Journal of Public Health: From Theory to Practice (2019) 27:349–356
https://doi.org/10.1007/s10389-018-0956-y

ORIGINAL ARTICLE

Built environment correlates of walking for recreation or exercise

Zeinab Aliyas [1,2]

Received: 3 June 2018 / Accepted: 26 June 2018 / Published online: 14 July 2018

Abstract

Background Walking is known as the most common type of physical activity that may be influenced by the built environment, which in turn may affect the health of residents. The current study aimed at investigating the relationship of the built environment to exercise and recreational walking in residential neighborhoods.

Method Five hundred questionnaires were distributed from March to May 2016 in four residential neighborhoods of Bandar Abbas in Iran, out of which 398 questionnaires turned out to be qualified to be used in the study. Furthermore, the number of parks as well as their total area were estimated within a radius of 1500 m from the respondents' living place.

Results Considering the participants' gender, the appealing characteristics of built environment were more likely to increase walking activity among females than males. The association between walking patterns and environmental factors was different between male and female residents. In addition, the correlations between walking behavior and some other socio-demographic factors were determined.

Conclusion The present study suggests that urban planners and designers as well as public health promoters need to highly consider the contribution of built environment variables in neighborhoods as well as socio-demographic variables to promote walking behavior changes among the adult population.

Keywords Exercise walking · Recreational walking · Neighborhood · Built environment

Introduction

Physical activity is known as an important modifiable behavior in preventing many diseases such as diabetes, hypertension, obesity, and premature death (Sallis et al. 2012; Eyre et al. 2004). In contrast, the World Health Organization in 2002 revealed physical inactivity as the cause of 1.9 million deaths. It is worth noting that the level of physical inactivity is rising in many societies (Armstrong et al. 2000). In this respect, the physical inactivity of 70–80% of Iranians can be put down to living a sedentary lifestyle, leading to an enormous public health problem (Bahrami et al. 2006; Sheikholeslam et al. 2004).

Walking is known as the most common type of physical activity among people in many countries including Iran (Momenan et al. 2011). Identifying the factors influencing different types of physical activity can be helpful in promoting public health. In this regard, the factors which influence the specific types of physical activity that are now being widely promoted for health benefits have been less investigated compared to the general types (Humpel 2002; Humpel et al. 2004). In addition to individual and social factors, built environment is known to affect the physical activity of people in different domains (exercise, recreation, transport) and different settings (neighborhood, park) (Sallis et al. 2008; King et al. 2003). Today, several scholars put the blame fordecline in people's health on urban environmental factors including the neighborhood environment or neighborhood parks quality (Su et al. 2014; Bai et al. 2013; Doescher et al. 2017; Sugiyama et al. 2014). The association between walking for transportation and characteristics of built environment has been revealed in previous studies (Lee and Moudon 2006; Troped et al. 2003); however, the link between built environment and leisure-time physical activity including recreational and exercise walking need attention due to the importance of its health outcome. Hence, the current study attempted

✉ Zeinab Aliyas
z.aliyas@iauba.ac.ir

[1] Young Researchers and Elite Club, Bandar Abbas Branch, Islamic Azad University, Bandar Abbas, Iran

[2] Department of Architecture, Bandar Abbas Branch, Islamic Azad University , Bandar Abbas, Iran

to examine the association of built environment variables with exercise and recreational walking.

The previous studies on recreational or exercise walking revealed the relevance of these types of physical activity to perceived safety (Van Dyck et al. 2013; Van Lenthe et al. 2005; Sugiyama et al. 2014), neighborhood aesthetics (Jack and McCormack 2014; McCormack et al. 2013; Ball et al. 2001; Nehme et al. 2016), proximity to potential destinations such as parks (Sugiyama et al. 2014; Nehme et al. 2016; Sugiyama et al. 2013), attractiveness of parks (Sugiyama et al. 2014), quality of parks, and facilities presented in the parks (Van Lenthe et al. 2005; Sugiyama et al. 2017; Sugiyama et al. 2015; Doescher et al. 2017). However, there was a lack of attention to specific types of walking in the studies. In addition, the results varied depending on the type of walking considered in the studies. For example, the studies conducted to examine the association of built environment with utilitarian and leisure-time walking revealed different results depending on the type of walking they investigated (Jack and McCormack 2014; McCormack et al. 2013; Doescher et al. 2017; Lee and Moudon 2006). To illustrate, the results of a small number of studies that investigated the association between built environment and exercise walking (Van Dyck et al. 2013; Hovell et al. 1989; Hovell et al. 1992; Lovasi et al. 2008; Hosler et al. 2014; Ball et al. 2001) were different from those of the studies which linked this association to recreational walking or general leisure-time physical activity in neighborhoods. Consequently, it is important to understand the relationship between built environments and each type of walking in promoting health behavior. The present study tried to investigate the relationship of built environments to exercise and recreational walking separately. The adult population of four residential neighborhoods in Bandar Abbas, a city in Iran, participated in this study.

Methodology

Sample selection and data collection

The present study was conducted in Bandar Abbas from March to May 2016. The city of Bandar Abbas is located as the southeast coastal city of the country. The city has a population of about 0.54 million and contains 84 neighborhoods. A cross-sectional household survey was conducted in four residential neighborhoods of the town from three generations (old, average, and new). Five hundred questionnaires were distributed according to the number of households in each neighborhood (A: 165, BB: 170, HD: 87, KH: 78) using systematic sampling. Systematic sampling allowed the researcher to estimate the number and the total area of parks around each respondent's household. Two trained educated students distributed the questionnaires door-to-door and gave one to an adult resident (above 18 years old) who was randomly selected in each household to participate in the research. A week after distribution, 461 questionnaires were collected for further analyses.

Walking measurements

Self-report walking activity was measured using the Behavioral Risk Factor Surveillance System questionnaire (Centers for Disease Control and Prevention 2012), which was modified based on the purpose of the study. Exercise walking was identified as walking, jogging, or brisk walking for the purpose of health or fitness. In this regard, recreational walking was identified as walking or strolling for the purpose of recreation or socialization. Each respondent was asked about the types, frequencies, durations, and locations of exercise and recreational activities. The respondents were classified as neighborhood exercise walkers or recreational walkers when they met all of the following conditions: engaging in any recreation or exercise walking activity during the previous month, identifying walking as their primary or secondary physical activity, and using outdoor spaces in their neighborhoods as places for walking or exercise.

Perceived environment

The items to measure perceptions of neighborhood park quality were adopted from the previous studies on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Li 2005; Bai et al. 2013; Saelens et al. 2003; Sallis et al. 1997; Sugiyama et al. 2009), with regard to the condition of parks in their neighborhood focusing on proximity, availability of facilities in the parks, and attractiveness of the parks. The opinion of the participants about parks could be related to one or multiple parks in their proximity that they usually used.

Perceived neighborhood safety was measured by the single item "it is safe to walk or jog alone in my neighborhood during the day" (Sallis et al. 1997), and three items were also used to assess the aesthetics of neighborhoods on a 5-point scale (1 strongly disagree to 5 strongly agree) (Sugiyama et al. 2009), with regard to attractiveness of buildings, interesting things to look at, and lots of greenery.

Objective measurements

The total number of parks and their total area within a radius of 1500 m (15 mins walking) from each respondents' household were estimated considering the distance of each participant's home to each park in each neighborhood using the street network distance, which is known as an appropriate method for estimating walking behavior (Apparicio et al.

2008). The information concerning park size was gathered from the municipality of the town.

Data analysis

Out of the total number of respondents, 63 participants were excluded since they had not provided the required responses on the built environment measures, did not mention the gender, did not walk enough, or were under 18 years old. The total sample size analyzed was 398. Using SPSS version 24, the descriptive analyses were used to show percentages for the study variables based on gender. Body mass index (BMI) was also calculated through dividing weight by the square of height (kg/m^2).

Approximate minutes spent on exercise and recreational walking per week were obtained by combining the reported frequencies and duration of these activities. In this study, walking for exercise or recreation in the neighborhood for any total length of time is referred to as "any walking." A subset that involves walking for 30 min/week or longer is identified as "regular walkers". Based on the recommendation of WHO, the studies conducted on physical activity consider 150 min of physical activity per week as a substantial level (Sigal et al. 2006); however, this cut-off point of 150 min is used for upper levels of physical activity. A lower cut-off point was considered in the present study since it concentrates on specific types of physical activity (Kramer et al. 2013).

Due to the different levels of walking behavior between male and female, binary logistic regression was performed to examine how built environments were associated with exercise and recreational walking based on gender (Miller and Brown 2005). Since each environmental variable could be separately correlated with each type of walking behavior, the environmental items were tested in separate models to assess the correlates of each built environment factor on recreational and exercise walking without adjusting to the other environmental factors. In addition to the link between specific types of walking and built environments, adjusted binary logistic regression was performed to assess the association of exercise and recreational walking with age, education, presence of children in the households, and body mass index based on gender.

Results

With regard to the gender of the 398 participants in the survey, the majority of the participants were female (51%) and 49% were male. The respondents' age ranged from 18 to 70, with a mean of 32.3 (SD = 10.58). A substantial portion of the participants in the survey had at least one child under 12 years old in their households. In addition, more than half of the participants had a bachelor or another higher education degree. More than half of the male respondents had normal weight, followed by 50% of the female participants. With regard to walking, around half of the participants were regular walkers for recreation and exercise. Table 1 shows full details of sample characteristics of the respondents based on gender.

As shown in Table 2, the female participants with higher BMI (OR = 1.17; 95% CI = 1.05, 135; $P = .004$) and education (OR = 4.13; 95% CI = 1.35, 12.6; $P = .01$) were more likely to walk recreationally in their neighborhood. Beside this, the female group aged between 31 and 40 was less likely to walk recreationally (OR = 0.39; 95% CI = 0.16, 0.92; $P = .03$). The likelihood of exercise walking among the male participants aged above 50 years old was 8 times more than the other age group (OR = 8.78; 95% CI = 0.96, 79.99; $P = .05$). Moreover, the men with higher BMI were more likely to walk for exercise in their neighborhood (OR = 1.11; 95% CI = 1.01, 1.21; $P = .02$). In addition to men, the female participants who had children in their household were less likely to walk for recreation (OR = 0.47; 95% CI = 0.22, 0.99; $P = .05$) and exercise (OR = 0.46; 95% CI = 0.23, 0.93; $P = .03$).

Table 1 Proportion of reporting for exercise and recreational walking, age, children in household, education and body mass index by gender

Demographic information	Male (%)	Female (%)
Age*		
18 to 30	45.3	59.9
31 to 40	33	24
41 to 50	11.7	13
50 <	10.1	3.1
Children in the household*		
0	44.1	37.4
1 or more	55.9	62.6
Education*		
Diploma or lower	32.4	47.2
Bachelor	51.6	40
Postgraduate	16	12.8
BMI*		
Underweight = < 18.5	6.4	7
Normal weight = 18.5–24.9	63.1	50
Overweight = 25–29.9	30.6	43
Recreational walking		
Any walker	49.2	47.3
Regular walker	50.8	52.7
Exercise walker		
Any walker	42.6	52.2
Regular walker	57.4	47.8

Data was collected in Bandar Abbas from March to May in 2016

*some respondents did not respond to the question

Table 2 Odds ratios and 95% confidence intervals (CI) for selected socio-demographic variables and the likelihood of walking for exercise and recreation by gender

Demographic information	Recreational walking		Exercise walking	
	Odds ratio (95%CI)		Odds ratio (95%CI)	
	Male	Female	Male	Female
Age				
18 to 30	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
31 to 40	0.77 (0.31–1.87)	0.39 (0.16–0.92)*	0.61 (0.23–1.61)	0.76 (0.33–1.72)
41 to 50	1.2 (0.4–3.6)	1.53 (0.47–4.96)	1.25 (0.39–4.01)	1.88 (0.62–5.73)
50 <	3.42 (0.63–18.62)	1.63 (0.88–3.45)	8.78 (0.96–79.99)*	0.68 (0.09–4.90)
Children in the household				
0	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
1 or more	1.04 (0.45–2.29)	0.47 (0.22–0.99)*	1.89 (0.79–4.50)	0.46 (0.23–0.93)*
Education				
Diploma or lower	1.00 (ref)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Bachelor	1.15 (0.51–2.61)	1.57 (0.76–3.25)	1.78 (0.76–4.13)	0.72 (0.36–1.43)
Postgraduate	1.11 (0.42–2.96)	4.13 (1.35–12.60)**	0.64 (0.22–1.80)	1.18 (0.42–3.28)
BMI	1.04 (0.97–1.26)	1.17 (1.05–1.35)**	1.11 (1.01–1.21)*	1.04 (0.86–1.15)*

Data was collected in Bandar Abbas from March to May 2016

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Unadjusted regression for each built environment variable was separately performed. The results showed different association for each type of walking. The female group who obtained a higher safety score walked more for exercise (OR = 1.70; 95% CI = 1.33, 2.16; $P = .002$) and recreation (OR = 2.06; 95% CI = 1.59, 2.67; $P = .001$) in their neighborhoods. In addition, the female respondents who perceived higher aesthetics of neighborhood (OR = 1.46; 95% CI = 1.13, 1.89; $P = .01$) or had a greater number of parks within a radius of 1500 m from their households (OR = 1.3; 95% CI = 1, 1.65; $P = .03$) were more likely to walk recreationally in their neighborhoods. For men, perceiving good facilities in the parks increased the likelihood of exercise walking (OR = 1.78; 95% CI = 1.2, 2.64; $P = .02$) and recreational walking (OR = 1.44; 95% CI = 0.98, 2.1; $P = .04$). In addition to the park facilities, the attractiveness of parks increased the likelihood of exercise walking among male participants (OR = 1.67; 95% CI = 1.2, 2.33; $P = .01$) and female participants (OR = 1.77; 95% CI = 1.31, 2.39; $P = .001$). Proximity to a park played a significant role in promoting exercise walking for both gender groups, but it increased the likelihood of recreational walking only among the female group (OR = 1.30; 95% CI = 1., 1.70; $P = .004$). The results also showed no significant association between the total area of parks within a radius of 1500 m from the participants' household and any exercise or recreational walking. Table 3 presents the results of binary logistic regression analysis for exercise and recreational walking based on gender.

Discussion

In this study, built environment characteristics were measured within a radius of 1500 m from the participants' households. However, the association between these built environment characteristics and exercise or recreational walking was different depending on the participants' gender. Previous studies also showed significant differences in walking patterns resulting from built environment (Su et al. 2014; McCormack et al. 2013; Doescher et al. 2017; Jack and McCormack 2014). However, a few studies considered leisure-time walking patterns based on gender (Humpel et al. 2004; Su et al. 2014; Kramer et al. 2013). The findings revealed that perceiving high built environment characteristics is more likely to increase walking activity among females than males. The differences between the two genders may result from disparity in walking patterns (Pollard and Wagnild 2017) or differences in individual attitudes between men and women (Miller and Brown 2005). Perceiving higher aesthetic quality of neighborhood increased the probability of recreational walking among the female respondents (Su et al. 2014), whereas access to greater facilities was more likely to promote walking among the male participants.

Women who felt safer were more likely to walk in their neighborhoods. This result is consistent with the findings of previous studies which clarified that safety was a greater concern for women than men (Chadee et al. 2006; Paydar et al. 2017). In addition, measuring physical

Table 3 Unadjusted regression for exercise and recreational walking based on gender

Neighborhood level	Recreational walking		Exercise walking	
	Odds ratio (95%CI)		Odds ratio (95%CI)	
	Male	Female	Male	Female
Perceived environment				
Neighborhood safety	0.86 (0.66–1.12)	2.06 (1.59–2.67)***	1.26 (0.96–1.64)	1.70 (1.33–2.16)***
Neighborhood aesthetics	1.22 (0.92–1.61)	1.46 (1.13–1.89)**	0.93 (0.71–1.23)	1.27 (0.99–1.63)
Park facilities	1.44 (0.98–2.10)*	1.79 (1.26–2.54)***	1.78 (1.20–2.64)*	1.60 (1.13–2.25)
Park attractiveness	1.69 (1.26–2.28)	1.72 (1.24–2.40)	1.67 (1.20–2.33)**	1.77 (1.31–2.39)***
Proximity to park	0.87 (0.64–1.17)	1.30 (1.0–1.70)*	1.48 (1.08–2.02)*	1.32 (1.01–1.73)*
Objective measurements				
Number of parks	1.03 (0.95–1.12)	1.3 (1.0–1.65)*	1.02 (0.85–1.01)	1.02 (0.94–1.11)
Park size	0.83 (0.61–1.12)	1.24 (1.10–2.05)	0.96 (0.81–1.18)	1.08 (0.96–1.21)

Data was collected in Bandar Abbas from March to May 2016

Each item was assessed in a separate model. In total, 14 models were run

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

activity objectively also revealed perception of safety as a big concern for female walkers (Bennett et al. 2007). Even though the findings did not show any association between perceived safety and any walking among men, the role of safety in promoting walking for general adult's population cannot be ignored. This could be due to a perception of a high level of safety among the participants of the present study. Proximity to parks also increased the probability of exercise walking among both gender groups, which was in line with the results of the previous studies (Van Dyck et al. 2013; Baran et al. 2016). The inconsistent link between recreational walking and proximity for the male group can be due to men's habit of this type of walking (Lovasi et al. 2008). Usually people walk recreationally to enjoy, relax, or socialize; hence, distance can be less important than other characteristics. As found in the previous studies, people may walk further for recreation rather than other types of walking (Yang and Diez-Roux 2012) or due to the differences between individual attributes of gender groups. Women usually spend more time at home to do house work or take care of children, and they can perform recreational walking as part of taking children to the parks. Hence, females prefer to take shorter walking distances that take less time. This statement could also support the findings of the study which revealed that the presence of a higher number of parks increased walking among the female group, because it may increase the proximity of residents to parks and create more various destinations for users which is in disagreement with the findings of the previous study (Kaczynski et al. 2014). This inconsistency of findings may result from concentration of this study on specific patterns of walking.

The present study also found a positive association between park aesthetics and exercise walking for both gender groups, which is in agreement with previous studies (Bai et al. 2013; Sallis et al. 2006). However, no association was discovered between park aesthetics and recreational walking. This could be due to the fact that this activity mostly happens in parks (Lee 2004; Cohen et al. 2007), and due to the fast redevelopment of the city, the sidewalks of the neighborhoods in the city have been narrowed for the sake of easier vehicle use, leading to a decrease in facilities and amenities for walking in neighborhood streets. With regard to the size of parks, the study found no link between the total size of parks around the participant's households and any type of walking which is also in agreement with the results of the previous studies (Schipperijn et al. 2013). This finding proves that there may be more important factors than size in promoting walking activity, or that size may not be the primary feature of parks in encouraging people to do physical activity.

Findings of the study also revealed the association of sociodemographic variables with walking behaviors. Those respondents who were reported to have higher BMI were more likely to walk for exercise in their neighborhoods. In addition, the female respondents with higher BMI were more likely to walk for recreation in their areas, which is in line with a previous study (Van Dyck et al. 2013). In addition, the presence of children in the households decreased the likelihood of walking in the female group, which may be due to women having restricted time which might delay the feasibility of walking and eventually highly influence an individual's decision to

walk (Dieleman et al. 2002; Miller and Brown 2005). Furthermore, the findings revealed the association of walking with education and age groups, which should be considered and evaluated in future studies.

With regard to the scope and limitation of this study, it is necessary to draw attention to the following points. First of all, the researchers considered only perceived built environment measurements, while it is also important to use variables in objective measurement of the built environment, as found in the previous Iranian case studies, which showed considerable differences between objective and subjective measurement of urban qualities (Lotfi and Koohsari 2009). Secondly, the study considered four neighborhoods in one city, which may limit the generalization of the findings to other cities in the country. Iran is a large country with different urban planning and geographical varieties, which may influence perceiving built environment or walking behavior.

Conclusion

This study attempted to compensate for the paucity of multilevel research on evaluating the influence of neighborhood built environment factors on specific types of walking. In addition, this study tried to add evidence to the growing body of knowledge with regard to the correlation between built environment and walking behavior. The study highlighted how park characteristics including proximity, aesthetic, and facilities can contribute to walking behavior; moreover, it is suggested that the effect of built environment on walking pattern varies depending on gender. With regard to the findings, it is proposed that environment has different effects on the reasons why people walk. Hence, the study suggests that urban planners and designers as well as public health promoters need to strongly consider the contribution of neighborhoods' built environment variables as well as socio-demographic variables to promoting walking behavior changes among adult population.

Acknowledgements This research was performed as a part of the PhD thesis of the author. I would like to express my sincere gratitude to my advisor Dr. Norsidah Ujang for sharing her pearls of wisdom with me during the course of this research.

Funding This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

Human and animal rights and informed consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Apparicio P, Abdelmajid M, Riva M, Shearmur R (2008) Comparing alternative approaches to measuring the geographical accessibility of urban health services: distance types and aggregation-error issues. Int J Health Geogr 7(1):7. https://doi.org/10.1186/1476-072X-7-7

Armstrong T, Bauman AE, Davies J (2000) Physical activity patterns of Australian adults: results of the 1999 National Physical Activity Survey. Australian Institute of Health and Welfare, Canberra

Bahrami H, Sadatsafavi M, Pourshams A, Kamangar F, Nouraei M, Semnani S, et al (2006) Obesity and hypertension in an Iranian cohort study; Iranian women experience higher rates of obesity and hypertension than American women. BMC Public Health 6: 158. https://doi.org/10.1186/1471-2458-6-158

Bai H, Stanis SAW, Ph D, Kaczynski AT, Ph D, Besenyi GM (2013) Perceptions of neighborhood park quality: associations with physical activity and body mass index. Ann Behav Med 45:39–48. https://doi.org/10.1007/s12160-012-9448-4

Ball K, Bauman A, Leslie E, Owen N (2001) Perceived environmental aesthetics and convenience and company are associated with walking for exercise among Australian adults. Prev Med 33:434–440. https://doi.org/10.1006/pmed.2001.0912

Baran PK, Smith WR, Moore RC, Floyd MF, Bocarro JN, Cosco NG et al (2016) Park use among youth and adults. Environ Behav 46(6):768–800. https://doi.org/10.1177/0013916512470134

Bennett G, McNeill L, Wolin K, Duncan D, Puleo E, Emmons K (2007) Safe to walk? Neighborhood safety and physical activity among public housing residents. PLoS Med 4(10):1599–1606

Centers for Disease Control and Prevention (2012) Behavioral Risk Factor Surveillance System (BRFSS) questionnaire 2012. National Center for Chronic Disease Prevention and Health Promotion, Atlanta GA, 64 pp

Chadee D, Austen L, Ditton J (2006) The relationship between likelihood and fear of criminal victimization: evaluating risk sensitivity as a mediating concept. Br J Criminol 47(1):133–153. https://doi.org/10.1093/bjc/azl025

Cohen DA, McKenzie TL, Sehgal A, Williamson S, Golinelli D, Lurie N (2007) Contribution of public parks to physical activity. Am J Public Health 97(3):509–514. https://doi.org/10.2105/AJPH.2005.072447

Dieleman FM, Dijst M, Burghouwt G (2002) Urban form and travel behaviour: micro-level household attributes and residential context. Urban Stud 39(3):507–527. https://doi.org/10.1080/00420980220112801

Doescher MP, Lee C, Saelens BE, Lee C, Berke EM, Adachi-Mejia AM et al (2017) Utilitarian and recreational walking among Spanish- and English-speaking Latino adults in Micropolitan US towns. J Immigr Minor Heal 19(2):237–245. https://doi.org/10.1007/s10903-016-0383-5

Eyre H, Kahn R, Robertson RM, Clark NG, Doyle C, Hong Y et al (2004) Preventing cancer, cardiovascular disease, and diabetes: a common agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association. Circulation 109(25):3244–3255. https://doi.org/10.1161/01.cir.0000133321.00456.00

Hosler AS, Gallant MP, Riley-Jacome M, Rajulu DT (2014) Relationship between objectively measured walkability and exercise walking

among adults with diabetes. J Environ Public Health 2014:1–6. https://doi.org/10.1155/2014/542123

Hovell MF, Sallis JF, Hofstetter CR, Spry VM, Faucher P, Caspersen CJ (1989) Identifying correlates of walking for exercise: an epidemiologic prerequisite for physical activity promotion. Prev Med 18(6): 856–866. https://doi.org/10.1016/0091-7435(89)90021-2

Hovell MF, Hofstetter CR, Sallis JF, Rauh MJD, Barrington E (1992) Correlates of change in walking for exercise: an exploratory analysis. Res Q Exerc Sport 63(4):425–434. https://doi.org/10.1080/02701367.1992.10608765

Humpel N (2002) Environmental factors associated with adults' participation in physical activity a review. Am J Prev Med 22(3):188–199. https://doi.org/10.1016/s0749-3797(01)00426-3

Humpel N, Marshall AL, Leslie E, Bauman A, Owen N (2004) Changes in neighborhood walking are related to changes in perceptions of environmental attributes. Ann Behav Med 27(1):60–67. https://doi.org/10.1207/s15324796abm2701_8

Jack E, McCormack GR (2014) The associations between objectively-determined and self-reported urban form characteristics and neighborhood-based walking in adults. Int J Behav Nutr Phys Act 11(1):71. https://doi.org/10.1186/1479-5868-11-71

Kaczynski AT, Besenyi GM, Stanis SAW, Koohsari MJ, Oestman KB, Bergstrom R et al (2014) Are park proximity and park features related to park use and park-based physical activity among adults? Variations by multiple socio-demographic characteristics. Int J Behav Nutr Phys Act 11(1):146. https://doi.org/10.1186/s12966-014-0146-4

King WC, Brach JS, Belle S, Killingsworth R, Fenton M, Kriska AM (2003) The relationship between convenience of destinations and walking levels in older women. Am J Health Promot 18(1):74–82. https://doi.org/10.4278/0890-1171-18.1.74

Kramer D, Maas J, Wingen M, Kunst AE (2013) Neighbourhood safety and leisure-time physical activity among Dutch adults: a multilevel perspective. Int J Behav Nutr Phys Act 10(1):11. https://doi.org/10.1186/1479-5868-10-11

Lee C (2004) Physical activity and environment research in the health field: implications for urban and transportation planning practice and research. J Plan Lit 19(2):147–181. https://doi.org/10.1177/0885412204267680

Lee C, Moudon AV (2006) Correlates of walking for transportation or recreation purposes. J Phys Act Health 3:77–98. https://doi.org/10.1016/j.trd.2006.02.003

Li F (2005) Multilevel modelling of built environment characteristics related to neighbourhood walking activity in older adults. J Epidemiol Community Health 59(7):558–564. https://doi.org/10.1136/jech.2004.028399

Lotfi S, Koohsari MJ (2009) Analyzing accessibility dimension of urban quality of life: where urban designers face duality between subjective and objective reading of place. Soc Indic Res 94(3):417–435. https://doi.org/10.1007/s11205-009-9438-5

Lovasi GS, Moudon AV, Pearson AL, Hurvitz PM, Larson EB, Siscovick DS et al (2008) Using built environment characteristics to predict walking for exercise. Int J Health Geogr 7(1):10. https://doi.org/10.1186/1476-072X-7-10

McCormack GR, Friedenreich CM, Giles-Corti B, Doyle-Baker PK, Shiell A (2013) Do motivation-related cognitions explain the relationship between perceptions of urban form and neighborhood walking? J Phys Act Health 10(7):961–973. https://doi.org/10.1123/jpah.10.7.961

Miller YD, Brown WJ (2005) Determinants of active leisure for women with young children—an "ethic of care" prevails. Leis Sci 27(5): 405–420. https://doi.org/10.1080/01490400500227308

Momenan AA, Delshad M, Mirmiran P, Ghanbarian A, Azizi F (2011) Leisure time physical activity and its determinants among adults in Tehran: Tehran Lipid and Glucose Study. Int J Prev Med 2(4):243–251. https://doi.org/10.5888/pcd10.120194

Nehme EK, Oluyomi AO, Calise TV, Kohl HW (2016) Environmental correlates of recreational walking in the neighborhood. Am J Health Promot 30(3):139–148. https://doi.org/10.4278/ajhp.130531-QUAN-281

Paydar M, Kamani-Fard A, Etminani-Ghasrodashti R (2017) Perceived security of women in relation to their path choice toward sustainable neighborhood in Santiago, Chile. Cities 60:289–300. https://doi.org/10.1016/j.cities.2016.10.002

Pollard TM, Wagnild JM (2017) Gender differences in walking (for leisure, transport and in total) across adult life: a systematic review. BMC Public Health 17(1):341. https://doi.org/10.1186/s12889-017-4253-4

Saelens BE, Sallis JF, Black JB, Chen D (2003) Neighborhood-based differences in physical activity: an environment scale evaluation. Am J Public Health 93(9):1552–1558. https://doi.org/10.2105/AJPH.93.9.1552

Sallis JF, Johnson MF, Calfas KJ, Caparosa S, Nichols JF (1997) Assessing perceived physical environmental variables that may influence physical activity. Res Q Exerc Sport 68(4):345–351. Available from: http://www.tandfonline.com/doi/abs/10.1080/02701367.1997.10608015

Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J (2006) An ecological approach to creating active living communities. Annu Rev Public Health 27(1):297–322. https://doi.org/10.1146/annurev.publhealth.27.021405.102100

Sallis J, Owen N, Fisher E (2008) Ecological models of health behavior. In: Glanz K, Rimer B, Viswanath K (eds) Health behavior and health education: theory, research, and practice, 4th edition. Jossey-Bass, San Francisco, pp 465–485

Sallis JF, Floyd MF, Rodríguez DA, Saelens BE (2012) Role of built environments in physical activity, obesity, and cardiovascular disease. Circulation 125(5):729–737. https://doi.org/10.1161/circulationaha.110.969022

Schipperijn J, Bentsen P, Troelsen J, Toftager M, Stigsdotter UK (2013) Associations between physical activity and characteristics of urban green space. Urban For Urban Green 12(1):109–116. https://doi.org/10.1016/j.ufug.2012.12.002

Sheikholeslam R, Mohamad A, Mohammad K, Vaseghi S (2004) Non communicable disease risk factors in Iran. Asia Pac J Clin Nutr 13(Suppl 2):S100

Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD (2006) Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association. Diabetes Care 29(6):1433–1438. https://doi.org/10.2337/dc06-9910

Su M, Tan YY, Liu QM, Ren YJ, Kawachi I, Li LM et al (2014) Association between perceived urban built environment attributes and leisure-time physical activity among adults in Hangzhou, China. Prev Med 66:60–64. https://doi.org/10.1016/j.ypmed.2014.06.001

Sugiyama T, Leslie E, Giles-Corti B, Owen N (2009) Physical activity for recreation or exercise on neighbourhood streets: associations with perceived environmental attributes. Health Place 15(4):1058–1063. https://doi.org/10.1016/j.healthplace.2009.05.001

Sugiyama, T., Giles-Corti, B., Summers, J., du Toit, L., Leslie, E., & Owen, N. (2013). Initiating and maintaining recreational walking: A longitudinal study on the influence of neighborhood green space. Preventive Medicine, 57(3), 178–182. https://doi.org/10.1016/j.ypmed.2013.05.015

Sugiyama T, Cerin E, Owen N, Oyeyemi AL, Conway TL, Van Dyck D et al (2014) Perceived neighbourhood environmental attributes

associated with adults? Recreational walking: IPEN adult study in 12 countries. Health Place 28:22–30. https://doi.org/10.1016/j.healthplace.2014.03.003

Sugiyama T, Gunn LD, Christian H, Francis J, Foster S, Hooper P et al (2015) Quality of public open spaces and recreational walking. Am J Public Health 105(12):2490–2495. https://doi.org/10.2105/AJPH.2015.302890

Sugiyama T, Giles-Corti B, Summers J, du Toit L, Leslie E, Owen N (2017) Initiating and maintaining recreational walking: a longitudinal study on the influence of neighborhood green space. Prev Med 57(3):178–182. https://doi.org/10.1016/j.ypmed.2013.05.015

Troped PJ, Saunders RP, Pate RR, Reininger B, Addy CL (2003) Correlates of recreational and transportation physical activity among adults in a New England community. Prev Med 37(4):304–310. https://doi.org/10.1016/S0091-7435(03)00137-3

Van Dyck D, Cerin E, Conway TL, De Bourdeaudhuij I, Owen N, Kerr J et al (2013) Perceived neighborhood environmental attributes associated with adults' leisure-time physical activity: findings from Belgium, Australia and the USA. Health Place 19(1):59–68. https://doi.org/10.1016/j.healthplace.2012.09.017

Van Lenthe FJ, Brug J, MacKenbach JP (2005) Neighbourhood inequalities in physical inactivity: the role of neighbourhood attractiveness, proximity to local facilities and safety in the Netherlands. Soc Sci Med 60(4):763–775. https://doi.org/10.1016/j.socscimed.2004.06.013

World Health Organization (2002) The World Health Report 2002: reducing risks, promoting healthy life. WHO, Geneva

Yang Y, Diez-Roux AV (2012) Walking distance by trip purpose and population subgroups. Am J Prev Med 43(1):11–19. https://doi.org/10.1016/j.amepre.2012.03.015