figure 5).

The rapid growth of Tehran's population in recent decades has led to the development of the city and its traffic network, and especially the rapid transit expressways which dissect the urban fabric. As a result, a weakened pavement network has suffered extensive disconnection, creating many dead-ends in the network. On the basis of recent records, cul-de-sacs comprise 18.7% of the existing network in District 6 (TGIC, 2007). In addition, the spatial organization of the district lacks appropriate mixed land uses, and the distance between home and work has increased compared with the past. Thus, in the absence of an efficient public transport network, people who are under increasing time pressure, and so are always in a hurry, tend to use private cars. The lack of adequate facilities for other modes of public transport has created the necessity of relying on cars. Only two subway lines exist in inner Tehran and bus networks are limited in their coverage.

However, preferring car use over walking has become a habit which is hard to change. In general people's choice of transportation is based on previous experience, and they opt for the means that provides the least annoyance and most reassurance. The fear of being late for work or for an appointment leads people to use the most reliable means of transport, and this cannot be neglected when considering attitudes to walking. People also follow the custom and social traditions of where they live, and they can influence each other's behavior. Thus specific actions become part of the way of life, and such attitudes are hard to change. Pedestrians need to regain their rights and dignity. This can be achieved by developing appropriate infrastructure, implementing regulations, enhancing the cultural and habit of walking, and promoting its benefits through education for both sexes and all age groups, education levels, and occupations.

General public education promoting walking is among the factors affecting the choice of walking for any given purpose. This study showed that among the factors deterring people in Tehran from walking for social reasons are a lack of information, publicity, and education about walking and its benefits. This issue is related to both the beneficiaries (the pedestrians) and the municipal authorities—the city planners, and especially the municipal administrators who are responsible for policy supervision and implementation.

It should be noted that this study suffered from a number of limitations. Tehran encompasses a vast area and comprises twenty-two districts. District 6 is located centrally and while it has many features similar to other districts, it also varies socially

and economically from other districts. Therefore, the results of this research would likely vary in other parts of the city, especially in the peripheral districts to the north (which is characterized by luxury high-rise towers), and to the south (characterized by traditional lower middle class and lower class occupations).

In addition, there was a lack of official data sources available for this study. Previous research has used subjective (self-report) data on behavior and environment and also a mix of subjective data on behavior and objective data on environment (Alfonzo et al, 2008; McCormack et al, 2004; Tropod et al, 2001). The presence of both types of data enables researchers to compare experimental data and existing official data. This study examined people's perceptions of the physical environment when walking. It did not include objective physical environmental data due to research time constraints and availability limitations of data such as car ownership, income levels, land-use characteristics, digital cadastral data bases, retail and shopping center locations, and age and gender information about household membership. Finally, people are hesitant and wary of answering questions about their lives, habits, and income levels because they are suspicious of the intent of the organization responsible for the questions. Public authorities are not keen to divulge data as they fear that the data might be used negatively against their organization or personnel. The reliability of the available data is also a matter of concern to researchers.

Conclusion

This study compared people's perceptions of neighborhood environments with their walking time in both residential and commercial areas. The comparison showed a significant difference between people's perceptions of their own neighborhood environment and walking duration.

The regression analysis showed that both physical and sociocultural factors have an influence on walkability, while in mixed-use areas only the sociocultural factors proved to be important. Residential and mixed land uses were examined separately since it was assumed that land use affects pedestrian behavior and the decision to walk.

The results confirm that some factors motivate people to walk more than others. These factors differ between residential and commercial areas. The results of the study show that security, street connectivity, public health education, and sociodemographic indicators such as age and education influence pedestrian movement in residential areas. Local sociocultural behavior and indicators such as age and education were found to be the most influential in the commercial areas in the study.

In residential areas, physical factors have greater influence on walkability, while the sociocultural factors prove to be more important in mixed, multifaceted areas. In other words, those respondents who were in a neighborhood either as shopkeepers or as shoppers expressed less concern for physical conditions such as the pavement condition or street furniture, and more apprehension about crime, pollution, and harassment. In contrast, respondents from the exclusively residential areas believed that obstacles along the route such as debris from construction sites, pavement discontinuity, and the lack of suitable walkways to public transport were among the factors that discouraged them from walking. Additionally, walking duration was not considered to be leisure time by adults in this study. It seems that people who did not have enough time or were in a hurry chose not to walk.

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