	がある」と回答する者の割合を増やす、など		・日常的なウォーキングのマップ作製
歩行の安全に関する目標	「自宅近隣は交通事故の危険が少なく、安全に歩くことができる」と回答する者の割合を増やす	将来的	・危険個所の調査、マップ作製、整備 ・WHO のプログラムであるセーフコミュニティとの協働
自転車の安全に関する目標	「自宅近隣は交通事故の危険が少なく、安全に自転車に乗ることができる」と回答する者の割合を増やす	将来的	・通学路、よく利用される道路など、優先順位の高い個所を同定して整備する
幼児の遊び場に関する目標	「自宅周辺に、幼児の、利用しやすく、安全な遊び場所がある」と回答する親の割合を増やす	将来的	・交通規制によって生活道路の安全性を高める ・既存の公園、遊び場、学校等の整備 ・安心して子供が遊べる公園・広場等になるように整備する
児童の遊び場に関する目標	「自宅周辺に、小学生の、利用しやすく、安全な遊び場所がある」と回答する親の割合を増やす	将来的	
その他の環境要因に関する目標	「日常のちょっとした買い物は、自宅から歩いて行ける範囲で済ませることができる」と回答する者の割合を増やす、「自宅近隣は歩道が良く整備されている」と回答する者の割合を増やす、「掃除が行き届き、街並みや景観がきれいだ」と回答する者の割合を増やす、など	将来的	・環境要因に関する研究の推進 ・景観改善の工夫と、その効果の検討 ・優先的に整備すべき歩道の同定
行動レベル			
活動的な通勤に関する目標	活動的な交通手段（徒歩、自転車等）を使って通勤する者の割合を増やす	高い	・活動的な通勤・通学・買い物に関する調査（国民健康・栄養調査、あるいはパーソントリップ調査） ・モビリティマネジメントとの協働 ・歩道・自転車道の整備 ・駐輪場の整備
活動的な通学に関する目標	活動的な交通手段（徒歩、自転車等）を使って通学する者（児童、生徒）の割合を増やす	高い	
活動的な交通手段を用いた買い物に関する目標	活動的な交通手段（徒歩、自転車等）を使って買い物する者の割合を増やす	将来的	
散歩・ウォーキングに関する目標	散歩・ウォーキングを実施する者の割合を増やす	将来的	・ウォーキングマップ等の作成 ・ウォーキングできる場所の整備 ・ウォーキングに着目した対策・プログラム・イベント

目標設定の実現性：目標達成の実現性ではなく、目標として設定するための根拠、状況が整っているかどうかを表わしている。「高い」とは具体的な目標設定を行える可能性が高い項目、「将来的」とは将来に向けて具体的な設定方法を検討すべき目標項目である。目標設定の実現性を高めるためには、その目標を達成することの重要性を明らかにすること、目標の測定方法を確立すること、達成するための具体的な方策がある程度示されること、省庁横断的な目標の場合には連携体制を整えること、などが必要である。

表 2　健康づくりのための食環境整備の枠組みと具体的な項目

(2011 試見案)

レベル		食物へのアクセス(フードシステム)		情報へのアクセス(健康・食情報システム)	
		物理的環境 Physical environment	経済的環境 Economic environment	社会的環境 Social environment	情報環境 Information environment
個人・家族 (Family,home)		栄養バランスのとれた食物へのアクセシビリティ(自力で買い物可能か？)	世帯収入	家族・友人の支援(サポート)	
			くらし向き(ゆとり感)	家族や友人からの栄養・食情報の入手	
組織: (Oraganizational : School, Worksite)		組織内における栄養バランスのとれた食物の入手可能性(食堂、売店、自動販売機など)	食品の価格	友人や同僚の食に関する意識・規範	学校の食堂、社員食堂、売店等で提供される食物への栄養成分表示
			販売促進		
近隣・地域 (Neighborhood, Community)		栄養バランスのとれた食物の入手可能性		食物入手が困難な住民への自治会等による支援	
		食料品店の分布と販売品目	食品の価格	お裾分けなど、互いに食べ物を気軽に交換し合う関係	食や栄養をテーマとした取組み(教室、イベントなど)の実施
		飲食店、ファーストフード店の分布	販売促進	食の文化や伝統、季節性などを大事にしようという社会規範	飲食店や食品売り場、外食施設における栄養成分表示
				食の安全面で信頼できる店や生産者の存在	地域の広報、ミニコミ誌、ケーブルテレビなどからの正しい栄養・食情報の提供
社会・政策 (Policy, Economy)	メディア				メディア(テレビ、新聞、雑誌、インターネットなど)からの正しい栄養・食情報の提供
	企業	栄養バランスのとれた商品の拡大・提供	入手しやすい価格設定		食品企業等の広告
	行政	食品の安全性確保の制度・法整備	食料不安(food insecurity)への対応(制度、施策)		栄養・食に関する啓発普及事業の実施 栄養表示に関する制度・法整備

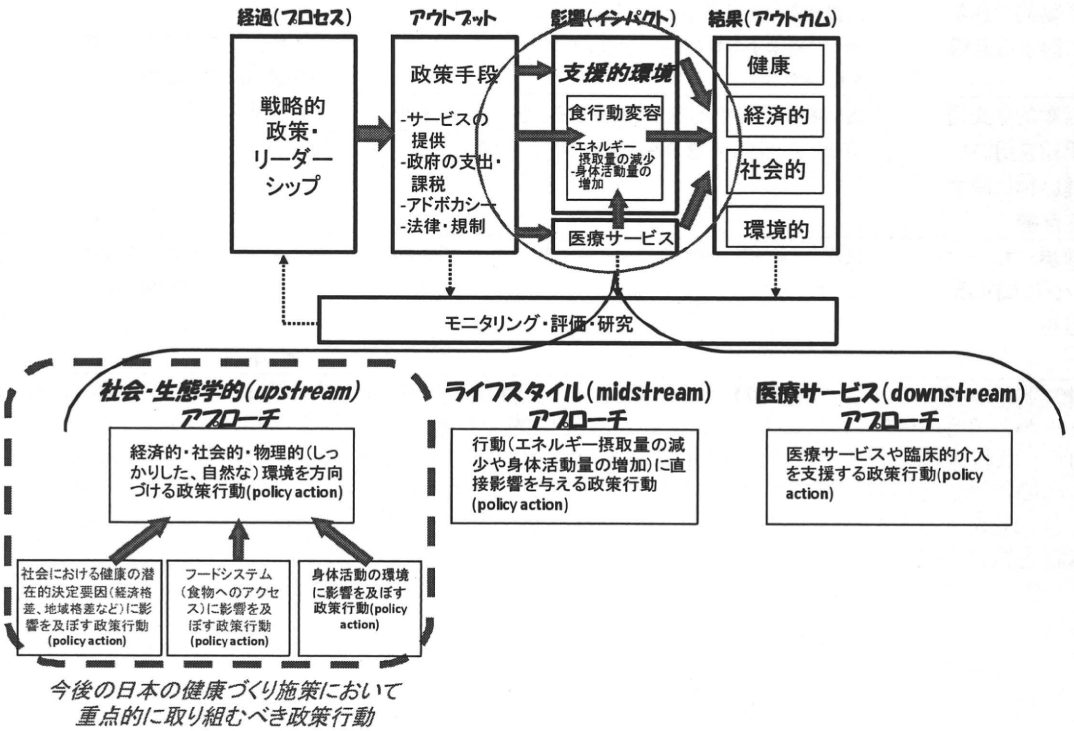

図 2　肥満に関する政策行動(policy action)の枠組み:
'upstream', 'midstream', 'downstream'の各政策ターゲットの分類[7]に、一部加筆

表 3：喫煙対策の実施状況を評価する自己点検票の内容

たばこ対策の領域	市町村版	都道府県版
受動喫煙の防止	官公庁（市役所、議会庁舎等の場所別） 学校（市町村立幼稚園等の校種別）	官公庁、学校（都道府県立、私立、大学等）、医療機関、職場（民間職場）、飲食店、公共交通機関（鉄道、バス、タクシー）
禁煙支援・治療	健診等の保健事業における取組み （母子健康手帳交付時、国保の特定健診等） たばこ対策事業としての取組み （禁煙治療や補助剤への費用補助等） 禁煙治療へのアクセス （人口・面積あたり、禁煙治療・OTC薬*別）	
喫煙防止	喫煙防止のための委員会の設置 学校における喫煙防止教育の実施状況 （市町村立小・中・高の校種別に把握） たばこ販売へのアクセス （人口・面積あたり、コンビニエンスストア・自動販売機別）	学校における喫煙防止教育の実施状況 （都道府県立高校、私立中・高の校種別に把握）
情報提供・教育啓発	講演会・セミナー等の実施、ホームページ・広報誌で情報を提供、等	
たばこ対策の推進体制	喫煙率減少の数値目標の設定 たばこ対策推進のための委員会の設置 たばこ対策担当者・専従体制 たばこ対策予算	喫煙率減少の数値目標の設定 たばこ対策推進のための委員会の設置 たばこ対策担当者・専従体制 たばこ対策予算

* 禁煙補助剤として薬局・薬店で市販されている薬剤。ニコチンガムとニコチンパッチの2種類がある。

表 4：今後の喫煙対策環境整備の重要課題

1. たばこ事業法の改廃
2. たばこ税の大幅引き上げの実現
3. 屋内全面禁煙を義務付ける法規制の強化
4. 禁煙支援・治療にかかわる環境整備
   - 健診の場での禁煙勧奨・支援の制度化
   - 無料の禁煙電話相談（Quitline）の整備
5. 国・自治体レベルでの環境整備のモニタリング

Ⅲ. 研究成果の刊行に関する一覧表

Ⅲ.研究成果の刊行に関する一覧表

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Inoue S, Ohya Y, Shimomitsu T, et al	Association between Perceived Neighborhood Environment and Walking among Adults in 4 Cities in Japan	J Epidemiol	20(4)	277-286	2010
石井香織、井上茂、下光輝一、他	日本人成人における健康増進に寄与する推奨身体活動の充足に関連する自宅近隣の環境要因	日本健康教育学会誌	18(2)	115-125	2010
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岡田真平、井上茂、鎌田真光、下光輝二、他	チェックリスト方式による身体活動環境評価の有用性—長野県東御市の行政職員による環境評価—	運動疫学研究			In press
齋藤義信、小熊祐子、井上茂、他	移動および余暇の歩行行動に関連する環境要因－藤沢市在住の60～69歳を対象とした横断研究－	運動疫学研究			In press
Tudor-Locke C, Craig CL, Inoue S, et al	How Many Steps/day are Enough? For Adults	Int J Behav Nutr Phys Act.			In press
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Ⅳ. 研究成果に関する刊行物・別冊

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Original Article

Association between Perceived Neighborhood Environment and Walking among Adults in 4 Cities in Japan

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ABSTRACT

Background: Recent research highlights the importance of environment as a determinant of physical activity; however, evidence among Japanese is sparse. The aim of this study was to examine the association between perceived neighborhood environment and neighborhood walking for multiple purposes among Japanese.

Methods: We conducted a population-based, cross-sectional study of 1461 Japanese adults (age: 48.2 ± 14.1 years, men: 44.8%). Neighborhood environment and walking were assessed by a validated questionnaire. The odds ratio of active walkers was calculated in relation to environmental characteristics after adjustment for age, sex, and other potential confounders.

Results: Participants were more likely to walk when they perceived that there was high residential density (odds ratio, 1.47; 95% confidence interval, 1.11–1.96), fair land use mix–diversity (1.37, 1.04–1.81), good walking/cycling facilities (1.56, 1.19–2.04), and attractive aesthetics (1.49, 1.14–1.95). Environmental factors associated with walking differed with respect to the purpose for walking. The environmental characteristics associated with walking for daily errands and with walking for commuting were similar, and included residential density and land use mix. Walking for leisure was associated with walking/cycling facilities, aesthetics, and traffic safety. Stratified analyses showed some sex-specific associations. Among women, there was an unexpected inverse association of leisure walking with both residential density and land use mix–diversity.

Conclusions: The association between neighborhood environment and walking differed by walking purpose. The results were generally consistent with those of studies conducted in Western countries, except for the association of high residential density and good land use mix–diversity with less leisure walking in women. These results suggest possible targets for environmental interventions to promote walking.

Key words: active transport; neighborhood environment; physical activity; policy; walking

INTRODUCTION

Regular physical activity reduces the risk of mortality, and the incidence of cardiovascular diseases, diabetes, and some cancers.[1–3] However, a large part of the population is not physically active in Japan and in many other countries.[4,5] Thus, physical activity promotion is a public health priority.[6] Data on physical activity determinants and correlates are needed as a basis for developing effective interventions. Many studies have focused on individual demographics and psychobehavioral factors.[7] However, recent progress in research suggests that certain environmental characteristics, such as residential density, access to destinations, walking facilities, aesthetics, safety, and access to exercise facilities are related to physical activity.[7–13] Interventions that target individuals have only a minimal impact on the physical activity levels of whole populations[14,15]; however, changes to the environment are believed to have a long-term and substantial impact.[16]

Although there is accumulating evidence on the association between physical activity and environment, the relevant studies have been mostly limited to Western countries, in particular the United States and Australia[12]; only a few have been undertaken in Japan.[17–19] Evidence from study settings—including Japan—where the environment, culture, and physical activity patterns differ from those of Western

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countries, is thus valuable. Indeed, evidence from Japan could support or refute the generalizability of previous studies conducted in Western countries, and/or add new findings regarding associations between environment and physical activity. Also, data from Japanese are needed for the development of physical activity interventions in Japan.

We previously reported associations of environment with physical activity, using a convenience sample of Japanese adults.[18] In that previous study, environmental characteristics were associated with physical activity, but the findings were limited by the use of simple measures that could not differentiate the purposes for walking. In the present cross-sectional study, we used a random community sample from 4 Japanese cities and measured walking as the outcome. Because environmental correlates are specific to the type and purpose of physical activity,[11,20] the aim of this study was to examine environmental correlates of neighborhood walking and its components, including walking for daily errands, walking for leisure, and commuting on foot.

METHODS

Participants and data collection

This cross-sectional study was conducted from February 2007 through January 2008. A total of 4000 residents aged 20 to 69 years and living in 4 Japanese cities (Koganei, Tsukuba, Shizuoka, Kagoshima) were randomly selected from the registry of residential addresses and stratified by sex, age (20–29, 30–39, 40–49, 50–59, and 60–69 years), and city of residence, so that the sample included 2000 subjects of each sex, 800 subjects of each age category, and 1000 subjects from each city. As a result, the addresses of 100 subjects of a specific sex, a specific age category, and a specific city were obtained. Four cities were chosen so as to include various environmental conditions. Koganei is in the Tokyo metropolitan area and Tsukuba is a university town located 50 km northeast of Tokyo. Shizuoka and Kagoshima are located in central and western Japan, respectively, and are the capital cities of prefectures that include both urban and relatively rural areas. For data collection, a questionnaire was sent to and collected from participants via postal mail. To increase the response rate, invitation letters that described the content of the study were sent to all 4000 subjects 2 weeks before the survey. During the survey period, a call center was established to answer the questions of the subjects. Nonrespondents were mailed 2 additional requests to join the survey. If a participant submitted an incomplete survey, we asked that the survey be completed again. Ultimately, of the 4000 subjects identified, 1508 (37.7%) responded to the survey. After data cleaning, valid data were obtained from 1461 participants (final response rate: 36.5%). All participants signed an informed consent document before answering the questionnaire, and the study received prior approval from the Tokyo Medical University Ethics Committee.

Assessment of perceived neighborhood environment

On the self-administered questionnaire, the Neighborhood Environment Walkability Scale–Abbreviated Japanese Version (NEWS–AJ) was used as the environmental measure.[21–23] The NEWS questionnaire was originally developed in the United States to evaluate several neighborhood environmental factors believed to be related to physical activity undertaken for multiple purposes. It has been used in various countries.[24–26] The NEWS–AJ consists of 54 questions that assess 8 neighborhood environmental factors: (1) residential density, (2) land use mix–diversity, (3) land use mix–access, (4) street connectivity, (5) walking and cycling facilities, (6) aesthetics, (7) traffic safety, and (8) crime safety. Several of these factors are related to the concept of walkability, which is the ability to walk from one's home to nearby destinations. "Neighborhood" in this questionnaire meant the area within a 15-minute walk from a participant's residence. A sample of the questions used is shown in the Appendix. Scores on the 8 subscales were calculated by using a standardized scoring manual.[27] Higher scores indicate a more favorable environment for walking. The score for residential density was calculated as the sum of the weighted score of 5 items.[27] Land use mix–diversity was based on the reported walking distance to a list of 23 possible destinations, including shops, services, and recreation facilities. As for the other variables, scores were estimated as the mean of scale items that used a 4-point rating scale (1 = strongly disagree, 4 = strongly agree), including reverse coding of selected items. The psychometric properties of the questionnaire and the process by which it was translated into Japanese were reported in a previous study.[23] The test–retest reliabilities of the 8 subscales were from $r = 0.76$ to $r = 0.96$.

Assessment of walking

For the assessment of physical activity, a self-administered questionnaire was used. The questionnaire asked participants about their walking frequency (days/week), and average walking duration each day (min/day), with respect to 6 purposes: walking for daily errands, walking for leisure, commuting on foot to work, commuting on foot to school, walking during work, and walking for other purposes. The questionnaire instructed participants to consider all walks that involved at least 5 minutes of continuous activity. Walking time (min/week) was calculated as the product of walking frequency and duration. In this study, 4 variables were examined: (1) neighborhood walking (sum of the duration of 4 types of walking, walking for daily errands, walking for leisure, commuting on foot to work, and commuting on foot to school, min/week), and 3 specific types of walking, namely, (2) walking for daily errands (min/week), (3) walking for leisure (min/week), and (4) commuting on foot to work (min/week). We examined these 3 specific types of walking because they were expected to occur in the participant's neighborhood.

Although commuting to school was also expected to occur in the neighborhood, we excluded this variable from the specific analyses because the present sample included only 31 participants (2.1%) who walked to school. The Spearman correlation coefficient between total walking time (the sum of 6 types of walking time) calculated from the questionnaire and step counts per day, as assessed by accelerometer in a part of the present study sample ($n = 783$), was 0.30 ($P < 0.001$).

Sociodemographic and other variables

The sex and age of each participant were obtained from the registry of residential addresses of each city. Information on employment status, years of education, height, weight, and self-rated health was obtained by self-report. Body mass index (BMI) was calculated from self-reported weight and height. Self-rated health was measured with a single item that asked participants to rate their health: participants chose the most suitable answer from a 5-point scale—excellent, very good, good, fair, and poor—for the statement, "In general, would you say that your health is...?".

Statistical analyses

To examine the association between the neighborhood environment as the independent variable and walking as the dependent variable, odds ratios for active walkers were calculated using logistic regression models. For the analysis, the scores for the 8 environmental variables were converted into tertiles (high/middle/low for residential density and good/fair/poor for the other 7 variables). For each of the 4 walking variables, participants were classified into 2 groups. For neighborhood walking, participants were divided into 2 groups by using the median: ≤90 min/week or >90 min/week. Regarding walking for daily errands, walking for leisure, and commuting on foot to work, the proportions of participants who reported walking for these purposes were less than 50%. Thus, participants were divided into 2 groups for each of these purposes: those who walked for a given purpose and those who did not. In the analyses of commuting on foot to work, we used data only from employed participants ($n = 1083$). To calculate odds ratios, the environmental factors expected to be associated with lower levels of walking were used as references ("low" for residential density and "poor" for the other 7 variables), ie, an odds ratio higher than 1.00 indicates the association of an activity-supportive environmental characteristic with active walking. Odds ratios were adjusted by age, sex, location of residence, employment status, educational level, BMI, and self-rated health. Statistical significance was considered to be present when $P < 0.05$. All analyses were conducted by using SPSS version 15.0 for Windows (SPSS Inc., Tokyo, Japan).

RESULTS

Table 1 shows the characteristics of the participants. In the overall sample, 44.8% were men. The mean age ± standard deviation (SD) was 48.2 ± 14.1 years. The sample included participants of Tsukuba (25.1%), Koganei (26.9%), Shizuoka (26.1%), and Kagoshima (21.9%). The proportion of overweight participants (BMI ≥25 kg/m^2) was 26.5% of men and 12.4% of women. The proportions of participants who

Table 1. Characteristics of participants

	Overall $n = 1461$		Men $n = 654$		Women $n = 807$	
	n	%	*n*	%	*n*	%
Age, years						
≤29	221	15.1	82	12.5	139	17.2
30–39	212	14.5	84	12.8	128	15.9
40–49	307	21.0	136	20.8	171	21.2
50–59	327	22.4	160	24.5	167	20.7
60+	394	27.0	192	29.4	202	25.0
mean ± SD	48.2 ± 14.1		49.6 ± 13.7		47.1 ± 14.3	
Location of residence						
Tsukuba	366	25.1	177	27.1	189	23.4
Koganei	393	26.9	172	26.3	221	27.4
Shizuoka	382	26.1	168	25.7	214	26.5
Kagoshima	320	21.9	137	20.9	183	22.7
Education, years						
≤12	600	41.1	268	41.0	332	41.1
13+	861	58.9	386	59.0	475	58.9
Employment status						
Employed	1083	74.1	559	85.5	524	64.9
Not employed	378	25.9	95	14.5	283	35.1
BMI, kg/m^2						
≥25	273	18.7	173	26.5	100	12.4
<25	1188	81.3	481	73.5	707	87.6
Mean ± SD	22.4 ± 3.2		23.4 ± 3		21.5 ± 3.1	
Self-rated health						
Excellent	20	1.4	9	1.4	11	1.4
Very good	182	12.5	78	11.9	104	12.9
Good	577	39.5	245	37.5	332	41.1
Fair	603	41.3	281	43.0	322	39.9
Poor	79	5.4	41	6.3	38	4.7
Neighborhood walking[a]						
No	417	28.9	217	33.4	200	25.2
Yes	1026	71.1	432	66.6	594	74.8
Mean ± SD[b], min/week	209 ± 185		203 ± 176		214 ± 191	
Walking for daily errands						
No	837	57.3	468	71.6	369	45.7
Yes	624	42.7	186	28.4	438	54.3
Mean ± SD[b], min/week	121 ± 126		91 ± 101		134 ± 133	
Walking for leisure						
No	949	65.0	438	67.0	511	63.3
Yes	512	35.0	216	33.0	296	36.7
Mean ± SD[b], min/week	180 ± 168		194 ± 180		170 ± 157	
Commuting on foot to work						
No	1038	71.0	426	65.1	612	75.8
Yes	423	29.0	228	34.9	195	24.2
Mean ± SD[b], min/week	111 ± 90		123 ± 99		98 ± 76	
Commuting on foot to school						
No	1430	97.9	641	98.0	789	97.8
Yes	31	2.1	13	2.0	18	2.2
Mean ± SD[b], min/week	106 ± 77		114 ± 83		101 ± 75	

[a]Neighborhood walking was defined as the sum of walking for daily errands, walking for leisure, commuting on foot to work, and commuting on foot to school.
[b]Mean ± SD indicates walking time for participants who did each type of walking.

Table 2. Number and proportion of participants in each environmental category

	Range of category[a]	Overall $n = 1461$		Men $n = 654$		Women $n = 807$	
		n	%	*n*	%	*n*	%
Residential density (5–805)[b]							
High	259<	432	29.8	178	27.5	254	31.8
Medium	184<, ≤259	514	35.5	234	36.1	280	35.0
Low	≤184	502	34.7	236	36.4	266	33.3
Mean ± SD		248 ± 96		242 ± 93		252 ± 98	
Land use mix–diversity (1–5)[b]							
Good	3.41<	471	32.8	214	33.3	257	32.4
Fair	2.57<, ≤3.41	483	33.7	211	32.9	272	34.3
Poor	≤2.57	481	33.5	217	33.8	264	33.3
Mean ± SD		2.95 ± 0.87		2.94 ± 0.84		2.96 ± 0.88	
Land use mix–access (1–4)[b]							
Good	3.14<	479	33.1	204	31.6	275	34.3
Fair	2.57<, ≤3.14	484	33.4	213	33.0	271	33.8
Poor	≤2.57	485	33.5	229	35.4	256	31.9
Mean ± SD		2.87 ± 0.63		2.85 ± 0.63		2.90 ± 0.64	
Street connectivity (1–4)[b]							
Good	3.00<	436	30.3	192	29.8	244	30.7
Fair	2.70<, ≤3.00	540	37.6	233	36.2	307	38.7
Poor	≤2.70	462	32.1	219	34.0	243	30.6
Mean ± SD		2.80 ± 0.73		2.76 ± 0.77		2.83 ± 0.7	
Walking/cycling facilities (1–4)[b]							
Good	2.40<	473	32.8	195	30.3	278	34.9
Fair	1.80<, ≤2.40	457	31.7	219	34.0	238	29.9
Poor	≤1.80	510	35.4	230	35.7	280	35.2
Mean ± SD		2.20 ± 0.65		2.17 ± 0.63		2.22 ± 0.67	
Aesthetics (1–4)[b]							
Good	2.80<	557	38.6	233	36.1	324	40.6
Fair	2.30<, ≤2.80	443	30.7	198	30.7	245	30.7
Poor	≤2.30	443	30.7	214	33.2	229	28.7
Mean ± SD		2.48 ± 0.67		2.42 ± 0.66		2.52 ± 0.66	
Traffic safety (1–4)[b]							
Good	3.00<	496	34.2	197	30.4	299	37.3
Fair	2.50<, ≤3.00	548	37.8	263	40.6	285	35.5
Poor	≤2.50	406	28.0	188	29.0	218	27.2
Mean ± SD		2.67 ± 0.54		2.63 ± 0.55		2.70 ± 0.54	
Crime safety (1–4)[b]							
Good	3.17<	585	40.3	267	41.2	318	39.6
Fair	2.83<, ≤3.17	445	30.7	211	32.6	234	29.1
Poor	≤2.83	421	29.0	170	26.2	251	31.3
Mean ± SD		2.97 ± 0.46		2.98 ± 0.45		2.96 ± 0.47	

[a]Classification of categories was by tertiles.
[b]Figures in parentheses indicate score ranges.

reported neighborhood walking, walking for daily errands, walking for leisure, and commuting on foot to work were 71.1%, 42.7%, 35.0%, and 29.0%, respectively.

Table 2 shows the mean scores and SDs for the 8 environmental variables. The tertiles of these variables are also indicated, and participants were categorized into 3 groups.

Table 3 shows the odds ratios for active walkers by environmental factor in the overall sample. Four environmental variables (high residential density, fair land use mix–diversity, good walking/cycling facilities, and good aesthetics) were significantly associated with neighborhood walking. Participants were more likely to walk when they perceived that there was high residential density (odds ratio, 1.47; 95% confidence interval, 1.11–1.96), fair land use mix–diversity (1.37, 1.04–1.81), good walking/cycling facilities (1.56, 1.19–2.04), and good aesthetics (1.49, 1.14–1.95). Regarding walking for particular purposes, there were specific associations between environment and walking. Active walking for daily errands was associated with 6 categories in 4 environmental variables: high residential density, good and fair land use mix–diversity, good and fair land use mix–access, and good street connectivity. In contrast, the environmental factors that were significantly associated with walking for leisure were different, and included good walking/cycling facilities, good and fair aesthetics, and good and fair traffic safety. The results regarding commuting on foot to work were similar to those for walking for daily errands: 3 environmental variables were significant—high residential density, good land use mix–diversity, and good land use mix–access.

Analyses stratified by sex (men, Table 4; women, Table 5) revealed some differences between men and women. Walking for daily errands and commuting on foot to work were associated with a higher number of environmental variables in women than in men. In men, there was no significant association between environment and commuting on foot to work. In the analyses of walking for leisure, the associations between environment and walking also differed by sex. Among men, those who perceived good and fair walking/cycling facilities, good aesthetics, and good traffic safety tended to walk for leisure; among women, high residential density, good land use mix–diversity, and good and fair aesthetics were significantly associated with this type of walking. An interesting unexpected result was that women who reported high residential density and good land use mix–diversity walked less for leisure.

DISCUSSION

In the present study, the perceived environmental features of a neighborhood were associated with walking in that neighborhood. In addition, the environmental variables associated with walking differed with regard to the purpose for walking, which was consistent with previous studies.[10,11] Walking for transportation (ie, errands and commuting to work) was associated with neighborhood walkability, as defined by high residential density, mixed land use, and good street connectivity. Walking for leisure was associated with the quality of pedestrian facilities, neighborhood aesthetics, and traffic safety.

Because sex differences in the associations between environment and physical activity have not been widely studied, those observed in the present study are of particular interest. Sex-specific analyses revealed significant associations between environment and commuting on foot to work only in women. The reasons for this are unclear. One possible reason is that women are more likely to work within walking

Table 3. Odds ratios for active walkers by environmental factors (all respondents)

	Neighborhood walking $n = 1443$			Walking for daily errands $n = 1461$			Walking for leisure $n = 1461$			Commuting on foot to work $n = 1083$[e]		
	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[b] (95% CI)	*P* value
Residential density												
High	57.6 (246/427)	1.47 (1.11, 1.96)	0.008	54.4 (235/432)	2.09 (1.56, 2.81)	<0.001	33.8 (146/432)	0.94 (0.70, 1.26)	0.677	51.1 (162/317)	1.99 (1.41, 2.81)	<0.001
Medium	49.4 (252/510)	1.12 (0.85, 1.46)	0.424	41.8 (215/514)	1.30 (0.98, 1.72)	0.067	35.4 (182/514)	1.02 (0.78, 1.35)	0.868	38.8 (149/384)	1.26 (0.90, 1.76)	0.171
Low	43.6 (216/495)	1.00		33.9 (170/502)	1.00		35.3 (177/502)	1.00		27.3 (102/373)	1.00	
Land use mix–diversity												
Good	54.1 (251/464)	1.19 (0.89, 1.60)	0.238	48.4 (228/471)	1.69 (1.25, 2.30)	<0.001	34.8 (164/471)	0.93 (0.68, 1.27)	0.643	47.6 (162/340)	1.51 (1.06, 2.16)	0.023
Fair	55.0 (264/480)	1.37 (1.04, 1.81)	0.027	46.2 (223/483)	1.53 (1.14, 2.05)	0.004	37.9 (183/483)	1.17 (0.88, 1.57)	0.278	39.1 (140/358)	1.05 (0.74, 1.49)	0.769
Poor	41.2 (195/473)	1.00		34.1 (164/481)	1.00		32.6 (157/481)	1.00		29.6 (108/365)	1.00	
Land use mix–access												
Good	56.2 (266/473)	1.33 (1.00, 1.78)	0.053	52.2 (250/479)	2.11 (1.56, 2.84)	<0.001	37.0 (177/479)	1.01 (0.75, 1.36)	0.944	47.6 (157/330)	1.68 (1.18, 2.38)	0.004
Fair	51.1 (247/483)	1.17 (0.89, 1.55)	0.257	43.8 (212/484)	1.55 (1.16, 2.06)	0.003	35.1 (170/484)	1.00 (0.75, 1.34)	0.988	38.0 (139/366)	1.14 (0.81, 1.60)	0.441
Poor	42.9 (204/475)	1.00		33.0 (160/485)	1.00		33.0 (160/485)	1.00		30.9 (116/376)	1.00	
Street connectivity												
Good	50.6 (219/433)	1.01 (0.77, 1.34)	0.924	47.0 (205/436)	1.43 (1.07, 1.91)	0.015	36.5 (159/436)	1.05 (0.79, 1.40)	0.750	36.7 (115/313)	0.98 (0.70, 1.39)	0.929
Fair	52.1 (279/536)	1.11 (0.85, 1.45)	0.440	45.0 (243/540)	1.28 (0.97, 1.68)	0.080	34.3 (185/540)	1.03 (0.79, 1.36)	0.811	44.1 (179/406)	1.31 (0.95, 1.80)	0.097
Poor	47.6 (215/452)	1.00		37.0 (171/462)	1.00		34.6 (160/462)	1.00		33.8 (117/346)	1.00	
Walking/cycling facilities												
Good	55.8 (261/468)	1.56 (1.19, 2.04)	0.001	46.9 (222/473)	1.26 (0.96, 1.65)	0.100	39.1 (185/473)	1.47 (1.11, 1.93)	0.006	42.0 (144/343)	1.36 (0.99, 1.88)	0.059
Fair	50.9 (230/452)	1.22 (0.93, 1.60)	0.150	43.1 (197/457)	1.13 (0.86, 1.49)	0.381	35.0 (160/457)	1.21 (0.92, 1.61)	0.177	41.4 (139/336)	1.19 (0.86, 1.65)	0.298
Poor	44.3 (223/503)	1.00		39.2 (200/510)	1.00		31.0 (158/510)	1.00		33.2 (129/389)	1.00	
Aesthetics												
Good	57.8 (318/550)	1.49 (1.14, 1.95)	0.004	48.1 (268/557)	1.28 (0.97, 1.69)	0.079	43.4 (242/557)	2.22 (1.66, 2.97)	<0.001	40.8 (162/397)	1.03 (0.74, 1.42)	0.882
Fair	46.7 (204/437)	0.99 (0.75, 1.31)	0.942	41.5 (184/443)	1.04 (0.78, 1.39)	0.774	34.3 (152/443)	1.57 (1.16, 2.12)	0.004	38.0 (127/334)	0.90 (0.65, 1.27)	0.561
Poor	43.6 (191/438)	1.00		37.7 (167/443)	1.00		25.1 (111/443)	1.00		36.1 (122/338)	1.00	
Traffic safety												
Good	54.0 (263/487)	1.02 (0.77, 1.35)	0.895	43.3 (215/496)	0.87 (0.65, 1.17)	0.356	39.3 (195/496)	1.48 (1.10, 2.00)	0.009	41.8 (150/359)	1.08 (0.77, 1.51)	0.675
Fair	49.1 (265/540)	0.93 (0.71, 1.22)	0.591	43.4 (238/548)	0.99 (0.75, 1.31)	0.949	36.7 (201/548)	1.39 (1.04, 1.86)	0.025	36.9 (146/396)	0.92 (0.66, 1.28)	0.631
Poor	46.4 (188/405)	1.00		41.1 (167/406)	1.00		27.3 (111/406)	1.00		36.1 (116/321)	1.00	
Crime safety												
Good	50.4 (293/581)	1.03 (0.79, 1.36)	0.816	43.2 (253/585)	1.05 (0.8, 1.39)	0.721	36.6 (214/585)	1.07 (0.81, 1.42)	0.618	40.5 (169/417)	1.22 (0.87, 1.69)	0.245
Fair	51.6 (225/436)	1.14 (0.86, 1.52)	0.366	42.7 (190/445)	1.05 (0.79, 1.41)	0.721	35.5 (158/445)	1.14 (0.85, 1.53)	0.375	37.1 (125/337)	0.91 (0.65, 1.28)	0.590
Poor	47.8 (199/416)	1.00		42.5 (179/421)	1.00		32.3 (136/421)	1.00		36.6 (118/322)	1.00	

Abbreviations: OR, odds ratio; CI, confidence interval.

[a]Odds ratios were calculated after adjustment for age, sex, location of residence, employment status, education, BMI, and self-rated health.

[b]Odds ratios were calculated after adjustment for age, sex, location of residence, education, BMI, and self-rated health.

[c]For the 4 respective categories, an active walker was defined as a respondent who reported neighborhood walking >90 min/week, walking for daily errands, walking for leisure, or walking to work.

[d]Figures in parentheses indicate (number of active walkers/number of participants in category).

[e]Commuting on foot to work was examined only among the 1083 participants who were employed.

Table 4. Odds ratios for active walkers by environmental factors (men)

	Neighborhood walking $n = 649$			Walking for daily errands $n = 654$			Walking for leisure $n = 654$			Commuting on foot to work $n = 559$[e]		
	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[b] (95% CI)	*P* value
Residential density												
High	54.2 (96/177)	1.47 (0.95, 2.27)	0.083	36.5 (65/178)	1.74 (1.09, 2.76)	0.020	37.6 (67/178)	1.56 (0.99, 2.47)	0.056	48.4 (75/155)	1.33 (0.81, 2.18)	0.264
Medium	42.9 (100/233)	0.87 (0.58, 1.31)	0.503	29.5 (69/234)	1.20 (0.77, 1.88)	0.419	28.2 (66/234)	0.84 (0.54, 1.30)	0.439	43.7 (86/197)	1.18 (0.74, 1.88)	0.486
Low	40.8 (95/233)	1.00		22.0 (52/236)	1.00		33.5 (79/236)	1.00		31.2 (63/202)	1.00	
Land use mix–diversity												
Good	50.5 (107/212)	1.36 (0.87, 2.14)	0.180	29.0 (62/214)	1.21 (0.73, 1.99)	0.457	36.9 (79/214)	1.53 (0.95, 2.48)	0.081	48.3 (86/178)	1.34 (0.79, 2.27)	0.280
Fair	51.2 (108/211)	1.67 (1.09, 2.58)	0.019	35.5 (75/211)	1.70 (1.07, 2.71)	0.026	33.6 (71/211)	1.58 (1.00, 2.51)	0.052	44.0 (80/182)	1.20 (0.73, 1.97)	0.475
Poor	35.0 (75/214)	1.00		21.2 (46/217)	1.00		28.6 (62/217)	1.00		29.6 (56/189)	1.00	
Land use mix–access												
Good	51.5 (104/202)	1.37 (0.88, 2.13)	0.162	35.8 (73/204)	1.88 (1.17, 3.02)	0.009	35.8 (73/204)	1.41 (0.88, 2.26)	0.155	48.2 (81/168)	1.07 (0.64, 1.80)	0.784
Fair	46.9 (100/213)	1.11 (0.73, 1.67)	0.633	29.6 (63/213)	1.42 (0.90, 2.24)	0.135	34.3 (73/213)	1.23 (0.79, 1.91)	0.369	37.5 (69/184)	0.71 (0.44, 1.16)	0.175
Poor	39.4 (89/226)	1.00		21.8 (50/229)	1.00		29.3 (67/229)	1.00		36.8 (74/201)	1.00	
Street connectivity												
Good	43.8 (84/192)	0.83 (0.54, 1.26)	0.381	27.6 (53/192)	1.05 (0.66, 1.66)	0.831	33.3 (64/192)	1.01 (0.65, 1.58)	0.965	36.6 (59/161)	0.71 (0.43, 1.16)	0.173
Fair	48.7 (113/232)	1.08 (0.72, 1.62)	0.701	33.5 (78/233)	1.42 (0.92, 2.18)	0.111	32.2 (75/233)	1.20 (0.78, 1.84)	0.415	46.3 (94/203)	1.06 (0.67, 1.68)	0.803
Poor	44.7 (96/215)	1.00		25.1 (55/219)	1.00		33.3 (73/219)	1.00		38.0 (71/187)	1.00	
Walking/cycling facilities												
Good	50.5 (98/194)	1.72 (1.13, 2.61)	0.011	29.7 (58/195)	1.10 (0.71, 1.71)	0.677	38.5 (75/195)	1.90 (1.22, 2.95)	0.005	42.7 (70/164)	1.25 (0.78, 2.00)	0.363
Fair	48.6 (106/218)	1.46 (0.98, 2.19)	0.066	31.1 (68/219)	1.16 (0.76, 1.77)	0.499	33.8 (74/219)	1.56 (1.01, 2.40)	0.045	43.2 (80/185)	1.07 (0.67, 1.71)	0.762
Poor	38.8 (88/227)	1.00		26.1 (60/230)	1.00		27.0 (62/230)	1.00		36.6 (74/202)	1.00	
Aesthetics												
Good	53.7 (124/231)	1.41 (0.93, 2.12)	0.102	33.9 (79/233)	1.36 (0.88, 2.11)	0.163	39.1 (91/233)	1.76 (1.13, 2.74)	0.013	46.3 (93/201)	1.24 (0.77, 1.99)	0.370
Fair	41.3 (81/196)	0.94 (0.62, 1.44)	0.785	26.3 (52/198)	0.96 (0.61, 1.51)	0.853	32.8 (65/198)	1.42 (0.90, 2.25)	0.128	38.2 (65/170)	0.97 (0.60, 1.58)	0.910
Poor	40.8 (87/213)	1.00		25.7 (55/214)	1.00		26.6 (57/214)	1.00		35.4 (64/181)	1.00	
Traffic safety												
Good	50.0 (97/194)	1.26 (0.81, 1.95)	0.303	26.4 (52/197)	0.76 (0.47, 1.21)	0.245	38.6 (76/197)	1.65 (1.03, 2.64)	0.039	44.2 (72/163)	1.19 (0.72, 1.97)	0.487
Fair	47.5 (124/261)	1.18 (0.78, 1.78)	0.426	30.0 (79/263)	0.95 (0.62, 1.46)	0.817	35.4 (93/263)	1.48 (0.95, 2.32)	0.086	40.4 (90/223)	1.04 (0.65, 1.66)	0.877
Poor	38.3 (72/188)	1.00		28.7 (54/188)	1.00		23.9 (45/188)	1.00		35.7 (60/168)	1.00	
Crime safety												
Good	42.9 (114/266)	0.83 (0.55, 1.27)	0.400	25.8 (69/267)	0.67 (0.43, 1.05)	0.081	35.6 (95/267)	1.35 (0.85, 2.13)	0.201	40.5 (92/227)	1.00 (0.62, 1.62)	0.999
Fair	49.5 (103/208)	1.10 (0.71, 1.70)	0.682	28.9 (61/211)	0.77 (0.49, 1.21)	0.261	35.1 (74/211)	1.47 (0.92, 2.37)	0.108	38.0 (68/179)	0.71 (0.43, 1.18)	0.191
Poor	45.0 (76/169)	1.00		32.4 (55/170)	1.00		26.5 (45/170)	1.00		41.9 (62/148)	1.00	

Abbreviations: OR, odds ratio; CI, confidence interval.

[a]Odds ratios were calculated after adjustment for age, sex, location of residence, employment status, education, BMI, and self-rated health.

[b]Odds ratios were calculated after adjustment for age, sex, location of residence, education, BMI, and self-rated health.

[c]For the 4 respective categories, an active walker was defined as a respondent who reported neighborhood walking >90 min/week, walking for daily errands, walking for leisure, or walking to work.

[d]Figures in parentheses indicate (number of active walkers/number of participants in category).

[e]Commuting on foot to work was examined only among the 559 participants who were employed.

Table 5. Odds ratios for active walkers by environmental factors (women)

	Neighborhood walking $n = 794$			Walking for daily errands $n = 807$			Walking for leisure $n = 807$			Commuting on foot to work $n = 524$[e]		
	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[a] (95% CI)	*P* value	% of active walkers[c,d]	OR[b] (95% CI)	*P* value
Residential density												
High	60.0 (150/250)	1.49 (1.02, 2.18)	0.038	66.9 (170/254)	2.35 (1.60, 3.43)	<0.001	31.1 (79/254)	0.64 (0.43, 0.96)	0.029	53.7 (87/162)	3.29 (1.97, 5.49)	<0.001
Medium	54.9 (152/277)	1.35 (0.93, 1.95)	0.111	52.1 (146/280)	1.32 (0.92, 1.90)	0.127	41.4 (116/280)	1.12 (0.77, 1.62)	0.566	33.7 (63/187)	1.45 (0.87, 2.40)	0.153
Low	46.2 (121/262)	1.00		44.4 (118/266)	1.00		36.8 (98/266)	1.00		22.8 (39/171)	1.00	
Land use mix–diversity												
Good	57.1 (144/252)	1.10 (0.74, 1.63)	0.643	64.6 (166/257)	2.14 (1.44, 3.17)	<0.001	33.1 (85/257)	0.63 (0.41, 0.95)	0.027	46.9 (76/162)	1.77 (1.07, 2.94)	0.026
Fair	58.0 (156/269)	1.21 (0.84, 1.76)	0.310	54.4 (148/272)	1.38 (0.95, 1.99)	0.092	41.2 (112/272)	0.96 (0.65, 1.40)	0.822	34.1 (60/176)	1.01 (0.61, 1.67)	0.960
Poor	46.3 (120/259)	1.00		44.7 (118/264)	1.00		36.0 (95/264)	1.00		29.5 (52/176)	1.00	
Land use mix–access												
Good	59.8 (162/271)	1.35 (0.91, 1.98)	0.131	64.4 (177/275)	2.28 (1.55, 3.35)	<0.001	37.8 (104/275)	0.78 (0.52, 1.16)	0.216	46.9 (76/162)	2.83 (1.67, 4.80)	<0.001
Fair	54.4 (147/270)	1.22 (0.84, 1.78)	0.298	55.0 (149/271)	1.63 (1.12, 2.36)	0.010	35.8 (97/271)	0.80 (0.54, 1.17)	0.249	38.5 (70/182)	1.98 (1.19, 3.29)	0.008
Poor	46.2 (115/249)	1.00		43.0 (110/256)	1.00		36.3 (93/256)	1.00		24.0 (42/175)	1.00	
Street connectivity												
Good	56.0 (135/241)	1.19 (0.81, 1.75)	0.364	62.3 (152/244)	1.78 (1.22, 2.60)	0.003	38.9 (95/244)	1.08 (0.73, 1.59)	0.704	36.8 (56/152)	1.28 (0.77, 2.13)	0.336
Fair	54.6 (166/304)	1.14 (0.80, 1.63)	0.478	53.7 (165/307)	1.20 (0.85, 1.71)	0.307	35.8 (110/307)	0.97 (0.67, 1.40)	0.857	41.9 (85/203)	1.61 (1.01, 2.57)	0.048
Poor	50.2 (119/237)	1.00		47.7 (116/243)	1.00		35.8 (87/243)	1.00		28.9 (46/159)	1.00	
Walking/cycling facilities												
Good	59.5 (163/274)	1.53 (1.07, 2.18)	0.020	59.0 (164/278)	1.35 (0.95, 1.91)	0.091	39.6 (110/278)	1.24 (0.87, 1.79)	0.239	41.3 (74/179)	1.54 (0.97, 2.43)	0.065
Fair	53.0 (124/234)	1.08 (0.75, 1.57)	0.669	54.2 (129/238)	1.09 (0.76, 1.57)	0.636	36.1 (86/238)	1.02 (0.70, 1.49)	0.928	39.1 (59/151)	1.40 (0.87, 2.26)	0.171
Poor	48.9 (135/276)	1.00		50.0 (140/280)	1.00		34.3 (96/280)	1.00		29.4 (55/187)	1.00	
Aesthetics												
Good	60.8 (194/319)	1.59 (1.10, 2.30)	0.013	58.3 (189/324)	1.24 (0.87, 1.77)	0.239	46.6 (151/324)	2.83 (1.90, 4.22)	<0.001	35.2 (69/196)	0.79 (0.49, 1.27)	0.335
Fair	51.0 (123/241)	1.02 (0.7, 1.5)	0.914	53.9 (132/245)	1.10 (0.76, 1.60)	0.613	35.5 (87/245)	1.69 (1.11, 2.57)	0.014	37.8 (62/164)	0.87 (0.54, 1.42)	0.578
Poor	46.2 (104/225)	1.00		48.9 (112/229)	1.00		23.6 (54/229)	1.00		36.9 (58/157)	1.00	
Traffic safety												
Good	56.7 (166/293)	0.82 (0.56, 1.20)	0.317	54.5 (163/299)	0.95 (0.65, 1.37)	0.768	39.8 (119/299)	1.26 (0.85, 1.87)	0.248	39.8 (78/196)	0.95 (0.59, 1.53)	0.835
Fair	50.5 (141/279)	0.72 (0.49, 1.04)	0.083	55.8 (159/285)	1.02 (0.70, 1.47)	0.928	37.9 (108/285)	1.23 (0.83, 1.82)	0.299	32.4 (56/173)	0.80 (0.49, 1.30)	0.372
Poor	53.5 (116/217)	1.00		51.8 (113/218)	1.00		30.3 (66/218)	1.00		36.6 (56/153)	1.00	
Crime safety												
Good	56.8 (179/315)	1.23 (0.85, 1.76)	0.272	57.9 (184/318)	1.41 (0.99, 2.01)	0.059	37.4 (119/318)	0.96 (0.67, 1.40)	0.844	40.5 (77/190)	1.35 (0.85, 2.16)	0.208
Fair	53.5 (122/228)	1.14 (0.78, 1.66)	0.504	55.1 (129/234)	1.28 (0.88, 1.86)	0.190	35.9 (84/234)	0.98 (0.66, 1.44)	0.909	36.1 (57/158)	1.02 (0.63, 1.66)	0.930
Poor	49.8 (123/247)	1.00		49.4 (124/251)	1.00		36.3 (91/251)	1.00		32.2 (56/174)	1.00	

Abbreviations: OR, odds ratio; CI, confidence interval.

[a]Odds ratios were calculated after adjustment for age, sex, location of residence, employment status, education, BMI, and self-rated health.

[b]Odds ratios were calculated after adjustment for age, sex, location of residence, education, BMI, and self-rated health.

[c]For the 4 respective categories, an active walker was defined as a respondent who reported neighborhood walking >90 min/week, walking for daily errands, walking for leisure, or walking to work.

[d]Figures in parentheses indicate (number of active walkers/number of participants in category).

[e]Commuting on foot to work was examined only among the 524 participants who were employed.

distance. The association between environment and walking for daily errands was also stronger and more consistent in women than in men, most likely because women play a greater role in managing households, and have more opportunities to walk for errands such as shopping, than do men. Because of this, neighborhood features may have been more important for this type of walking in women than in men.

There were some unexpected findings in women. High residential density and good land use mix–diversity were both associated with less leisure walking among women. These results have 2 implications. One possibility is that high residential density and good land use mix–diversity, which were consistently related to walking for transportation in previous studies,[11] might create a less desirable environment for leisure walking. Leisure walking is generally faster and more continuous than transport walking. Very high residential density and a good land use mix could generate excess car and pedestrian traffic, thereby interfering with leisure walking. These results were not observed in studies conducted in the United States and Australia, probably because residential density is usually lower and land use mix is less diverse in these countries. We find it interesting that a particular environmental feature could promote 1 type of walking while inhibiting another. This finding also confirms the importance of examining purpose-specific walking in environmental studies. The second implication of the abovementioned findings is that styles of leisure walking might differ by sex. For example, women walking for leisure might seek out relaxing places and avoid high-density areas and mixed-use environments in order to escape people and distractions, while men may prefer more densely populated neighborhoods and convenient places for leisure walking, perhaps because they are not adversely affected by these environmental characteristics.

In a meta-analysis of 16 studies, Duncan reported that 4 environmental factors—physical activity facilities, sidewalks, shops and services (a variable similar to land use mix–diversity in the present study), and traffic safety—were associated with physical activity.[28] Owen reviewed 18 studies that examined environmental correlates of walking and observed that aesthetic attributes, facilities for walking (sidewalks, trails), accessibility of destinations (similar to land use mix–diversity in this study), perception of traffic, and busy roads were associated with walking for particular purposes.[10] This review also found that environmental factors associated with walking for exercise/leisure were different from those associated with walking for transport. Saelens and Handy showed that the findings from previous studies were confirmed in more recent investigations.[11] Although the present study is the first to find that high residential density and mixed land use could interfere with leisure walking among women, our results were generally consistent with those of earlier studies. Thus, results regarding the environmental correlates of walking and the specific environmental associations with different purposes for walking are generalizable to the Japanese population. This is an important finding because the physical and cultural environments in Japan differ from those of the Western countries in which previous studies were conducted. Among Japanese adults, living in walkable communities, as defined by high residential density, good land use mix, and good street connectivity, is an important factor in walking for transport, while walking facilities (eg, sidewalks), aesthetics, and traffic safety are important factors in walking for leisure. These are robust findings across countries.

The results regarding crime safety have been inconsistent. In Duncan's meta-analysis, no significant association was observed between crime safety and physical activity.[28] However, some previous studies reported associations between crime safety and physical activity,[29,30] and differences between sexes in these associations. Specifically, crime safety was associated with physical activity among women. We, too, examined sex-specific associations between perception of crime safety and walking; however, no significant association was identified for either sex. In Japan, variations in the perception of crime safety may be insufficient to demonstrate associations, as the country is generally perceived to be safe. Studies in a wider range of environments might more clearly illuminate the relationship between crime and physical activity.

There are several limitations in this study. First, the study was cross-sectional, so we are unable to address the direction of causality. Longitudinal or intervention studies are therefore needed in future research. Second, both environmental and walking measures were based on self-reports. We acknowledge the possibility of a discrepancy between perception and reality, even though the measures have been validated.[21–23] Third, the response rate was somewhat low, which might have resulted in selection bias. If we assume that these participants tended to have healthier lifestyles and greater motivation and skills to overcome environmental barriers to walking, as compared with the general population, then they may walk regularly even in a poor environment. If so, this study would underestimate the association of environmental factors with walking behavior. Studies with a higher response rate and less selection bias will enhance rigor in this field of research. Fourth, participants lived in central and western Japan, not in the colder northern region of the country. Climate may be an independent determinant of walking or an effect modifier of the associations between environment and walking. To ascertain the generalizability of the findings, studies encompassing a wider range of environments are needed.

In spite of these limitations, the present study offers new evidence on physical activity and environment in Japan, and helps to fill a large gap in the data from non-Western countries. The results revealed specific environment—walking

Appendix. Sample items on the Neighborhood Environment Walkability Scale–Abbreviated Japanese Version

Environmental factors	Number of items	Score range	Sample items	Choices
Residential density	5	5–805	How common are detached single-family residences in your immediate neighborhood? How common are apartments or condos of 1–3 stories in your immediate neighborhood?	1. None 2. A few 3. Some 4. Most 5. All
Land use mix–diversity	23	1–5	About how long would it take to get from your home to the nearest businesses or facilities listed below if you walked to them? Please put only one check mark for each business or facility. -convenience/small grocery store -elementary school -bank/credit union -park	1. 1–5 min 2. 6–10 min 3. 11–20 min 4. 20–30 min 5. 30+ min 6. don't know
Land use mix–access	6	1–4	Stores are within easy walking distance of my home. There are many places to go within easy walking distance of my home.	1. strongly disagree 2. somewhat disagree 3. somewhat agree 4. strongly agree
Street connectivity	3	1–4	The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less). There are many alternative routes for getting from place to place in my neighborhood. (I don't have to go the same way every time.)	
Walking/cycling facilities	4	1–4	There are sidewalks on most of the streets in my neighborhood. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.	
Aesthetics	4	1–4	There are many attractive natural sights in my neighborhood (such as landscaping, views). There are attractive buildings/homes in my neighborhood.	
Traffic safety	4	1–4	There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood. The speed of traffic on most nearby streets is usually slow (30 mph or less).	
Crime safety	5	1–4	My neighborhood streets are well lit at night. Walkers and bikers on the streets in my neighborhood can be easily seen by people in their homes.	

relationships and contributed to understanding the environmental correlates of our most common physical activity—walking.

Conclusion

The association of neighborhood environment with walking differed by the purpose for walking. The results of the present study were generally consistent with those of studies conducted in Western countries. However, there were some differences, eg, high residential density and good land use mix were associated with less leisure walking among Japanese women. The findings suggest possible targets for interventions that aim to promote walking.

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日本人成人における活動的な通勤手段に関連する環境要因

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ASSOCIATION OF BUILT-ENVIRONMENT AND ACTIVE COMMUTING AMONG JAPANESE ADULTS

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Abstract

Background: Understanding the long-term effects of environment on health behavior is important for the promotion of population-based physical activity.
Purpose: The purpose of this study was to examine the relationship between perceived environment and active commuting among Japanese adults.
Methods: Internet-based cross-sectional survey were conducted to 3,000 Japanese adults aged 30-59 years. Seven sociodemographic attributes (gender, age, marital status, employment status, living status, educational attainment and household income), type of commute and International Physical Activity Questionnaire Environment Module were assessed by self-administered questionnaire.
Results: Of all respondents to the survey, 2,032 (mean age: 43.8±9.2, male: 62.5%) were employed. Those who use an active commute were 1,401 (68.9%). In both genders, high residential density (male: OR=2.28, female: OR=3.08), good access to shops (OR=2.03, 3.06), public transportation (OR=1.65, 3.78), recreational facilities (OR=1.31, 1.44), presence of sidewalks (OR=1.42, 1.77), crossroads (OR=1.87, 1.76), having a destination (OR=1.84, 2.34), and not having household vehicles (OR=15.13, 41.24) were associated with an active commute. The results indicated some gender differences. Among male, the presence of a bicycle lane and good aesthetics was positively associated with the active commute, while traffic safety was negatively associated. On the other hand, crime safety was associated with the active commute in female.
Conclusion: The results indicate that perceived environment was associated with the active commute among Japanese adults.

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key word：Ecological model, Mobility management, Physical activity, Exercise, Population-approach

Ⅰ．緒　　言

身体活動や運動による健康への利益は，多くの研究によって明らかになっているが，定期的に運動を行っている者の割合は男性で30.2%，女性で28.1%[1)]と少ないのが現状である．現在までに，人々の身体活動を促進させる方法として，心理行動社会的なアプローチに大きな関心がよせられ，行動科学の研究の知見を活かした介入の有用性が示されている[2,3)]．身体活動に影響を与える要因についてのこれまでの研究は，セルフ・エフィカシーやソーシャルサポートなど，心理社会的要因を中心として個人または少人数を対象に行われてきた．しかし，国民レベルでの身体活動の推進を図るためには，これら少人数に対するアプローチに加え，効果的なポピュレーション戦略の構築が重要な課題である．

これらの課題に対し，Ecological model[4)]が提唱され，身体活動の決定要因とされている，人口統計学的および生物学的要因，行動要因，心理要因，社会要因，環境要因，身体活動特異的要因について現在

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までに数多くの知見が得られている．近年は，欧米において身体活動を推進するための，環境要因に焦点を当てた研究が行われ，人々の行動に長期的に影響を与える環境を整えることにより，ポピュレーションベースでの身体活動・運動の推進が行えると期待されている[5]．諸外国における環境要因に関する研究から，住居密度や近隣に目的地があること，景観が良いことなどが成人の身体活動に影響を与えているといった知見が得られている．しかし，これらの研究は主にアメリカやオーストラリアにおいて実施されたものである[6−12]．日本人を対象とした身体活動を促進する環境要因の研究は，成人や高齢者を対象に行われているものが認められる[13−15]．対象者や焦点を当てている身体活動，調査している環境要因が異なるものの，身体活動と環境要因の間には関連があることが示されており，諸外国の成人と同様に我が国の成人においても身体活動には環境要因が重要な役割を果たしていることが推察される．

欧米では，身体活動を推進する環境要因に関する研究は数多く認められるが，日本での研究は少なく，更なるエビデンスの蓄積が求められる．さらに，歩行や運動，移動などの人々が行う身体活動の種類によって影響する環境要因が異なることが指摘されており[16]，特定の身体活動に対しどのような環境要因が関連しているのかを明らかにすることが必要である．

日本では，就労者は時間的制約が多いため運動ができないことが指摘されている[17]．国内の15歳から64歳における就労者の割合は70.7%を占めており[18]，このような対象における通勤中の身体活動は，生理学的・心理学的側面の健康に対し効果があることが示されている．たとえば，通勤中の身体活動は，高血圧リスクの低下[19]やQuality of Lifeの向上[20]，BMI[21]や全死亡[22]などとの関連が認められており，健康への効果が大きいことが明らかとなっていることからも，通勤中の身体活動およびそれに関連する環境要因を明らかにすることは重要である．

これまで，通勤中の身体活動に関連する環境要因に関する検討は，自転車行動に焦点を当てた研究[23]や自転車と歩行を合わせて検討した研究[24,25]など，諸外国においていくつか認められるが，日本においては検討されていないのが現状である．また，諸外国では，活動的な通勤手段とは「車を使用しないこと」が主な定義となっており，日本のように公共交通機関が発達した国においては，通勤中の身体活動を活動的にする手段が豊富であり，他の通勤手段に替えることができる可能性が高いことから，通勤中の身体活動に着目することは有用である．通勤手段を活動的にするために，これらに関連している環境要因に注目していくことは，日本人成人の健康増進に対しインパクトが大きく，意義があるものと考える．

そこで本研究の目的は，横断研究によって日本人成人の活動的な通勤手段に関連する環境要因を明らかにすることとした．

Ⅱ．方　　法

A．対象者および調査方法

本研究は横断調査によって実施した．2009年１月にインターネット調査会社の登録モニター（登録者数約290,000名）30・59歳の3,000名を対象に調査を行った．対象者の調査参加方法は，インターネット調査会社よりe-mailにて調査の依頼を行い，e-mailに添付されているアドレスより調査画面へアクセスする方法とした．対象者3,000名の抽出は，30歳から59歳の男女を採択基準とし，性，年代によって層化し行った．すなわち，30代，40代，50代の男女それぞれ500名とした．対象者への調査の依頼は，最終的に回答が得られる目標対象者数を3,000名とし，9,418名に対し行った(返答率31.9%)．除外基準は，就労していない者とし，最終的に調査への回答があり，就労者の30・59歳の男女2,032名を分析対象者とした．また，調査への回答を得る前に，対象者に対し，文章にて本調査の趣旨，参加は自由意志であること，プライバシーと匿名性は厳守されることをWeb画面上で説明し，アンケートの回答をもって同意することとし回答を得た．また調査実施にあたっては，事前に早稲田大学スポーツ科学学術院研究倫理審査委員会の承認を得た．

B．調査項目

社会人口統計学的要因は，インターネット調査会社が把握している対象者それぞれの性，年齢，婚姻状況，職業，同居人数，教育歴，世帯収入に関するデータを用いた．通勤手段に関する調査項目は，「あなたの通勤の交通手段を選んでください．」という設

問に対し，自宅から他の場所へ移動する通勤手段を把握するため，片道5分以上利用する全ての通勤の交通手段を徒歩，自転車，オートバイ，自動車，バス・電車等の公共交通機関の中から選択する項目を用い調査した．従って，本調査項目は，自宅内もしくは自宅から片道5分以内の職場への移動は含まない．また，近隣の環境要因の調査には，先行研究にて信頼性が確認され，国際的に広く使用されている国際標準化身体活動質問紙環境尺度の日本語版(IPAQ-E: International Physical Activity Questionnaire Environmental Module)[15]を用いた．本尺度は，対象者の居住地周辺(歩いて10～15分の範囲)の環境をたずねるものであり，基本項目7問[住居密度，近所のスーパーや商店，近所のバス停・駅，近所の歩道，近所の自転車道，近所のレクリエーション施設，安全性(犯罪・夜間)]，推奨項目4問[近所の安全性(交通量)，近所で運動実施者を見かけること，近所の景観，家にある自動車・オートバイの台数]，オプション項目6問[近所の十字路・交差点，近所の歩道の整備，近所の自転車道の整備，自転車運転時の近所の安全性(交通量)，近所の安全性(犯罪・昼間)，近所の目的地]の計17問から構成されている．回答肢は，住居密度については，「あなたの近所の住宅は主にどのようなタイプのものですか」という設問に対し，「1：一戸建て，2：2～3階建てのアパート，3：一戸建てと，2～3階建てのアパートが混じっている，4：4～12階建てのマンション，5：13階建て以上のマンション」の中から1つを選ぶ項目であり，家にある自動車・オートバイについては，合計した台数をたずねる項目である．その他の項目は，「日用品を買うためのお店や，スーパーマーケット，商店街などが，自宅から簡単に歩いていける範囲にたくさんある(近所のスーパーや商店)」や「バス停，駅などが自宅から歩いて10～15分以内にある(近所のバス停・駅)」，「近所を歩くと，興味をひかれるもの(きれいな景観，楽しい景観など)がたくさんある(近所の景観)」，「近所には，銀行，郵便局，医療機関，公共の施設のような，歩いていける目的地が多い(近所の目的地)」など近所の環境についての質問に対し，これらが対象者の居住する地域にどの程度当てはまるのかを，「1：全くあてはまらない～4：非常によくあてはまる」の4つの選択肢の中から選ぶ形式とした．

C．分析方法

通勤手段が活動的である者と活動的でない者による，社会人口統計学的要因およびIPAQ-Eの分布の違いを検討するため，χ^2検定を行った．また，性別に年齢，教育歴，婚姻状況，同居の状況，世帯収入を調整したロジスティック回帰分析を行い，活動的な通勤手段を利用することに関連する環境要因を検討した．その際，徒歩，自転車，バス・電車等の公共交通機関のいずれか1つでも利用している者を通勤手段が活動的である者と分類し，それ以外のオートバイまたは自動車のみを利用している者を通勤手段が活動的でない者とした．また，社会人口統計学的要因は次のように分類した：性(男性/女性)，年代(30代/40代/50代)，婚姻状況(独身/既婚)，同居の状況(同居あり/同居なし)，教育歴(大学院，大学，短大，高専，専門/高校，中学)，世帯収入(300万円未満/300～500万円未満/500～700万円未満/700～1,000万円未満/1,000万円以上)．IPAQ-Eの項目は，先行研究[15]にならい，住居密度については「一戸建て」と「その他」の2分類，家にある自動車・オートバイは「0台」と「それ以上」の2分類，その他の項目は，「全くあてはまらない，ややあてはまらない」と「ややあてはまる，非常によくあてはまる」の2分類とした．統計解析には，SPSS 12.0J for Windows，SPSS Inc.，Chicago，USA.を用いた．

Ⅲ．結　　果

A．対象者の属性

調査に同意および回答が得られ，かつ就労していた者は2,032名であった．平均年齢は43.8±8.2歳であり，男性は62.5%を占めていた．そのうち，活動的な通勤手段を利用していた者は，男性で878名(69.1%)，女性で523名(68.7%)であり，平均年齢は43.9±8.4歳であった．また，既婚者は68.1%，同居をしている者は84.6%，教育歴が高い者は77.4%であり，世帯収入は300万～500万円未満(25.0%)の者の割合が一番高く，次いで700万～1,000万円未満(24.9%)，500万～700万円未満(24.1%)，1,000万円以上(15.9%)，300万円未満(10.1%)の順序であった．なお，婚姻状況，同居の状況，教育歴，世帯収入において通勤手段が活動的な者と活動的でない者で有意な差が認められた(Table 1)．