Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

Med Sci Sports Exerc. Author manuscript; available in PMC 2020 April 17.

Published in final edited form as:

Med Sci Sports Exerc. 2009 February ; 41(2): 314–321. doi:10.1249/MSS.0b013e318185496c.

Age Differences in the Relation of Perceived Neighborhood Environment to Walking

RYOSUKE SHIGEMATSU[1], **JAMES F. SALLIS**[2], **TERRY L. CONWAY**[2], **BRIAN E. SAELENS**[3], **LAWRENCE D. FRANK**[4,5], **KELLI L. CAIN**[2], **JAMES E. CHAPMAN**[5], **ABBY C. KING**[6]

[1]Faculty of Education, Mie University, Tsu, JAPAN

[2]Department of Psychology, San Diego State University, San Diego, CA

[3]University of Washington and Children's Hospital and Regional Medical Center, Seattle, WA

[4]School of Community and Regional Planning, University of British Columbia, Vancouver, BC, CANADA

[5]Lawrence Frank & Company, Point Robert, WA

[6]Stanford University School of Medicine, Stanford, CA

Abstract

SHIGEMATSU, R., J. F. SALLIS, T. L. CONWAY, B. E. SAELENS, L. D. FRANK, K. L. CAIN, J. E. CHAPMAN, and A. C. KING. Age Differences in the Relation of Perceived Neighborhood Environment to Walking.

Purpose: The strength of the relationship of environment to physical activity may differ by age group. Older adults were expected to be more affected by environmental attributes than younger adults. The present study examined age-related differences in associations between perceived neighborhood environment and physical activity.

Methods: Participants were 1623 adults aged 20 to 97 yr divided into five groups: ages 20–39, 40–49, 50–65, 66–75, and 76+. They were recruited from King County/Seattle, WA, neighborhoods selected to vary in land use and median income. Participants completed questionnaires about neighborhood environment attributes and walking for transportation and for leisure purposes. Neighborhood environment, within a 15- to 20-min walk from home, was measured on nine attributes with the validated Neighborhood Environment Walkability Scale questionnaire: residential density, proximity to nonresidential land uses, ease of access to nonresidential uses, street connectivity, walking/cycling facilities, esthetics, pedestrian traffic safety, crime safety, and proximity to recreation facilities. Participants reported frequency and duration of walking using the validated International Physical Activity Questionnaire and the Community Healthy Activities Model Program for Seniors. Partial correlations were computed, adjusting for demographics.

Results: Walking for transportation was significantly related to multiple perceived neighborhood attributes in all age groups, although walking for leisure was not. Walking for transportation was

Address for correspondence: Ryosuke Shigematsu, Ph.D., Faculty of Education, Mie University, 1577 Kurimamachiya, Tsu, Mie 514-8507, Japan; rshige@edu.mie-u.ac.jp.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

significantly related to almost all neighborhood environment variables in the youngest age group. In contrast, only two environmental attributes, proximity to nonresidential uses (like shops) and recreation facilities, were moderately correlated with walking for transportation in the two oldest groups.

Conclusion: Communities need to be designed with many favorable environmental attributes to support walking for transportation among younger adults. Having nonresidential destinations and recreation facilities within walking distance may be among the most important attributes to support older adults' physical activity.

Keywords

PHYSICAL ACTIVITY; AGING; SOCIOECONOMIC FACTORS; CITY PLANNING; RECREATION; TRANSPORTATION

Most of the US adult population does not meet physical activity recommendations (3). To increase the number of people who are physically active, numerous interventions based on psychological theories have been developed and evaluated (18,19). Although several effective interventions are available in the physical activity field (13), many are poorly disseminated (23), so they have had little impact on population physical activity.

Researchers have more recently increased attention to the role of the built environment in influencing physical activity. Numerous studies have found that neighborhood attributes such as residential density, destinations near homes, and street connectivity are related to walking and cycling for transportation and to total physical activity. Reviews of the literature have repeatedly concluded that neighbourhood environment factors are related to physical activity (7,8,21), and the Guide to Community Preventive Services has recommended land-use change as an effective physical activity intervention (10). Similarly, proximity to public and private recreation facilities and positive esthetic qualities are consistently related to leisure-time physical activity (11,26).

Neighborhood attributes can be measured objectively with geographic information systems (GIS). For example, a GIS-derived "walkability" index consisting of residential density, land use mix, retail floor area ratio, and street connectivity has been related to physical activity, body mass index (BMI), and other outcomes (7). GIS-based assessments of recreation facilities also have been related to physical activity (9).

Neighborhood attributes can be measured by self-report, and several reliable scales have been developed for this purpose (2). Self-report instruments can capture a wider range of environmental variables believed to be related to physical activity, such as esthetics, presence and conditions of sidewalks and bike trails, and perceptions of safety from traffic and crime. The Neighborhood Environment Walkability Scale (NEWS) was developed by Saelens et al. (27) to capture these perceived environment domains, and studies in several countries have supported its reliability and validity (6,15,17,27). Cerin et al. (4) adapted an abbreviated version of the NEWS and demonstrated associations of several subscales with physical activity.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Although a growing number of studies supports the relationship of environment factors to physical activity among older adults (1,20,28), more comprehensive studies in this area to expand knowledge on other factors such as the role of sidewalks, proximity of recreation facilities, and esthetics are needed for older adults (28). Moreover, it is unclear whether the strength of association differs by age group. There are reasons to believe that older adults may be more sensitive to environmental constraints and facilitators because they have fewer transportation options and perhaps reduced confidence in overcoming environmental barriers such as unsafe street crossings and lack of sidewalks. The prevalence of meeting physical activity recommendations is lowest among older adults in the United States (32). Age-related differences in the relation of environments to physical activity could explain some of the physical activity decline. The purpose of the present study was to examine age-related differences in associations between perceived neighborhood environment variables and physical activity by studying a large sample of adults across a broad age range and levels of physical activity in a large US metropolitan area.

METHODS

Overview of the Studies

Present analyses were conducted using two databases; the Neighborhood Quality of Life Study-Adult (NQLS-A) and the Senior NQLS (SNQLS). Methods for NQLS-A have been reported previously (7,14), although SNQLS was not. However, the overall study designs were very similar, and the primary difference between the studies was participants' ages; NQLS-A included 20–65 yr old, and SNQLS included those aged 66 yr and older. Both databases were designed as observational epidemiological studies with primary aims to evaluate the relationships between objectively defined high- and low-walkable neighborhoods and physical activity levels and to examine differences by socioeconomic status. To ensure wide variability in independent variables, study areas were selected that met definitions for four neighborhood types: low walkable/low income, high walkable/low income, low walkable/high income, and high walkable/high income. Both studies were conducted in King County, WA (Seattle area), and in the Baltimore–Washington, DC, region, but only the King County/Seattle data were available for use in the present investigation. The studies were approved by the ethics committees of participating academic institutions.

Neighborhood Selection

To recruit participants from geographic areas with a wide range of walkability, all census block groups in King County/ Seattle were ranked on a walkability index using data on land use for each parcel, street centerline, and GIS. The walkability index was calculated using four characteristics: a) net residential density (residential units divided by acres in residential use); b) land use mix (evenness of distribution of building floor area of residential, retail, entertainment, office, and institutional development); c) retail floor area ratio (retail building floor area divided by retail land area); and d) street connectivity (intersections per square kilometer). Detailed methods have been published (7,14). A high walkability index means a more walking-friendly area, especially for walking to destinations. All census block groups were ranked based on the walkability index and divided into deciles, and in both studies

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

block groups in the top four and bottom four deciles represented high- and low-walkable neighborhoods, respectively.

All census block groups were also divided into deciles based on median household income, derived from the US Census data. The top and the bottom deciles were excluded to avoid extreme values. In NQLS-A, the second, third, and fourth deciles and the seventh, eighth, and ninth deciles represented low- and high-income neighborhoods, respectively. In SNQLS, the second to fifth deciles and the sixth to ninth deciles represented low- and high-income neighborhoods, respectively. Block groups in the middle income deciles were included in SNQLS because income for older populations is arguably less important than net worth, which was not available from census data. Moreover, due to the narrower age range of SNQLS and smaller population, the eligible income deciles were expanded to enhance the feasibility of recruitment.

A two-by-two table was constructed to classify the selected census block groups by walkability (high/low) and income (high/low). In NQLS-A, clusters of adjacent block groups in the same quadrant were used to define neighborhoods, and final selections were made based on field visits from investigators. Four neighborhoods were selected for each quadrant, for a total of 16 neighborhoods. In SNQLS, individual block groups were selected that met criteria for walkability and income. The narrower age range of the target population (66+ yr) made recruitment impossible from contiguous block groups. Block group selection in SNQLS was made based solely on GIS and census data because field visits were not feasible.

Participant Recruitment

A commercial marketing firm provided contact information for people residing within the selected areas. An invitation letter was mailed to randomly selected households followed by recruitment phone calls (up to eight call backs). Persons unable to complete written surveys in English, living in their neighborhood for less than 3 months, living in nursing homes or other full-time residential care facilities, or unable to walk (specifically 10 ft at a time for SNQLS) were excluded. If the initially targeted person refused or was ineligible, an attempt was made to recruit another person in the same household. After signed consent was obtained, a questionnaire could be completed by mail, online, or phone. When data were missing, participants were contacted to encourage completion. For completing the assessment, participants received an incentive of $20 in NQLS-A and $25 in SNQLS.

Measurements

Perceived environment.—The NEWS questionnaire (27) was used in both studies, although several items were dropped in SNQLS to reduce the questionnaire length and allow for the addition of items of particular relevance to older adults. Of the 68 items in the original eight NEWS scales, 55 were retained in SNQLS. The decision to drop 13 of the original items was based on the work of Cerin et al. (4) to abbreviate the NEWS. For the present article, the 55 items measured in both NQLS-A and SNQLS were used to create comparable measures for analyses. The following scales were computed to define perceived neighborhood attributes with participants, where applicable, instructed to consider

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

neighborhood as the area within a 15- to 20-min walk from home: a) residential density (6 items); b) proximity to nonresidential land uses, such as restaurants and retail stores (land use mix–diversity) (23 items); c) ease of access to nonresidential uses (land use mix–access) (6 items); d) street connectivity (3 items); e) walking/cycling facilities, such as sidewalks and pedestrian/ bike trails (4 items); f) esthetics (4 items); g) pedestrian traffic safety (6 items); and h) crime safety (3 items). The land use mix–diversity scale (subscale B) includes reports of proximity to 23 destinations. Three items in this subscale were used to create two new measures to assess the proximity of parks and recreation facilities: 1) a count (0–3) of having a park, recreation center, or gym/fitness facility within a 20-min walk of home; and 2) a dichotomous measure indicating whether a park was within a 20-min walk of home. Test–retest reliability and several indicators of validity have been reported for NEWS in multiple studies (4,27). Details about the questionnaire, including response formats and scoring, are available at http://www.drjamessallis.sdsu.edu/measures.html. Higher scores are presumed to indicate more favorable environments for physical activity.

Walking for transportation and for leisure.—Walking for transportation and walking for leisure were the dependent variables. Walking is by far the most common physical activity across age groups (33), and walking for transportation and for leisure purposes has been associated with different attributes of neighborhood environments (24). For purposes of the current investigation, items were limited to those that were collected in parallel across the two studies. Amount of time spent walking in the past 7 d separately for transportation and leisure was assessed with the International Physical Activity Questionnaire (IPAQ) long version in NQLS-A. This survey has been validated in a 12-country study (5). In SNQLS, the Community Healthy Activities Model Program for Seniors (CHAMPS) questionnaire was used to assess walking in an average week using a categorical response scale to reflect total time spent. The CHAMPS has been validated in older adults (29,31) and was modified to include items specific to walking for transportation and leisure.

The IPAQ activity questions in NQLS-A were as follows: [Transportation] “During the last 7 days, on how many days did you walk for at least 10 minutes at a time to go from place to place; and, if at least on 1 day or more, how many minutes did you usually walk on one of those days?” and [Leisure] “How manydays did you walk for at least 10minutes at a time in your leisure time; and, if at least on 1 day or more, how many minutes did you usually walk on one of those days?” For both walking measures, the number of days per week was multiplied by the usual minutes per day to get the total minutes per week of each type of walking. The CHAMPS questions in SNQLS were as follows: [Transportation] “How many times during an average week did you walk to do errands such as to/from a store; and, if done at least once a week, how much total time did you spend?” and [Leisure] “How many times during an average week did you walk leisurely for exercise or pleasure; and, if done at least once a week, how much total time did you spend?” In the CHAMPS questionnaire, a seven-point ordinal response scale to indicate total time per average week spent in an activity was used: 0 (0 h a week), 1 (less than 1.0 h), 2 (1.0–2.5 h), 3 (3.0–4.5 h), 4 (5.0–6.5 h), 5 (7.0–8.5 h), and 6 (9.0 h or more per week). To create equivalent data in both groups, the total walking time per week in NQLS-A was recoded into the seven categories used in the SNQLS CHAMPS questionnaire.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Sociodemographic variables.—The survey included questions on sociodemographic characteristics: age, sex, height, weight, race/ethnicity, highest level of education, marital status, annual household income, months living at current address, number of individuals in the household, having a valid driver's license, and number of drivable motor vehicles in household.

Statistical Analysis

The hypothesis was that the perceived neighborhood environment explained walking behavior across all age groups, but associations may be stronger for those aged 66 yr and older. Therefore, participants were divided into five groups according to age: a) 20–39 yr, b) 40–49 yr, c) 50–65 yr, d) 66–75 yr, and e) 76 yr or older. To test the differences in perceived environments, walking outcomes, and sociodemographic information among age groups, chi-squaretest and *F*-test were applied.

Partial correlations with adjustment for covariates were computed. Covariates, selected according to previous studies and avoiding multicollinearity, were sex, body mass index (BMI; $kgIm^{-2}$), education level, income, and presence/ absence of a driver's license. *Z*-test was applied to test the differences among correlation coefficients across age groups. The Statistical Package for the Social Sciences version 15.0 (SPSS Inc., Chicago, IL) was used for all the statistical analyses. $P < 0.05$ was used to identify statistical significance.

RESULTS

Recruitment rates (enrolled participants/eligible contacts) were 40% in NQLS-A and 23% in SNQLS. After sending the questionnaire to persons who agreed to participate ($n = 1841$ across both studies), 1649 completed the questionnaire and sent it back. Of these, 2 persons did not provide their age and 24 persons had moved to the current address within the last 3 months, so they were excluded from analyses. Thus, the total number of participants was 1623. Participants self-selected the mode of questionnaire administration. The percent completing online surveys was 9.2% in NQLS-A and 11.0% in SNQLS. Significant variations among age groups were found for all sociodemographic characteristics (Table 1).

Table 2 shows mean NEWS scores for each age group. The youngest group (ages 20–39 yr) reported living in the highest density neighborhoods, and the oldest group (ages 76+ yr) reported living in the next highest density neighborhoods. In general, older adults (ages 66–75 and 76+ yr) reported lower scores on "land use mix–diversity," "land use mix–access," and "walking/cycling facilities," indicating that older adults lived in lower-walkable areas. On the other hand, on the subscale "pedestrian safety," older adults lived in higher-walkable areas. On the subscale "street connectivity," the youngest (ages 20–39 yr) and oldest groups (ages 66–75 and 76+ yr) had the highest scores, but the same three age groups also scored lower (less favorably) on the subscale "safety from crime." No significant differences among age groups were found for "neighborhood esthetics." The two oldest groups (ages 66–75 and 76+ yr) reported substantially less access to parks and recreation facilities.

Table 3 shows sociodemographic-adjusted partial correlation coefficients between perceived environment (NEWS) scores and walking behavior. All significant correlations were in the

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

expected direction, except three significant correlations for “safety from crime” (walking for transportation in ages 20–39 and 50–65 yr and walking for leisure in ages 20–39 yr) showing inverse associations. For transportation walking, all eight NEWS subscale scores were significantly correlated for the youngest group (ages 20–39 yr) compared with only two and four significant correlations in the two oldest groups (ages 66–75 and 76+ yr). However, the highest correlations overall were seen in the two oldest groups, for the land use mix factors

($p > 0.35$). Surprisingly, the two recreation facility variables were significantly correlated with transportation walking in the oldest age groups but were not correlated with leisure walking. For leisure walking, there were fewer significant neighborhood environment correlates, and almost all significant findings were in the youngest group (ages 20–39 yr). Most of correlations for leisure walking were lower than those for transportation walking, and differences were significant for some comparisons, indicating that perceived neighborhood attributes were more related with transportation walking than with leisure walking.

Differences in correlation coefficients across age groups were significant for “land use mix–diversity” (highest correlations for oldest two age groups), “land use mix–access” (highest for oldest two age groups), “street connectivity” (highest for youngest age group), and “pedestrian/traffic safety” (highest for youngest age group) for transportation walking and for “residential density” (highest for youngest age group) and “pedestrian/traffic safety” (lowest for oldest age group) for leisure walking. In general, the correlations for transportation and leisure walking were not significantly different among age groups.

DISCUSSION

The purpose of the present study was to examine the strength of association between perceived neighborhood environment and walking across a wide adult age range. Analyses of 1623 participants aged 20 to 97 yr revealed that some perceived neighborhood attributes were related to walking for transportation in all age groups, whereas associations with walking for leisure were weaker. Contrary to hypotheses, walking behavior, both for transport and leisure, was significantly related to almost all neighborhood environment variables in the youngest age group (ages 20–39 yr). By contrast, there were few environmental attributes significantly related to walking among older adults (ages 66–75 and 76+ yr). However, those few significant correlations for older adults were the highest in the table, specifically the correlations of walking for transportation with the two land use mix scales.

The finding that perceived neighborhood environment was more related to transport walking is consistent with previous studies, showing that walking for leisure among Australians was not associated with neighborhood walkability attributes (22) and that neighborhood context had little effect on the likelihood of exercising strenuously (25). It is likely that walking is more a function of how well environments support residents’ ability to accomplish daily activities. Moreover, seniors who are no longer spending time at work locations would be even more sensitive to the presence or absence of destinations near to where they live. This

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

might explain the highest correlations being found between proximity of destinations and walking for transportation among the oldest groups. It may be possible to improve the NEWS by adding items expected to be related to walking for recreation, like width of sidewalks or adequate shade.

Another possible explanation is that people may combine transport walking with leisure walking—a form of pedestrian trip chaining. For example, someone goes to a market on foot and on the way home he/she meets a friend and goes to the park to socialize before going home. The example also illustrates ambiguity in defining walking for transportation or leisure when one walking trip could have multiple purposes. The questionnaire in the present study did not allow reporting of walking for multiple purposes. Although older adults reported less land use mix and less access to recreation facilities than younger adults, older adults may be able to take better advantage of any nearby destinations because they have relatively more discretionary time than younger adults.

An explanation for the limited associations of leisure walking with perceived environmental attributes is that leisure walking may often occur outside the neighborhood, where neighborhood characteristics would be irrelevant. By contrast, it is assumed that most transportation walking is done in the neighborhood. A broader measure of leisure-time physical activity that included jogging, cycling, dance, and other types of activity might have shown stronger associations with access to recreation facilities near homes.

Proximity to recreation facilities was related to walking for transportation but not leisure in all age groups except one. There are several possible explanations for this unexpected finding. A participant could walk to a recreation facility to exercise there or to take a child to an activity class but report this as transportation walking (20). Present findings suggest that recreation facilities, including parks, might support active lifestyles by providing a place for leisure physical activity and a destination for walking.

The reason that walking, especially walking for transportation, in the youngest and oldest age groups was most consistently related to neighborhood environment could be their lifestyles. The percent of unmarried participants is expected to be higher in both the youngest and oldest groups, so these groups may have more free time for walking due to fewer obligations related to married life. These groups may spend more time around their neighborhoods because it is more likely that younger adults take care of children and older adults have retired. On the other hand, middle-aged adults leave home for their jobs, and they may not compensate for sedentary occupations by adopting active behaviors during leisure time when they are at home (12).

Younger and older adult groups had distinct patterns of correlations. Among the young to middle-aged groups (ages 65 yr or younger), almost all neighborhood attributes had significant correlations with transportation walking. This pattern suggests that communities need to have a broad range of features that support walking, including mixed use, connected streets, good pedestrian and cycling facilities, and favorable esthetics. Among those 66 yr and older, transport walking was strongly related to two main attributes: mixed land use and access to recreation facilities. This pattern suggests that communities that support

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

transportation walking among older adults need to have a wide variety of destinations near homes, including recreation facilities, as well as destinations that appeal to different age groups. It was expected that multiple neighborhood attributes would need to be favorable to support transportation walking among older adults, but this hypothesis was not fully supported in the univariate correlations that were undertaken.

The significant negative correlations of walking with “safety from crime” are difficult to explain. Findings for perceived crime are inconsistent in the literature (11,28), and present findings do not resolve these discrepancies. Perceived crime has been found to be unrelated to crime rates (6,16). When perceived crime safety was low, people may have continued to walk because they found ways of managing their concerns (16).

Study limitations include assessment of physical activity by questionnaire and constraints concerning the items used to allow for age-related comparisons across the two studies. However, self-report is the only feasible method for assessing purpose of walking. A limitation of both the IPAQ and the CHAMPS walking measures is they did not assess walking for combined transportation and recreation purposes simultaneously. Because some groups of older adults may in some circumstances underestimate physical activity energy expenditure (30) and premenopausal women may overestimate physical activity (34), systematic biases in reporting across the age groups in the present study could have affected the results. Varying numbers of participants in each age group is a limitation because statistical power differed by age group, particularly, for example, in the oldest age group where power was more limited because of this. In addition, the study sample was limited to one region of the country, that is, King County/Seattle, WA, which may differ in environmental characteristics (e.g., weather, terrain, neighborhood configurations) relative to other parts of the country. However, the Seattle region contains extensive GIS-derived information that facilitated this research. Strengths of the study included a large sample of community-dwelling adults across a very wide age range, assessed with comparable measures. The study design that included selection of study neighborhoods that varied in walkability assured a wide range of neighborhood attributes. In addition, correlations were adjusted for several important demographic variables (i.e., sex, BMI, education level, income, and driver’s license).

CONCLUSION

Results of the present investigation indicated that, in the present sample, perceived neighborhood environment attributes were related to walking for transportation among adults of all ages but were related to walking for leisure only among the youngest adults. Almost all environmental attributes were related to walking for transportation among younger adults, suggesting that communities should be designed with numerous features to support walking. By contrast, proximity to destinations, including park and recreation facilities, was the only correlate of walking for transportation among older adults in the current investigation comparing different age groups, and the correlation was the strongest found in these analyses. The implication is that older adults may benefit from living in neighborhoods within close proximity to common destinations such as shops, services, and recreation facilities. Future studies could replicate the present findings in other regions,

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

identify the specific destinations older adults walk to most often, apply more comprehensive measures of transport- and leisurebased physical activity, and explore the reasons underlying the currently reported age-related differences in associations of neighborhood attributes with walking for transportation and leisure.

Acknowledgments

The research presented in this article was funded by grants HL077141 and HL67350 from the National Heart, Lung, and Blood Institute. The results of the present study do not constitute endorsement by ACSM.

REFERENCES

1. Berke EM, Koepsell TD, Moudon AV, Hoskins RE, Larson EB. Association of the built environment with physical activity and obesity in older persons. Am J Public Health. 2007;97:486–92. [PubMed: 17267713]
2. Brownson RC, Chang JJ, Eyler AA, et al. Measuring the environment for friendliness toward physical activity: a comparison of the reliability of 3 questionnaires. Am J Public Health. 2004;94:473–83. [PubMed: 14998817]
3. Centers for Disease Control and Prevention (CDC). Adult participation in recommended levels of physical activity—United States, 2001 and 2003. MMWR Morb Mortal Wkly Rep. 2005; 54:1208–12. [PubMed: 16319815]
4. Cerin E, Saelens BE, Sallis JF, Frank LD. Neighborhood Environment Walkability Scale: validity and development of a short form. Med Sci Sports Exerc. 2006;38(4):1682–91. [PubMed: 16960531]
5. Craig CL, Marshall AL, Sjostrom M, et al. International Physical Activity Questionnaire: 12-country reliability and validity. Med Sci Sports Exerc. 2003;35:1381–95. [PubMed: 12900694]
6. De Bourdeaudhuij I, Sallis JF, Saelens BE. Environmental correlates of physical activity in a sample of Belgian adults. Am J Health Promot. 2003;18:83–92. [PubMed: 13677966]
7. Frank LD, Sallis JF, Conway TL, Chapman JE, Saelens BE, Bachman W. Many pathways from land use to health. J Am Plan Assoc. 2006;72:75–87.
8. Gebel K, Bauman AE, Petticrew M. The physical environment and physical activity: a critical appraisal of review articles. Am J Prev Med. 2007;32:361–9. [PubMed: 17478260]
9. Gordon-Larsen P, Nelson MC, Page P, Popkin BM. Inequality in the built environment underlies key health disparities in physical activity and obesity. Pediatrics. 2006;117:417–24. [PubMed: 16452361]
10. Heath G, Brownson R, Kruger J, Miles R, Powell K, Ramsey L. The effectiveness of urban design and land use and transport policies and practices to increase physical activity: a systematic review. J Phys Act Health. 2006;3:S55–76. [PubMed: 28834525]
11. Humpel N, Owen N, Leslie E. Environmental factors associated with adults' participation in physical activity: a review. Am J Prev Med. 2002;22:188–99. [PubMed: 11897464]
12. Jans MP, Proper KI, Hildebrandt VH. Sedentary behavior in Dutch workers: differences between occupations and business sectors. Am J Prev Med. 2007;33:450–4. [PubMed: 18022060]
13. Kahn EB, Ramsey LT, Brownson RC, et al. The effectiveness of interventions to increase physical activity. A systematic review. Am J Prev Med. 2002;22:73–107. [PubMed: 11985936]
14. Kerr J, Rosenberg D, Sallis JF, Saelens BE, Frank LD, Conway TL. Active commuting to school: associations with environment and parental concerns. Med Sci Sports Exerc. 2006;38:787–94. [PubMed: 16679998]
15. Leslie E, Saelens B, Frank L, et al. Residents' perceptions of walkability attributes in objectively different neighborhoods: a pilot study. Health Place. 2005;11(4):227–36. [PubMed: 15774329]
16. Loukaitou-Sideris A, Eck JE. Crime prevention and active living. Am J Health Promot. 2007;21:380–9. [PubMed: 17465184]
17. Malavasi LM, de Fatima S, Duarte M, Both J. Neighborhood Environment Walkability Scale (NEWS—Brazilian version): construct validity. Med Sci Sports Exerc. 2007;39(5 suppl):S189–90.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

18. Marcus BH, Forsyth LH. Motivating People to Be Physically Active. Champaign (IL): Human Kinetics; 2003 p. 3–88.
19. Marcus BH, Williams DM, Dubbert PM, et al. Physical activity intervention studies: what we know and what we need to know. Circulation. 2006;114:2739–52. [PubMed: 17145995]
20. Mowen A, Orsega-Smith E, Payne L, Ainsworth B, Godbey G. The role of park proximity and social support in shaping park visitation, physical activity, and perceived health among older adults. J Phys Act Health. 2005;4:167–79.
21. Transportation Research Board, Institute of Medicine. Does the Built Environment Influence Physical Activity?: Examining the Evidence. Washington (DC): National Academies Press; 2005 p. 1–148.
22. Owen N, Cerin E, Leslie E, et al. Neighborhood walkability and the walking behavior of Australian adults. Am J Prev Med. 2007; 33:387–95. [PubMed: 17950404]
23. Owen N, Glanz K, Sallis JF, Kelder SH. Evidence-based approaches to dissemination and diffusion of physical activity interventions. Am J Prev Med. 2006;31:S35–44. [PubMed: 16979468]
24. Owen N, Humpel N, Leslie E, Bauman A, Sallis JF. Understanding environmental influences on walking; Review and research agenda. Am J Prev Med. 2004;27:67–76. [PubMed: 15212778]
25. Ross CE. Walking, exercising, and smoking: does neighbourhood matter? Soc Sci Med. 2000;51:265–74. [PubMed: 10832573]
26. Saelens BE, Handy SL. Built environment correlates of walking: a review. Med Sci Sports Exerc. 2008;40(7 Suppl): S550–66. [PubMed: 18562973]
27. Saelens BE, Sallis JF, Black JB, Chen D. Neighborhood-based differences in physical activity: an environment scale evaluation. Am J Public Health. 2003;93:1552–8. [PubMed: 12948979]
28. Sallis JF, Kerr J. Physical activity and the built environment. President's Council on Physical Fitness and Sports Research Digest. 2006:Series 7, No. 4;1–8 (12 2006). Available at: http://www.presidentschallenge.org/misc/news_research/research_digests/3327%20Research%20Digest.pdf Accessed January 1, 2008.
29. Sallis JF, Saelens BE. Assessment of physical activity by self-report: status, limitations, and future directions. Res Q Exerc Sport. 2000;71:S1–14. [PubMed: 10925819]
30. Starling RD, Matthews DE, Ades PA, Poehlman ET. Assessment of physical activity in older individuals: a doubly labeled water study. J Appl Physiol. 1999;86:2090–6. [PubMed: 10368377]
31. Stewart AL, Mills KM, King AC, Haskell WL, Gillis D, Ritter PL. CHAMPS physical activity questionnaire for older adults: outcomes for interventions. Med Sci Sports Exerc. 2001;33(7):1126–41. [PubMed: 11445760]
32. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc. 2008;40(1):181–8. [PubMed: 18091006]
33. US Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, and Division of Nutrition and Physical Activity Promoting Physical Activity: A Guide for Community Action. Champaign (IL): Human Kinetics; 1999 p. 1–40.
34. Walsh MC, Hunter GR, Sirikul B, Gower A. Comparison of self-reported with objectively assessed energy expenditure in black and white women before and after weight loss. Am J Clin Nutr. 2004;79:1013–9. [PubMed: 15159231]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Med Sci Sports Exerc. Author manuscript; available in PMC 2020 April 17.

TABLE 1.

Sociodemographic characteristics by age group.

Characteristic	Ages 20–39	Ages 40–49	Ages 50–65	Ages 66–75	Ages 76+	*P*
Number	444	379	440	201	159	
Quadrant of walkability and income, %						
Low walkability and low income	21.6	26.9	24.8	22.4	25.8	<0.001
Low walkability and high income	22.3	28.5	25.9	31.8	20.1	
High walkability and low income	33.8	20.6	17.0	20.4	31.4	
High walkability and high income	22.3	24.0	32.3	25.4	22.6	
Mean age, yr	31.9 ± 4.9	44.5 ± 2.8	56.2 ± 4.3	70.1 ± 3.0	81.1 ± 4.5	<0.001
Percent female	47.0	49.3	39.8	46.8	56.6	0.003
BMI mean, $kg \cdot m^{-2}$	25.7 ± 5.4	26.6 ± 5.4	27.5 ± 5.4	26.7 ± 4.6	25.4 ± 4.7	<0.001
Race/ethnicity category, %						
White	76.7	83.3	87.0	84.5	84.9	0.001
Nonwhite	23.3	16.7	13.0	15.5	15.1	
Educational attainment, %						
Completed high school or less	6.1	10.8	8.4	15.0	23.3	<0.001
Some college or vocational training	27.7	28.0	29.4	31.3	35.2	
Completed college or university	41.2	38.4	33.5	31.3	26.4	
Completed graduate degree	25.0	22.8	28.7	22.4	15.1	
Marital status, %						
Married	46.8	64.1	62.2	69.2	40.9	<0.001
Widowed/divorced/separated	7.0	15.8	25.3	25.4	56.6	
Single and never married	35.6	15.8	9.1	3.0	1.9	
Living with partner	10.6	4.2	3.4	2.5	0.6	
Annual household income, %						
Less than $39,000	29.5	20.9	23.9	46.1	63.8	<0.001
$40,000–$59,000	24.0	15.4	20.0	16.1	17.4	
$60,000–$89,000	23.3	28.6	22.2	24.4	14.1	
$90,000 or more	23.3	35.2	33.9	13.3	4.7	
Time at current address, mean months	42 ± 45	111 ± 86	186 ± 127	284 ± 180	310 ± 218	<0.001

Characteristic	Ages 20–39	Ages 40–49	Ages 50–65	Ages 66–75	Ages 76+	*P*
Family members in household, including self	2.62 ± 1.40	3.09 ± 1.53	2.23 ± 1.14	1.95 ± 0.76	1.63 ± 0.76	<0.001
Percent with valid driver's license	96.2	95.3	95.2	95.5	88.7	0.006
Drivable motor vehicles at household, %						
None	5.2	5.3	4.6	3.5	8.2	<0.001
1 car	35.4	23.5	26.2	32.8	53.5	
2 cars	45.0	40.7	39.2	41.8	29.6	
3 cars or more	14.4	30.4	30.1	21.9	8.8	

Values are expressed as means ± SD except for percentage.

Author Manuscript
Author Manuscript
Author Manuscript
Author Manuscript

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

TABLE 2.

Neighborhood Environment Walkability Scale (NEWS) by age group.

NEWS Subscale or Item	Ages 20–39	Ages 40–49	Ages 50–65	Ages 66–75	Ages 76+	*P*
Residential density	237 ± 73	210 ± 54	206 ± 45	208 ± 43	219 ± 43	<0.001
Land use mix–diversity	3.44 ± 0.85	3.25 ± 0.87	3.17 ± 0.85	2.37 ± 0.81	2.29 ± 0.88	<0.001
Land use mix–access	2.97 ± 0.56	2.86 ± 0.60	2.87 ± 0.61	2.67 ± 0.65	2.68 ± 0.63	<0.001
Street connectivity	3.02 ± 0.75	2.94 ± 0.76	2.95 ± 0.75	2.80 ± 0.66	3.06 ± 0.70	0.001
Walking/cycling facilities	2.84 ± 0.72	2.67 ± 0.83	2.77 ± 0.81	2.53 ± 0.91	2.58 ± 0.91	<0.001
Neighborhood esthetics	3.12 ± 0.70	3.08 ± 0.67	3.17 ± 0.66	3.20 ± 0.57	3.12 ± 0.69	0.327
Pedestrian/traffic safety	2.81 ± 0.55	2.77 ± 0.55	2.85 ± 0.58	2.85 ± 0.48	2.94 ± 0.55	0.016
Safety from crime	3.36 ± 0.65	3.49 ± 0.58	3.48 ± 0.66	3.48 ± 0.61	3.38 ± 0.66	0.011
Mean recreation facilities in neighborhood	2.08 ± 0.94	2.01 ± 0.99	2.00 ± 1.05	1.29 ± 1.07	1.23 ± 1.12	<0.001
Park in neighborhood, %	90.5	87.3	86.4	66.3	59.1	<0.001

Values are expressed as means ± SD except for percentage.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

TABLE 3.

Partial correlation coefficients between Neighborhood Environment Walkability Scale (NEWS) and walking for transportation and leisure.

NEWS Subscale or Item	Ages 20–39	Ages 40–49	Ages 50–65	Ages 66–75	Ages 76+	χ^2 for Differences by Age Group
Transportation walking Residential density	0.277*	0.069	0.169*	0.189*	0.184	9.39
Land use mix–diversity	0.292*	0.143*	0.151*	0.424*	0.351*	19.47†
Land use mix–access	0.287*	0.128*	0.215*	0.339*	0.383*	12.44†
Street connectivity	0.244*	0.197*	0.143*	0.092	−0.080	13.87†
Walking/cycling facilities	0.182*	0.124*	0.180*	0.155*	0.121	1.15
Neighborhood esthetics	0.235*	0.122*	0.194*	0.101	0.063	5.89
Pedestrian/traffic safety	0.223*	0.026	0.126*	0.016	−0.132	18.93†
Safety from crime	−0.097*	−0.053	−0.129*	−0.119	0.057	4.63
Recreational facilities near home	0.160*	0.110*	0.091	0.220*	0.341*	9.55†
Park near home	0.137*	0.081	0.066	0.016	0.300*	9.27
Leisure walking Residential density	0.219*	0.112*	0.021‡	0.121	0.006	10.64†
Land use mix–diversity	0.129*‡	0.010	0.111*	0.175*‡	0.019‡	5.49
Land use mix–access	0.097*‡	−0.041‡	0.132*	0.173*	0.084‡	8.50
Street connectivity	0.078*‡	−0.009‡	0.031	0.084	−0.034	2.74
Walking/cycling facilities	0.096*	−0.029‡	0.065	0.136	−0.030	5.79
Neighborhood esthetics	0.160*	0.006	0.107*	0.041	0.072	5.48
Pedestrian/traffic safety	0.091	−0.079	0.097	0.082	−0.093	10.84†
Safety from crime	−0.138*‡	−0.075	0.011	−0.014	−0.112	5.77
Recreational facilities near home	0.063	0.009	0.108*	0.101	−0.060	4.49
Park near home	0.043	−0.014	0.067	0.048	−0.072	3.02

Adjusted for sex, BMI, education level, income, and driver's license.

*Significant correlation coefficients ($P < 0.05$).

†Significant difference among age groups ($P < 0.05$).

‡Significantly lower than transportation walking ($P < 0.05$).