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Walking time to school, children's active school travel and their related factors

Milad Mehdizadeh [a,b,*], AmirReza Mamdoohi [b], Trond Nordfjaern [c]

[a] Iran University of Science & Technology, School of Civil Engineering, Transportation Planning Department, Tehran, Iran
[b] Tarbiat Modares University, Civil & Environmental Eng. Faculty, Transportation Planning Department, Tehran, Iran
[c] St. Olavs University Hospital, Clinic of Substance Use and Addiction Medicine, Department of Research and Development, Box 3250 Sluppen, 7006 Trondheim, Norway

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ABSTRACT

Active school travel is one of the main opportunities for promotion of physical activity among children. Low physical activity in this group is associated with potential health risks. This research has three aims including two main aims and one intermediate aim. The two main aims were to identify variables that explain why the perceived walking time to school (PWTS) is below or above a threshold and to examine the role of PWTS as well as socioeconomic status, household factors, parental attitudes towards walking and walking safety on active school travel among children. The intermediate aim was to identify a threshold for the PWTS. This threshold may provide information about how to plan transport and roads around schools. Data were gathered in Rasht, Iran in 2014. The 1078 questionnaires were distributed among pupils aged 7–9 years in nine schools. The children were instructed to bring the forms to their parents who completed them (n=735, return rate=80%). To predict active school travel (0=inactive modes, 1=active modes), and PWTS (0=long, 1=short) two binary logistic regression analyses were carried out. Results showed that a 10 minutes PWTS was the threshold where the proportion of active mode use (walking) starts to decrease compared to the best performing alternative mode. Higher parental age (OR=1.02) and household income (OR=1.27), accessibility to public transport (OR=0.42), attending public school (OR=0.36), access to school service (OR=0.45) and contextual and design preconditions for walking (OR=0.81) were associated with PWTS to eligible schools. PWTS (OR=15.24) was a strong negative predictor of active school travel. Mother's driving license (OR=0.49), more owned cars (OR=0.53), higher mother's educational degree (OR=0.74), accessibility to public transport (OR=0.26), and access to school service (OR=0.22) were related to active school travel. This research found that PWTS is the most important barrier for children's active travelling while adjusting for a wide-range of demographics, socio-economic variables as well as safety and attitude factors in Iran.

* Correspondence to: Iran University of Science & Technology, School of Civil Engineering, Transportation Planning Department, Tehran, Iran.
E-mail addresses: milad_mehdizadeh@ymail.com, milad_mehdizadeh@civileng.iust.ac.ir (M. Mehdizadeh), armamdoohi@modares.ac.ir (A. Mamdoohi), nordfjar@gmail.com (T. Nordfjaern).

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1. Introduction

Active school travel is one of the main opportunities that parents have to promote physical activity among their children. Low rates of physical activity are associated with potential health risks among children, such as cardiovascular problems and bone health issues (Andersen et al., 2006; Biddle et al., 2004), metabolic syndrome (Bell et al., 2007; Pan and Pratt, 2008), high blood pressure (Leary et al., 2008; Sugiyama et al., 2007) and obesity (Hedley et al., 2004). Furthermore, since active school travel involves physical activity it could also promote mental health among children (Fotel and Thomsen, 2002; Fyhri and Hjorthol, 2009).

"Community school" (i.e. easily accessible schools for pupils in all urban regions), "Safe Route to School" (SRTS),"Walking School Bus" (i.e. children collectively walk to school in an adult-supervised and timetabled manner), School Travel Plan (STP), and Optimal School Siting (e.g. proximity of good quality schools in all regions) have been implemented as programmes targeted to promote physical activity in developed contexts such as North America, Europe, New Zealand, and Japan (McDonald, 2007; Easton and Ferrari, 2015; Collins and Kearns, 2010; Schoppa, 2012). Meanwhile, research regarding children's (pupils at elementary schools) active school travel in middle income or developing countries in Western Asia or the Middle East context remains scant (Mehdizadeh et al., 2016). Iran is an interesting case because the above-mentioned policies have not been implemented in this country. Furthermore, the overall active travel mode use in Iran is low, both in the general population and among children (Esteghamati et al., 2011; Hajian-Tilaki and Heidari, 2007; Kelishadi et al., 2010). Active school travel mainly includes walking in Iran and bicycling is rather uncommon. Consequently, active transport is here defined as walking and bicycling was excluded in the current study.

1.1. Aims

The core motivation underlying the current study was to add to the empirical knowledge base about predictors of short perceived walking time to school and active school travel (walking) in a developing Iranian context. Identifying a threshold for walking time to school may yield information about how to plan transport and roads around schools. Easily accessible schools for pupils in all urban regions might increase the probability of active school travel among children. In the current study, we defined the threshold for perceived walking time to school as the distance where walking starts to decrease compared to the best performing alternative mode. The best performing alternative mode refers to the mode which is most frequently selected at each perceived walking time to school (PWTS), excluding walking. Further, a walking time threshold could be used as a dependent variable for identifying variables that explain why PWTS is below or above the threshold, and also as an explanatory variable for identifying variables that explain why pupils walk or use a non-active mode in an Iranian setting. To sum up, this study has two main aims and one intermediate aim:

1) To identify variables that explain why PWTS was below or above the threshold. This included an investigation of factors affecting school choice as an explanatory factor for home-to-school distances in Iran.

2) To identify variables that explain why pupils walk. This included an examination of the role of PWTS as well as demographic, socio-economic, attitudes, and safety perception for walking.

3) An intermediate aim was to identify a walking time threshold using a somewhat similar definition as in previous studies in a new context: Iran.

1.2. Literature review

The majority of previous school travel studies have been conducted in high income regions such as North America, Western Europe, Australia, New Zealand and Japan. Meanwhile, the research is meagre in developing countries in Eastern Europe and, in particular, in less developed low income countries in Asia such as Iran. Table 1 shows important findings and methodological approaches in some previous studies related to active school travel in different regions of the world.

In North America, several studies have reported important barriers on children's active school travel. For instance, higher home-to-school distance (or walking time) has been reported to be the most important explanatory variable on active school travel (e.g. McDonald, 2008a, 2008b; McDonald et al., 2011). Household socioeconomic status such as increased car ownership (McDonald, 2005; McDonald et al., 2011; McMillan, 2003), higher income (Babey et al., 2009; McDonald, 2008a; Vovsha and Petersen, 2005), higher educational degree among mothers (McMillan, 2003), perceived neighborhood safety problems (e.g. McMillan, 2007; Rothman et al., 2015), and demographic characteristics (e.g. younger children) (McDonald, 2008b; McDonald et al., 2011) were also negatively related to active school travel among children. McDonald (2012) reported that there is a gender gap on school travel in the United States, while Mitra and Buliung, (2015) have found that gender exert no influences on mode use on school travel among children in Canada.

Furthermore, several studies have been conducted in Western Europe. These studies have examined demographic, socio-economic and built-environment characteristics associated with school travel mode use in countries such as the United Kingdom (e.g. Easton and Ferrari, 2015), Netherlands (Van Goeverden and De Boer, 2013), Belgium (Zwerts et al., 2010), Scotland (Waygood and Susilo, 2015), Ireland (Nelson et al., 2008), and Scandinavian countries (Fyhri and Hjorthol, 2009; Johansson et al., 2011). In these high income countries, several of the studies reported that distance (or travel time) had the most important role in reducing the probability of active school travel among children (e.g. Cooper et al., 2003; Fyhri and Hjorthol, 2009; Waygood and Susilo, 2015). Similarly to the North American context, the studies also reported significant

Table 1
Some previous studies related to active school travel in different regions of the world.

Region	Study authors	Research design	Age of respondents	Statistical analysis method	Explanatory variables	Main findings	Most critical variable for mode choice
North America	McMillan, 2007	Cross sectional, in California	Elementary schools pupils, grade 3–5	Binominal logit	Demographic, Socioeconomic, Traffic safety, Urban form, Distance, Social/cultural norms, Attitudes, Neighborhood safety	-Neighborhood safety and traffic safety, household transportation options, and social/cultural norms are more important than urban form for children's active travel to school - Higher walking distance to school reduced children's walking to school.	Distance from home-to-school
	McDonald, 2007	Longitudinal analysis, NPTS data, USA	Schoolchildren, 5–18 years	Logit model	Trip distance, Age, Gender, Race, Household income, Car ownership	- Active school travel decreased dramatically in the United States from 1969 to 2001. – 47% of the decline in active school travel is explained by increased distances between home and school.	Distance from home-to-school
	Mitra and Buliung, 2015	2006 TTS, cross-sectional, Toronto	11-year-old children and 14–15 year old	Multinomial logit model	Sociodemographic, Trip distance, Household travel interactions, Built Environment, Transit access, Season, School type	- Higher street intersections and neighborhood density had strong association with children's walking. - Child gender was not found as a predictor of active school travel. - Higher distance to school reduced the probability of active school travel.	Distance from home-to-school
	Rothman et al., 2015	Cross sectional survey in 2011, Toronto	Elementary schools pupils	Repeated-measures logistic regression	Reported walking to school, Parents' perception of traffic danger, Demographic, Socioeconomic, Built environment	- Higher perception of traffic danger might reduce the probability of walking to school. - Built environmental factors were important for walking.	Not reported
Western Europe	Van Goeverden and De Boer, 2013	Cross sectional, The Dutch and Flemish national travel surveys, Netherlands and Flanders	Primary and secondary school students	Structural weights model & Multinomial logistic regression	Distance, Season, Urban form, Demographic, Socioeconomic	- The threshold for distance to school as the distance where bicycling use starts to decrease was defined. - A 3 km threshold for distance was found. - Higher rate of car ownership was related to a higher distance to school.	Distance from home-to-school
	Easton and Ferrari, 2015	Cross sectional, 26,709 secondary pupils, pupil census data in Sheffield, UK	Aged 11–16	Cross-classified multilevel model	Demographic, Distance, School level factors, Urban form, Neighborhood factors	- It was suggested that considering multilevel modeling for school travel analysis is critical. - More boys travelled actively to school than girls. - Higher distance had a negative role on active school travel.	Distance from home-to-school

Table 1 (*continued*)

Region	Study authors	Research design	Age of respondents	Statistical analysis method	Explanatory variables	Main findings	Most critical variable for mode choice
	Nelson et al., 2008	Cross sectional, in Ireland	primary schools, 15–17 year old adolescents	Descriptive analysis & bivariate logistic regression	Age, Gender, Population density, Socio-economic status, Distance, Perceived barriers to active travelling	- More males than females commuted actively. – 2.5 mile threshold for distance was found. - Over 57% of respondents reported distance as a reason for inactive traveling.	Distance from home-to-school
	Waygood and Susilo, 2015	Cross sectional, 2005/2006 Scottish Household Survey	Children aged 10 and 11 years old	Descriptive & binary logistic regression	48 different items regarding perceptions of neighborhood quality, Demographic, Household factors, Built environment, Distance	- The perceptions of higher traffic danger negatively related to walking. - Perceptions of good local shops were related to more walking. - Increased rate of car ownership was associated with less walking.	Distance from home-to-school
Eastern Europe	Pojani and Boussauw, 2014	Cross sectional, in Tirana, the capital of Albania	Students aged 11 to 13	Descriptive, correlation coefficients, logistic regression	Demographic, Parental concern, Perceived distance, Household and parental factors, Some urban form	- Walking mode had the highest proportion on school travels. - Children who are driven to school might be from families with a higher income and be more likely to live further away from school. - The majority of students live very close to their schools. - Urban dense form of Tirana had positive influence on children's walking.	Distance from home-to-school & environmental characteristics
	Loucaides et al., 2010	Cross sectional, Cyprus	Grade 6 –12 and technical/vocational schools	Bivariate logistic regression	Physical activity, Perceived social & environmental Correlates, Distance, Age & gender, Weight, height and date of birth, School location	- Active modes had 19.4% of the modal share. - Parental perceptions of traffic danger and environment were correlated with active school travel. - Higher distance to school was negatively related to walking.	Having enough time for walking in the morning
Australia & New Zealand	Curtis et al., 2015	Cross sectional, nine primary schools in four urban regions in Australia	Children aged 9–13	Cluster analysis	Built environment measures near schools, Sociodemographic, Attitudes towards travel, Distance	- In more dense areas the probability of children's active school travel is high. - Increase in distance reduced the walking rate. - Five to ten minutes reported to be comfortable walking time. - Boys may travel more freely than girls to school.	Distance from home-to-school
	Conlon, 2013	ACTIVE study between 2011-12 in New Zealand	Children aged 10–18	Bivariate regressions	Distance, Socioeconomic, Demographic, Ethnicity, Parental behaviour/perception	- Attending the school near to home was positively associated with active transport.	Distance from home-to-school

						- A higher number of intersections was associated with less active traveling. - Parents with high rates of exercise allow their children to travel actively.	
Eastern Asia	Waygood and Kitamura, 2009	Cross sectional, Japan	Grade-five students at five different schools	ANOVA	Travel patterns, Urban & population density, Exercise, Cultural aspects, Travel times	- Higher population density might increase children's independent travel to school. - Higher travel times for each mode reduced their use.	Not reported
	Li and Zhao, 2015	Cross sectional, Third Travel Survey of Inhabitants in Beijing, China	Students aged 13–15	Descriptive & Multinomial logit model	Distance, Demographic, Socioeconomic, Surrounding environment, Policy factors	- A 3 km threshold for distance was found. - Higher rates of car ownership were related to a lower rate of active traveling.	Distance from home-to-school
Middle East	Ermagun and Samimi, 2015	Cross sectional, Tehran, Iran	Middle-school and high-school students	Nested logit model	Demographic, Socioeconomic, Travel times, Population density, Safety perception, Distance	- Nested logit model deals with assumptions of the MNL structure. - Attending the school near to home was positively associated with active transport. - Higher income and car ownership among households was negatively related to active school travel.	Distance from home-to-school
	Mehdizadeh et al., 2016	Cross sectional, in 9 schools in Rasht, Iran	Primary school pupils, Aged 7–9 years	Mixed logit model (random coefficient analysis)	Demographic, Socioeconomic, Built environment, School factors, Distance, Walking attitudes, Environmental norms, Risk perception & worry	- Perceived walking time to school had a random effect on mode choice. - The possible source of preference heterogeneity could be to own two or more cars. - Parents with stronger environmental personal norms were more likely to choose walking mode for their children.	Distance from home-to-school & school service situation

influences of other socio-economic (e.g. car ownership, income), household (e.g. parental educational background) and built environment factors on walking/cycling.

Meanwhile, in Eastern Europe, a relatively small body of studies has analyzed active school travel (Broberg and Sarjala, 2015; Loucaides et al., 2010; Pojani and Boussauw, 2014). One study examined the influence of socio-economic and environmental characteristics on active school travel in Albania (Pojani and Boussauw, 2014). In a very dense urban Albanian setting, walking had the highest share among available school travel alternatives. The findings also showed that higher home-to-school distance, car ownership and family income were negatively related to active school travel.

In addition to the contexts outlined above, some studies have been conducted in Australia and New Zealand. Some of these studies have shown that built-environment factors like distance has the most important impact on active school travel (Conlon, 2013; Curtis et al., 2015). In addition, Carver et al. (2013) reported that parental perceptions of traffic safety and injury risk were important for mode use among children.

As shown in Table 1, it is evident that a rather meagre body of studies has been conducted in the Eastern Asian and Middle East context. One study carried out among pupils (aged 13–15 years) found that home-to-school distance had a negative role on active school travel among students in China (Li and Zhao, 2015). The authors also recommended an examination of associations between travel time, school choice and modal split in future research. Further, Lin and Chang, (2010) examined the role of the built environment on children's school travel in Taipei. They reported that a higher shade-tree density and sidewalk coverage were positively related to walking to school among children.

Recently, some studies have examined factors important for pupils' (12–17 years) travels in Tehran, Iran (Ermagun and Levinson, 2016; Ermagun and Samimi, 2015). These studies analyzed a wide range of policy-sensitive variables and found that walking time to school, car ownership and safety concerns had a negative role on active travelling to school. Also, two studies have been conducted in a typical city in the northern part of Iran, Rasht (Hatamzadeh et al., 2016; Mehdizadeh et al., 2016). Hatamzadeh et al. (2016) found that higher distance, car ownership and age (elementary vs. high school students) were negatively related to walking among students. Moreover, Mehdizadeh et al. (2016) reported significant heterogeneity around the mean of walking time to school among a wide range of socio-economic, psychological, and built environment variables on school travel mode choice. To date, no studies have examined the walking time threshold and factors associated with this threshold in the Middle East context. There are also no studies that have investigated active school travel by a wide range of socio-economic, attitudinal and safety factors in this context.

As mentioned above, distance or time was the most important variable on active school travel in previous work. An increase in distance or walking time is strongly associated with the probability of active school travel among children (McDonald, 2008a). For instance, McDonald found that a 10 percent increase in walking time (perceived self-reported distance)—in essence distance to school—decreased children's walking probability by around 7.5 percent. McDonald and also McMillan used a self-reported distance measurement and showed that children who lived within one mile (1.6 km) of their school had a stronger probability of walking to school (McDonald, 2008a; McMillan, 2007). Another study used a self-reported walking time measure of commuting distance related to use of active modes in school trips (Ermagun and Samimi, 2015). Their results showed that a 1 percent increase in walking time led to a 2.37 percent decrease in active mode use.

Other studies have reported that the perceived distance should be at 3 km or below for an active modal shift to take place on school travel (Li and Zhao, 2015; Van Goeverden and De Boer, 2013). However, Timperio et al. (2006) found that 800 m could be a cut-off for walking and bicycling among children. They also measured distance to school with a proxy variable (shortest possible route from home-to-school). The large difference in identified threshold between 3 km and 800 m might be due to different operationalizations and distance measures across studies. However, in Van Goeverden and De Boer (2013) (a 3 km threshold), the analyses were based on reported distances from home-to-school by the respondents.

Meanwhile, a small body of studies has examined factors affecting school choice as an explanatory factor for perceived or actual home-to-school distances (De Boer and Blijie, 2006; Gorard, 1999; Van Goeverden and De Boer, 2013). School choice could determine the time and distance that a child has to travel, given its residential location (Van Goeverden and De Boer, 2013). The distance and time that a child has to travel to school is associated with the school choice from the collection of eligible schools (Van Goeverden and De Boer, 2013). For instance, poor accessibility (e.g. by walking), traffic barriers, higher age, higher income, car ownership, and parental educational degree could relate to higher home-to-school distances to eligible schools (De Boer and Blijie, 2006; Gorard, 1999; Van Goeverden and De Boer, 2013).

2. Materials and methods

2.1. Study area context

The study area in the current research was in Rasht. Rasht is the largest city in the northern part of Iran with an area of 180 km^2 and a population around 639,951 (Iran National Census, 2011). The urban road network of Rasht is a combination of narrow streets that result in limited car flow and a dense traffic on the inner-city main roads. Some public transit modes, such as metro and tram systems, are not available in Rasht. Public transport in Rasht includes urban scheduled buses and carpooling (public) taxis. The carpooling taxis have dedicated stations across the city. Narrow streets, a lack of well-maintained pavements and poor public transport facilities are important characteristics of the transport system in Rasht. Also, the bicycling use among youth and the general population is limited. Subject to a fee, some schools also provide

transport services for their pupils. The number of public and private primary schools are 123, and 122, respectively in Rasht. Also, the price of gasoline is overall cheaper in Iran (average price of 0.39 $ per liter) than in the rest of the world (average price 0.99 $ per liter).

The city of Rasht has some interesting characteristics that motivated us to select it as a case in the present study. First, the general urban transport patterns, the public transport system and the low proportion of walking/bicycling rates are rather similar to most Iranian cities and less developed countries in the Middle East (Hatamzadeh et al., 2016; Mehdizadeh et al., 2016). Further, like most other cities in Iran, Rasht has warm summers and cool winters which may influence choices of transport on children's school travel.

2.2. Sample

The respondents were parents of elementary pupils (7–9 years). Based on pupils' demographic proportions (e.g. gender), the socio-economic status of different regions of the city and type of school proportions, a random stratified sampling procedure was carried out. A total of 1078 questionnaires were distributed among pupils in 9 schools in 2014. The pupils were requested to bring the forms home to be completed by their parents. After two days, 80 percent of the questionnaires were returned (n=858). Uncompleted questionnaires (n=123) were not included in further analyses, which left a total of 735 cases available to analysis. Written consent was obtained from the parents.

2.3. Measures

Different measures that were applied in the study are outlined and explained in this section. Table 2 also shows variables that were included in the questionnaire. The parents were asked to report the frequency of how often they chose each mode (walking, car, school service, public transport, and other) on their children's school travels in the previous week (the maximum was five times). Further, Information was collected about children's and parental demographic and socio-economic characteristics. The access to school service (e.g. school bus, carpooling), accessibility to public transport and perceived safety of walking facilities in the home-to-school route was recorded. Parental attitudes towards walking were measured with a revised version of a validated 23-item instrument (Transport for London, 2011; Mehdizadeh et al., 2016). Parents reported their consent to the attitudes items on a five point Likert scale, (1) 'completely disagree' to (5) 'completely agree'.

The parents also reported their perceived walking time to school (as a proxy to active travel time and distance) in minutes. Also, PWTS and the shortest possible path in Google Earth between residential districts-and-school distances were strongly related. Several previous studies used a self-reported (or approximate) walking time and physical distance measure (Ermagun and Samimi, 2015; McDonald, 2008a; McMillan, 2007; Timperio et al., 2006). Further, Nelson et al. (2008) showed

Table 2
Variables used in the questionnaire.

Measure	Scale or response category
School travel modes	
The frequency of how often parents chose each mode	In a week (the maximum was five times)
Demographic characteristics	
Children's gender	Boy vs girl
School grade of the children	7–9 years old
Parent's age	Continuous variable
Socio-economic and household characteristics	
Number of children in the household	Continous variable
Father's driving license status	Has/has not
Mother's driving license status	Has/has not
Father's occupational status	Full time vs part time
Mother's occupational status	Full time vs part time
Father's educational status	High (university degree) vs low
Mother's educational status	High (university degree) vs low
Number of private cars owned by households	Continous variable
Respondents' perception about their own income compared with the city average	5 point Likert scale, much lower to much higher
The number of hours of parental exercise in a week	0 h, <1 h, 1–2 h, 2–3 h, >3 h
Transport system	
Access to school service	Yes/no
Access to public transport in the home-to-school route	Yes/no
Perceived safety of walking facilities in the home-to-school route	
Parental perceived safety of walking facilities in the home-to-school route	5 point Likert scale, very unsafe to very safe
Parental attitudes toward walking	
Parental attitudes towards walking with a revised version of a validated 23-item instrument (TFL, 2011)	5 point- Likert scale, strongly disagree to strongly agree
Walking time to school	
Parental perceived walking time to school	Continuous variable (in minutes)

that there were no significant differences between self-reported physical distance and actual distances, indicating that perceived distance is a valid proxy to actual distance.

2.4. Statistical analysis

Descriptive statistics were applied to detect the PWTS threshold for active mode use on school trips. In this way, the plot of the number of children walking versus the PWTS was used to identify the threshold. Pearson's chi-square (χ^2) tests were used to investigate proportion differences in socio-economic status, household factors and modal split across short and long PWTS groups. Independent samples t-tests were applied to examine mean differences in walking attitudes between those who had short PWTS and those who had long PWTS. Principal component analyses (PCA) with iteration and varimax roation were applied to explore walking attitudes dimensional structures. To determine the number of dimensions Kaiser criterion and the Scree plot were applied. Cronbach's α coefficients were calculated to test scale reliability and internal consistency. To predict active school travel versus inactive modes (0=inactive, 1=active modes), and short PWTS versus long PWTS (0=long, 1=short), two binary logistic regression analyses (n=735) were carried out. The predictors were added in two models using the enter method in SPSS 21.0 statistical software package. In addition to the variables that are found statistically significant in a 95% confidence interval, all non-significant examined variables have been adjusted for and reported in the two models.

3. Results

3.1. Detecting the PWTS threshold for active modes

PWTS ranged from one minute to 120 min. The mean PWTS was 25.00 min (Std. deviation=20.22). About 50% of parents perceived a PWTS of more than 15 minutes, while 15 percent perceived more than 40 min. The PWTS threshold has been defined as the time where the walking frequency starts to decrease compared to the best performing alternative mode. Descriptive analyses (Fig. 1) showed that 10 min PWTS was the threshold in the current sample. Hence, it was assumed that a PWTS equal to or less than 10 minutes constituted a short trip where active mode use is more prominent than each of the other modes, and more than 10 minutes is a long trip to school where active school travel is low compared to the best performing alternative mode. In this time interval (10 min), the frequency of walking and the best performing alternative (school service) was 39 and 38 times, respectively. After the 10 minute threshold, the walking frequency was substantially reduced to 19 times, and school service was the most frequently chosen mode (Fig. 1). Pearson's chi-square test also showed that modal use by short and long PWTS differed significantly (χ^2 *(df= 4) =206.80, p= 0.000*).

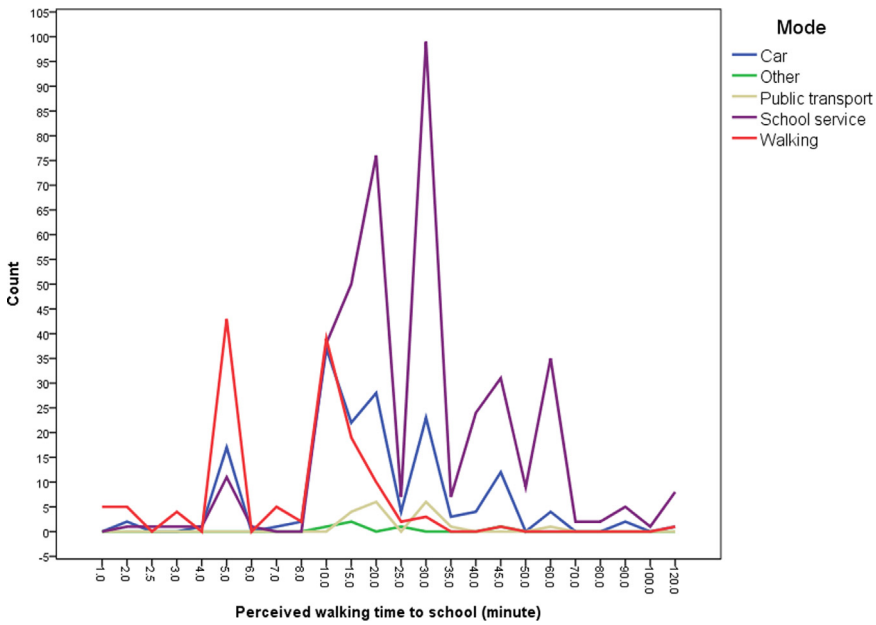

Fig. 1. Detecting the threshold for perceived walking time to school (PWTS).

Table 3
Demographic and household characteristics by the two PWTS groups (short and long trips).

Characteristics	Short trips	Long trips	Characteristics	Short trips	Long trips
Gender of child			**The number of hours of parental exercise in a week"**		
Boy	106	258	No exercise	61	153
Girl	112	259	< 1 h.	67	162
Type of school **			1–2 h.	39	106
Public	147	432	2-3 h.	19	48
Private	71	85	> 3 h.	32	48
Child's grade			**Monthly income** *		
One	87	211	< 500,000 toman	27	97
Two	65	149	500,000–1 million	145	346
Three	66	157	1 million–1.5 million	37	63
Father's driving license			> 1.5 million	9	11
Yes	200	486	**Respondent's age** *		
No	18	31	18–25 years old	10	35
Mother's driving license			26–30	27	85
Yes	154	341	31–39	124	275
No	64	176	40–49	52	117
Owned cars *			> 50	5	10
0	49	114	**Father's education** *		
1	137	357	Illiterate	1	3
2	30	42	Under high school	34	121
2+	2	4	High school	110	273
Father's occupational status *			Bachelor of Science and higher	74	119
Full time job	134	302	**Mother's education** *		
Part time job	55	145	Illiterate	0	1
Retired	4	6	Under high school	31	83
Unemployed	4	9	High school	114	319
Other	21	55	Bachelor of Science and higher	73	114
Mother's occupational status **			**Access to public transport** **		
Full time job	27	56	Yes	82	305
Part time job	46	54	No	136	212
Retired	2	3	**Access to school service** **		
Housewife	133	391	Yes	188	478
Other	10	13	No	30	39

Pearson chi-square.
Short trips (PWTS < = 10 min); Long trips (PWTS > 10 min).
* $P < 0.05$.
** $p < 0.001$.

3.2. Demographic and household factors among the two PWTS groups (short and long trips)

Proportion differences in socio-economic and household factors across short and long PWTS were examined by Pearson's chi-square test (Table 3). The share of each variable group: Type of school, monthly income, parental age, car ownership, father's education, mother's education, father's job, mother's job, income level, accessibility to public transport, and access to school service were significantly different across the two PWTS groups.

3.3. Walking attitude scores by PWTS (short and long trips)

Descriptives for the walking attitude items separated for those who perceived short and long PWTS are reported in Table 4. As shown, the item "*Good design of streets makes walking more enjoyable*" had the highest score in the short and long PWTS groups. Parents who perceived short walking time to school reported more agreement to walking attitudes such as *"Walking is a convenient way of getting about"," Walking is an interesting way to travel","I feel more relaxed when I walk to my destination","I don't think there is enough pedestrian information and signposts in my local area"*, and *"Walking for 15 minutes is something I would happily consider"*. These parents also reported less agreement to the item "*Walking is a method of transport that you would want to be seen using*".

Table 4
Descriptives for attitudes towards walking items among short and long PWTS.

Item (symbol)	PWTS groups				*p*-value	d-value
	Short		Long			
	Mean	SD	Mean	SD		
Walking is a method of transport that you would want to be seen using (*W1*)	3.56	1.02	3.73	0.98	**0.033**	−0.21
Walking is enjoyable (*W2*)	4.52	0.63	4.51	0.60	0.895	0.04
Walking is a convenient way of getting about (*W3*)	4.12	0.85	3.96	0.87	**0.039**	0.21
Walking is an interesting way to travel (*W4*)	4.07	0.87	3.88	0.92	**0.019**	0.20
Walking makes a difference to improving the environment (*W5*)	4.36	0.71	4.30	0.72	0.268	0.10
Walking gives me time to think (*W6*)	4.29	0.81	4.28	0.70	0.835	0.04
Walking is good for rush hour journeys in Rasht (*W7*)	3.36	1.20	3.37	1.20	0.889	−0.03
Walking is the fastest way to travel for short journeys (*W8*)	3.82	0.92	3.80	0.97	0.832	0.03
Walking is a method of transport that I would use and/or recommend (*W9*)	2.99	1.16	3.11	1.14	0.214	−0.09
Traffic fumes make people dislike walking on Rasht streets (*W10*)	4.50	0.67	4.43	0.72	0.244	0.09
Rasht is a city for walking (*W11*)	4.11	0.89	4.08	0.86	0.624	0.05
Walking is a good way to get fit (*W12*)	4.43	0.60	4.34	0.66	0.099	0.13
I feel more relaxed when I walk to my destination (*W13*)	3.65	1.06	3.47	1.11	**0.039**	0.20
Walking sets a good example to children (*W14*)	2.48	1.14	2.67	1.20	**0.021**	−0.19
Walking is good for journeys in my local area (*W15*)	3.25	1.24	3.34	1.26	0.343	−0.09
I don't feel safe walking by myself in my local area (*W16*)	2.01	1.00	2.00	1.02	0.911	0.01
Dirty and vandalized streets make people dislike walking in Rasht (*W17*)	3.75	1.00	3.70	1.13	0.557	0.05
Walking is only for people who can't afford other ways of getting there (*W18*)	4.56	0.70	4.55	0.66	0.945	0.01
I don't think there is enough pedestrian information and signposts in my local area (*W19*)	4.53	0.66	4.40	0.80	**0.018**	0.19
Good design of streets makes walking more enjoyable (*W20*)	4.68	0.47	4.64	0.54	0.270	0.11
Walking for 15 min is something I would happily consider (*W21*)	4.05	0.88	3.94	0.96	**0.038**	0.14
I enjoy walking where pavements are well-maintained (*W22*)	4.31	0.84	4.30	0.81	0.865	0.02
Information and signs make it easy to find your way around Rasht (*W23*)	3.71	1.15	3.70	1.10	0.979	0.01

Bolded figures are significant at $p < 0.05$.

3.4. Dimensionality and reliability indices for walking attitudes items

The PCA showed that walking attitudes consisted of three underlying dimensions. The first dimension was labelled '*Comfort and Convenience of walking*' ($\alpha = 0.721$, average corrected inter-item correlation (aiic) = 0.57, explained variance

Table 5
Logistic regression predicting perceived walking time to school PWTS[a].

Variables	B (S.E)	Odds Ratio	95% C.I.		P-value
			Lower	Upper	
Constant	.11 (.85)	–	–	–	0.895
Number of children in household	.04 (.12)	1.04	.81	1.34	.732
Gender (Boy = 1, Girl = 0)	.28 (.17)	1.32	.95	1.85	.097
Type of school (public = 1, private = 0)	−.99 (.25)	.36	.22	.60	**.000**
School grade of children (1, 2, 3)	.15 (.10)	1.16	.95	1.41	.136
Father's driving license (has = 1, has not = 0)	−.59 (.33)	.59	.29	1.10	.070
Mother's driving license status (has = 1, has not = 0)	−.35 (.19)	.70	.47	1.04	.079
Number of households' private cars	−.11 (.17)	.89	.63	1.25	.512
Father's occupational status (full time = 1, other = 0)	−.01 (.06)	.98	.86	1.12	.860
Mother's occupational status (full time = 1, other = 0)	−.08 (.08)	.91	.78	1.07	.270
Father's educational status (high = 1, low = 0)	.14 (.14)	1.15	.85	1.54	.348
Mother's educational status (high = 1, low = 0)	−.02 (.17)	.98	.70	1.37	.905
Income	.26 (.13)	1.27	1.02	1.64	**.031**
Parental exercise in a week (see Table 1)	.02 (.06)	1.02	.90	1.16	.698
Parental age	.02 (.01)	1.02	1.01	1.05	**.039**
Accessibility to public transport (yes = 1, no = 0)	−.85 (.17)	.42	.30	.60	**.000**
School service (yes = 1, no = 0)	−.78 (.27)	.45	.26	.78	**.005**
perceived safety of walking (see Table 1)	.09 (.08)	1.09	.92	1.30	.276
Comfort and Convenience of walking	.12 (.08)	1.14	.96	1.32	.098
Design feasibility for pedestrians	.07 (.08)	1.07	.91	1.26	.370
Contextual and design preconditions for walking	−.20 (.08)	.81	.68	.97	**.022**

-: Bolded figures are significant at $p < 0.05$ or below.

[a] Chi-square = 78.53 (df = 20), enter method, sig = 0.000. $R^2 = 0.127$ (Cox & Snell), 0.170 (Nagelkerke). 72.4% correctly predicted; dependent variable: PWTS (< = 10 min: 1 otherwise: 0).

Table 6
Logistic regression predicting active school travel[a].

Variables	B (S.E)	Odds Ratio	95% C.I.		P-value
			Lower	Upper	
Constant	.18 (1.29)	–	–	–	0.886
PWTS_10 (< =10 min =1, > 10 min=0)	2.72 (.26)	15.24	9.04	25.70	**.000**
Number of children in household	.17 (.18)	1.18	.82	1.71	.358
Gender (Boy=1, Girl=0)	−.04 (.25)	.96	.57	1.59	.881
Type of school (public=1, private=0)	.12 (.37)	1.13	.54	2.34	.740
School grade of children (1, 2, 3)	.03 (.14)	1.04	.77	1.39	.795
Father's driving license (has=1, has not=0)	−.71 (.44)	.48	.20	1.17	.111
Mother's driving license status (has=1, has not=0)	−.69 (.30)	.49	.27	0.89	**.020**
Number of household's private cars	−.62 (.25)	.53	.32	.88	**.015**
Father's occupational status (full time=1, other=0)	.05 (.10)	1.05	.86	1.28	.610
Mother's occupational status (full time=1, other=0)	.01 (.12)	1.01	.80	1.28	.889
Father's educational status (high=1, low=0)	−.09 (.22)	.90	.58	1.41	.669
Mother's educational status (high=1, low=0)	−.38 (.20)	.74	.46	0.99	**.048**
Income	.09 (.19)	1.09	.75	1.60	.630
Parental exercise in a week (see Table 2)	.13 (.09)	1.14	.94	1.37	.158
Parental age	−.01 (.02)	.99	.95	1.03	.729
Accessibility to public transport (yes=1, no=0)	−1.33 (.26)	.26	.15	.44	**.000**
School service (yes=1, no=0)	−1.50 (.35)	.22	.11	.44	**.000**
perceived safety of walking (see Table 2)	−.07 (.12)	.92	.72	1.18	.543
Comfort and Convenience of walking	.16 (.12)	1.17	.92	1.49	.190
Design feasibility for pedestrians	−.01 (.12)	.99	.78	1.26	.956
Contextual and design preconditions for walking	−.09 (.12)	.91	.71	1.16	.473

-: Bolded figures are significant at $p < 0.05$ or below.
[a] Chi-square=253.62 (df=21), enter method, sig=0.000. R^2=0.292 (Cox & Snell), 0.470 (Nagelkerke). 86.5% correctly predicted; dependent variable: Active mode: 1 versus Inactive: 0.

(ev)=24.17%) included six items (*W9*, *W8*, *W4*, *W15*, *W13*, and *W3*). This dimension included items related to evaluations of the convenience and attractiveness of walking. The second dimension was named '*"Design feasibility for pedestrians*' (α=0.679, aiic=0.54, ev=16.39%) and included three items (*W22*, *W20*, and *W21*) that described evaluations of the street designs and pavements. The third dimension labelled '*Contextual and design preconditions for walking*' (α=0.528, aiic=0.52, ev=13.27%) included three items (*W17*, *W10*, and *W16*) which illustrated that people dislike walking in dirty, vandalized and unsafe streets.

3.5. Predictors of short versus long PWTS

Table 5 shows that the model significantly predicted short versus long PWTS (χ^2=78.535, $p < 0.001$). Attending to a public school, accessibility to public transport, access to school service, and favourable 'contextual and design preconditions for walking' were negatively related to short PWTS. Increased household income level, and parental age were positively related to a short PWTS.

3.6. Predictors of active mode (walking) versus inactive modes

Table 6 shows that the model significantly predicted active school travel versus inactive modes (Model χ^2=253.623, $p < 0.001$). A short walking time to school was strongly associated with active school travel. Mother's driving license, more owned cars, higher mother's educational degree, accessibility to public transport, and access to school service were negatively related to active school travel.

4. Discussion

The findings showed that a 10 min perceived walking time to school was the maximum threshold where the proportion of active mode use started to decrease compared to the best performing alternative mode. A 10 min PWTS seems to represent a short trip to school that increases the probability of children's physical activity in this Iranian setting. When the groups of short and long PWTS were compared, certain demographics such as parental age, household income, accessibility to public transport, type of school (public vs private), school service status (De Boer and Blijie, 2006; Gorard, 1999; Van Goeverden and De Boer, 2013) and psychological factors (parents' attitudes towards walking) were also significant predictors of a short perceived walking time to eligible schools.

Older parents perceived a shorter walking time to school than younger parents. This could suggest that older parents tend to live closer to their children's school than younger parents. Households that reported a higher monthly income tended to have a shorter trip to school. This could reflect that more wealthy parents reside close to schools, were housing usually is more expensive. These findings are in contrast with some previous studies in Western Europe (Van Goeverden and De Boer, 2013; De Boer and Blijie, 2006). They reported that higher household income and age were related to higher home-to-school distances to eligible schools. Intriguingly, parents who had registered their child in public schools perceived a longer walking time than those who had children registered in private schools. This supports the idea that private school locations are more scattered and more available in diverse neighborhoods than public schools in Iran (Ermagun and Samimi, 2015; Mehdizadeh et al., 2016). Among psychological factors, considering stronger *'Contextual and design preconditions'* like dirty, vandalized and unsafe streets and sidewalks for walking in local areas, may decrease short PWTS to eligible schools in neighborhood in Iran.

When the groups of active mode (walking) versus inactive school travel modes (i.e. car, school service, public transport, and other motorized modes) were compared, perceived walking time to school (as a measure of distance), some characteristics of mothers (their driving license status and educational background), car ownership, accessibility to school service and public transport were important predictors of active school travel in Iran. In line with several previous studies (see Table 1) that have been conducted in North America (e.g. McMillan, 2007), Western Europe (e.g. Nelson et al., 2008), Australia and New Zealand (e.g. Curtis et al., 2015), perceived walking time to school was the most important predictor of active school travel in Iran. Based on findings of the current study and several studies in different regions, it may be that distance from home-to-school is the most critical variable for active school travel rather independently of cultural context.

When PWTS was short ($\leq$ 10 min) the probability of children walking to school increased 15.24 times more than on long walking trips ($>$ 10 min). In order to promote physical activity among children, policymakers could consider the 10 min PWTS threshold in policies aimed to promote active school travel. If we assume that the children median walking speed is 4.3 kph (2.7 mph) (McDonald, 2008a) then, by translating walking time to physical distance, it can be concluded that our PWTS threshold is equal to 0.71 km (0.45 mile). One previous study reported 1.6 km (1 mile) distance to school as a threshold for increased active travel among pupils in the United States (McMillan, 2007). McDonald (2008a) reported a 1.6 km (1 mile) threshold that all pupils live in an area of 3 mi^2; a 0.8 km (0.5 miles) threshold equates to an area of 0.8 mi^2, assuming circular neighborhoods in the United States whereas, Timperio et al. (2006) reported a 800 m (0.5 mile) threshold in Australia.

Regarding the role of gender for mode use, this variable did not have a consistent and definite role on children's active school travel in prior studies. In the current study, we did not find any gender differences on active school travel. Although some studies have reported that more boys actively travel to school in Western Europe (e.g. Nelson et al., 2008; Easton and Ferrari, 2015), some studies did not reveal any gender differences, for instance in Canada (e.g. Mitra and Buliung, 2015) and Iran (Mehdizadeh et al., 2016). Studies to come could investigate whether the lack of a gender difference in mode use choices on school travels is a general tendency in the Middle East context.

In schools that offer carpooling services the probability of children's walking to school was lower than in schools that did not offer such services. In Iran, both public and private schools are common and households pay high fees for registering their pupils' in private schools. Those who are able to pay these fees are usually wealthier than parents with children in public schools where registration is free of charge. However, the type of school was not found to be a significant factor on active school travel in the present study. On the contrary, a study in Toronto concluded that children who attended private schools had a stronger tendency to use carpooling and school services (Mitra and Buliung, 2015). The type of school has not reflected a consistent role on mode use in different regions of the world (see also Table 1).

Regarding the relative role of other socio-economic and household variables for mode use among children, those children with mothers who had a driving license and higher educational degree were less likely to walk to school. Although some previous studies reported similar findings (e.g. McMillan, 2003), this variable has also shown inconsistency in relation to mode choice across studies. Well-educated mothers might experience more worry regarding traffic safety or security on their children's active school trips. Future work could focus on interaction models to obtain more accurate knowledge about how, for instance, parental education and worry operate together in influencing active travel mode use among children. Of note, parental attitudes dimensions towards walking did not relate to active mode use. This suggests that more active mode use on school trips cannot be expected by merely aiming to influence cognitive evaluations of walking through attitude interventions among parents.

Higher access to car had a strong negative impact on children's active school travel in the current study. In line with several studies in high income societies, such as North America (e.g. McDonald et al., 2011) and Western Europe (e.g. Van Goeverden and De Boer, 2013), household car ownership had negative impacts on active school travel in Iran. This variable has a rather reliable negative role on active school travel in different regions of the world (Table 1). Policymakers should manage car use demand in urban roads to prevent the probability of using car on school travel.

4.1. Limitations

Information about urban form and residential density characteristics were not gathered in the survey. These variables might be related to school siting, PWTS and active mode choice. Further, this study used a perceived self-reported measure of walking time. For spatial planners actual walking time might be more informative than the perceived time, which should

be considered as a proxy variable. However, it was complicated to implement a measure of actual walking time in the current study because it is difficult for researchers to access Iranian population registries and to obtain adequate information about residential addresses. Further, the information in the registers is inaccurate and unreliable. In addition, the data had some limitations regarding interpretations of the PWTS threshold. The perceived walking time in minutes above 10 minutes were 5-min intervals (e.g. 10, 15, 20 …). For example, although respondents had the opportunity to report values between 10 and 15 min (i.e. 11, 12, 13, and 14 minutes), most of them still would have rounded off to 10 or 15 minutes. However, the possible inaccurateness of the 10-min PWTS threshold value had no large impact on the main results. For instance, the sensitivity analysis showed that a 15 min threshold had no substantially different results regarding the main aims.

The present study did not examine interaction terms between the predictors of perceived walking time threshold and active school travel. For instance, a third variable may be correlated with another factor that has a strong influence on PWTS or active school travel. The current study did not incorporate interaction terms in order to avoid too complicated models. However, future studies could examine interactions terms with the predictors that we used in the present study. Furthermore, the present study was based on cross-sectional and self-reported data which impose limitations regarding causal inferences and potential socially desirable responses.

5. Conclusions

This study adds to the knowledge base of the active school travel literature. In contrast to many studies that have been conducted in developed regions in North America, Australia, and Western Europe, this study was conducted in the Middle East context, Iran. The findings showed that similarly to other contexts, home-to-school distance or walking time (where bicycling is uncommon) is the most important barrier on children's active school travel. Several previous studies reported a cut-off for walking, bicycling use (or active school travel) with somewhat similar definitions in a Western context, but this is the first study to do this in an Iranian context. What we defined as a threshold in this study is the cut-off time where the walking frequency starts to decrease compared to the other best performing alternative transport mode. To the authors' knowledge, the current study is the first that have examined a wide-range of factors (socio-economic, household characteristics, safety perception about walking facilities and walking attitudes) potentially affecting school choice as an explanatory factor for perceived home-to-school walking time in a Middle East context. Also, a scant body of research has examined socio-economic and urban form characteristics on perceived walking time to school independently of country context. In this Iranian setting, active school travel mode choice tended to decrease by a lower time threshold compared to other countries in the world. Furthermore, this study found that favourable attitudes towards walking among parents might be important for perceived home-to-school walking time.

Conflict of interest statement

The authors have no conflict of interest to report.

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