VALIDATION OF A SENIOR WALKING ENVIRONMENTAL ASSESSMENT TOOL

by

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ABSTRACT

Research supporting associations between built environment and physical activity is limited by the absence of a reliable, valid, and objective measure of the built environment. This study assesses the validity of the Senior Walking Environmental Assessment Tool (SWEAT), a reliable 35-question instrument measuring a variety of street, sidewalk, and building characteristics.

Neighborhood built environment was objectively measured through observation of street-segments in the quarter-mile surrounding each participant's home with SWEAT and Geographic Information Software (GIS). Two methods of describing the built environment in relation to walking using SWEAT and GIS variables were compared. Principal Components Analysis (PCA) was used to create four indices: Functionality, Maintenance, Comfort/Safety, and Pleasantness. *A priori* hypotheses in the conceptual model behind SWEAT identified four separate indices: Functional, Safety, Aesthetics, and Destinations. Walking behavior (destination walking and exercise walking) data and relevant covariates from a cross-sectional survey of community-dwelling adults (n=120) in Portland, Oregon were used to evaluate the association between each index and walking behavior, while adjusting for confounding variables.

All indices from the conceptual model were independently associated with walking for transportation as part of daily routine, while only Aesthetics was associated with walking for exercise. Of the PCA indices Functionality and Pleasantness were associated with walking for transportation; Comfort/Safety and Maintenance were associated with walking for exercise. While the conceptual model explains transportation walking, the PCA indices better explain both transportation and exercise walking behaviors. The results of this study establish SWEAT as a valid audit tool and propose a method of operationalizing street-level data into neighborhood-level variables.

INTRODUCTION

Walking, particularly as a mode of transportation, has steadily decreased in recent decades (Alfonzo, 2005). In 2001, nearly 90% of daily trips were made by personal vehicle, while only 9% were walked (U.S. Dept of Transportation, 2003). Concurrently, obesity has become a significant issue in the United States. One-third of the adult U.S. population is currently obese, and the prevalence is rising (CDC, 2006b). The epidemic poses a threat to public health by increasing the burden of illnesses such as type 2 diabetes, coronary heart disease, stroke, and some cancers and increasing health care costs (CDC, 2006a). A national health objective in *Healthy People 2010* is to reduce the prevalence of obesity to 15%.

Because reduced activity level is closely linked to obesity risk (Hu et al, 2003; Levine et al, 2005), physical activity must be encouraged to reduce obesity in the U.S. In particular, energy expenditure related to daily activity may be more important than exercise activity in preventing obesity (Sternfeld et al, 2004). In particular, increasing walking for exercise and transportation has been shown to reduce obesity risk (Hu et al, 2003; Sternfeld et al, 2004).

Creating built environments conducive to walking is a central component of encouraging physical activity at the community level. The term "built environment" encompasses urban design, land use, and transportation systems. The built environment defines and describes the communities in which individuals live, and therefore impacts the way that individuals live. A growing body of research has identified specific built environment characteristics associated with obesity. In particular, urban sprawl – low density development – is associated with obesity (Frank et al, 2004; Lopez, 2004; Rutt &

Coleman, 2004). The built environment has also been shown to be related walking (Cunningham & Michael, 2004; Owen et al, 2004; Saelens et al, 2003). However, to design communities that enable walking, the specific characteristics of the built environment related to walking must be known.

This study contributes to the growing body of research by determining the validity of SWEAT, a reliable 35-question instrument measuring a variety of specific street, sidewalk, and building characteristics, and by developing a valid measure of the built environment related to walking for transportation. Specifically, the aims of this study are to:

- Describe participant local neighborhoods using sidewalk, street, and amenities variables obtained using SWEAT and Geographic Information Software (GIS);
- Develop two sets of measures of the built environment related to walking using the conceptual framework used to develop SWEAT and Principal Components Analyses (PCA).
- Evaluate the validity of SWEAT by comparing the two sets of measures in their association with walking behavior and propose a measure of built environment characteristics related to walking.

The results of this study will aid researchers in performing future studies that will inform interventions and policies to create pedestrian-friendly environments that are more conducive to activity, healthy weight, and overall health.

PRELIMINARY STUDIES

This study uses secondary data from the Neighborhood, Built Environment and Health among Urban Seniors Study (Michael YL, Principal Investigator), which examined the effect of the physical environment on walking behavior among the senior population in Portland, Oregon. SWEAT was developed as part of this study using a conceptual framework [Figure 1] based on themes appearing in an extensive literature review and two published frameworks (Pikora 2002; Saelens 2003). The framework relates physical/built environment factors directly to walking, relates walking directly to mental and physical health, and individual and neighborhood factors indirectly to walking and health via perception of environment. This study assessed the association between physical/built environment factors and walking, signified by a solid line in Figure 1.

Figure 1: SWEAT conceptual model

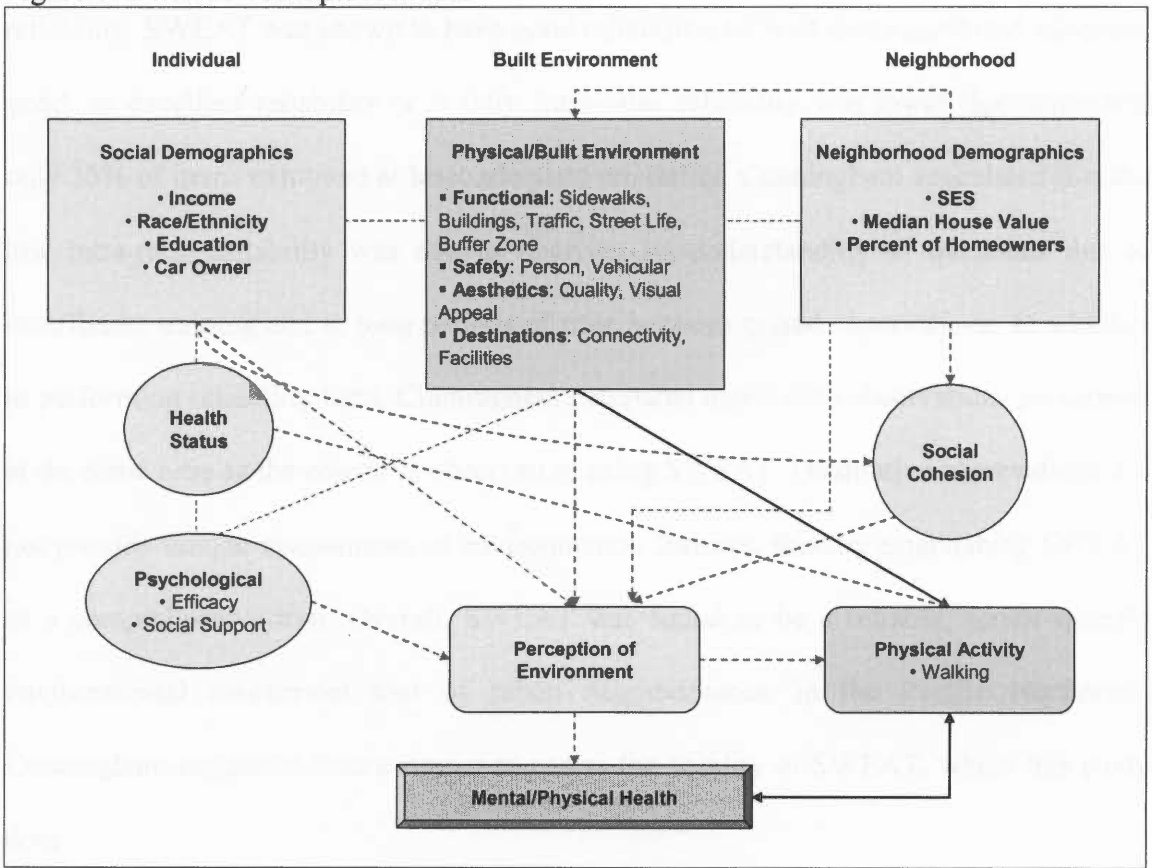


Figure adapted from Cunningham, 2005.

The Australian environmental audit instrument SPACES (Pikora 2002) was used as template for SWEAT, because it is comprehensive, theory-based, and observational. Experts in urban planning, exercise science, and gerontology were consulted to provide face validity. The instrument was field tested before finalizing the 35-question observational instrument. See Appendix A for a copy of SWEAT.

Intra-rater and inter-rater reliability of SWEAT was assessed using the same dataset as the proposed study with the addition of repeated observations (Cunningham, 2005). Repeated observations by the original observer were used to assess intra-rater reliability; repeated observations by another observer were used to assess inter-rater reliability. SWEAT was shown to have good reliability; 68% of items exhibited adequate, good, or excellent reliability ($\kappa > 0.6$). Intra-rater reliability was lower than expected; only 35% of items exhibited at least adequate reliability. Cunningham speculated that the low intra-rater reliability was due to observer misunderstanding of questions due to insufficient training and to long periods of time between paired observations. In addition to performing reliability tests, Cunningham compared qualitative observations performed at the same time as the objective observation using SWEAT. Qualitative observations did not provide unique assessments of environmental features, thereby establishing SWEAT as a comprehensive tool. Overall, SWEAT was found to be a reliable, senior-specific environmental assessment tool of urban neighborhoods in the Pacific Northwest. Cunningham suggested future studies to assess the validity of SWEAT, which this study does.

METHODS

This cross-sectional secondary data analysis investigated the relationship between walking behaviors and the built environment characteristics measured by SWEAT to assess the validity of SWEAT. In 2002-2003 a randomly-selected sample of street segments in eight Portland, Oregon neighborhoods were observed using SWEAT. Adults living on these street segments were interviewed about their walking behaviors in their neighborhood during the same time period. A local neighborhood was defined for each participant as the quarter-mile radius around their home. Geographic Information Software (GIS) and Regional Land Information System (RLIS) were used to obtain additional built environment features of each participant's local neighborhood – such as number of services and facilities. A PCA was used to identify theoretical indices. These PCA indices and indices from the conceptual model behind SWEAT were used to create two sets of factor scores. The association between these built environment scores and participant use of walking for transportation was assessed with logistic regression models.

Study Population

Data collection occurred in eight municipally-defined neighborhoods recognized by the Portland Office of Neighborhood Involvement. The method of choosing these neighborhoods is described elsewhere (Cunningham, 2005). Street-segments, defined as the section of road between consecutive intersections, were identified for each neighborhood using GIS (Archview 3.3) and Regional Land Information System (RLIS). Highways, heavy industrial roads, and roads within parks were excluded. A 10% sample of identified street segments was selected for observation. A total of 363 street segments were audited (Cunningham, 2005). For this analysis, alleyways (n=7) were also excluded from analysis.

Participating households are a convenience sample of households on audited street segments. Households whose taxlot was on or adjacent to the audited street segments were canvassed by trained interviewers. One hundred and twenty-eight participants were interviewed. Participants with less than three audited street segments within a quarter-mile of their home were excluded from analysis. The final sample in this study was 120 households on 63 unique street segments containing 3-18 segments within a quarter-mile radius of the household, or "local neighborhood." A quarter-mile (approximately 400 meters) was selected as the definition of a local neighborhood because of its frequent use in the literature (Hoehner et al, 2005; Jago et al, 2005; Pikora et al, 2006; Rutt & Coleman 2005) and because it was hypothesized to be a common distance for walking trips.

Of the 120 participants, 93 (83.4%) were white and 61 (50.8%) exercised three or more times per week. On average, they had lived in their neighborhood for 13.7 years. Of the 59 participants whose gender was recorded, 64.4% were female. According to 2000 Census data for the eight audited neighborhoods, 50.4% of residents are female and 68.0% are white (Office of Neighborhood Involvement, n.d.), suggesting that study participants may not be representative of the general neighborhood population.

Table 1 shows the mean, standard deviation, and range of audited street segments within participants' local neighborhood by named neighborhood. The mean number of audited segments within participants' local neighborhood was greater than 10 for all named neighborhoods except Montavilla and Sullivan's Gulch. A cluster of interviewed households in the Montavilla neighborhood were geographically separate from other audited segments, limiting the number of audited segments in their local neighborhood. Sullivan's Gulch contains a freeway and a large mall, reducing the total number of street segments in the neighborhood.

Table 1: Number of segments in local neighborhood, by named neighborhood

Named neighborhood	Number of participants	Mean	Std Dev	Minimum	Maximum
Buckman	14	10.79	1.37	9	14
Cathedral Park	20	13.30	4.09	3	18
Creston-Kenilworth	18	10.89	1.71	8	14
Montavilla	12	7.58	3.55	4	13
Richmond	11	12.91	2.81	8	15
St Johns	20	10.15	1.87	8	15
Sullivan's Gulch	13	6.46	1.13	5	8
Woodlawn	12	10.17	2.48	6	14

Data Collection

Street segments were observed between October 2002 and August 2003 by trained observers using SWEAT. Nine observers were trained over two data collection periods, October-December 2002 and January-August 2003. Training consisted of two 4-hour sessions, including practice on example street segments and review of an extensive training manual. Most observations were performed in November, December, May, June, July, and August. The average atmospheric temperature during observation was 63°F and it was raining during 3% of observations. Each assessment took an average of 17 minutes and observers rated SWEAT as moderately easy to use (Cunningham et al, 2003). In addition, GIS and RLIS were used to obtain counts of potential walking destinations within a quarter-mile of each audited street segment.

Trained interviewers canvassed homes on or near audited street segments in the summer of 2003. Households whose taxlot is on or directly adjacent to the audited street segment were eligible for canvassing. Canvassing occurred between 3 pm and 7 pm on weekdays. Any adult resident aged 18 years or older providing informed consent was interviewed. Households without someone answering the door were canvassed a second time (Wilkerson, 2006). The survey response rate was 32 percent among households with someone answering the door.

Independent Variables

Built environment characteristics were assessed using SWEAT. Information on a wide variety of street, sidewalk, and building features was recorded for audited street segments. A description of these features is provided in Figure 2. SWEAT is also provided in Appendix A.

Amenities within a quarter-mile of each segment were obtained using GIS and RLIS. Counts were obtained of bus stops, restaurants, neighborhood grocery, convenience stores, supermarkets, malls, hospitals, medical offices, libraries, pharmacies, banks, beauty shops, schools, senior services, community centers, senior centers, pools, parks/trails, and community gardens. The size (square feet) of community centers, parks/trails, and community gardens and the length of each street segment were also obtained.

Covariates

Items from the structured household interview were included covariates. Minority status, gender, and health status were selected because they were commonly confounders in prior studies (Frank et al, 2005; Hoehner et al, 2005; Jago et al, 2005; King et al, 2005; Rutt & Coleman, 2004; Suminski et al, 2005; VanLenthe et al, 2004). Years lived in the area, walking for exercise within neighborhood, walking for exercise outside of neighborhood, perceived safety of walking during day, perceived safety of walking after dark, familiarity with neighbors, perceived convenience of local shopping, perceived neighborhood attractiveness, perceived sidewalk condition, and physical activity level were included based on hypothesized of importance. The interview format is provided in Appendix B.

Figure 2: Features measured by SWEAT

Functional	
Buildings	▪ **Building type/use** (Single family, apt/condo, townhome, duplex, institutional, retail, commercial, public, religious, mixed use) ▪ **Building height** (1, 2, 3, 4, 5+ stories)
Sidewalks	▪ **Continuous sidewalk** ▪ **Sidewalk width** (minimum, maximum) ▪ **Slope** (flat/gentle, steep) ▪ **Material** (asphalt, concrete, bricks, gravel, dirt, grass, under repair, private lawn, other material) ▪ **Sidewalk condition** ▪ **Obstructions** (bump/crack/hole, weeds/leaves, poles/signs, standing water, tables/chairs, trees/shrubs, parked cars, other)
Street life	▪ **Benches, Other resting places** ▪ **Porches** ▪ **Buffer zone objects** (bike racks, controller boxes, fire hydrants, grate, mailboxes, newspaper boxes, parking meter, planter garbage can, signal poles, signs, streetlight, furniture, telephone booth, trees, utility pools, wall, water fountain, other) ▪ **Buffer zone width** ▪ **Parking type** (on-street, behind building/underground, between building and street, independent lot) ▪ **Signs** ▪ **Restrooms**
Aesthetics	▪ **Bars** on windows ▪ **Bench condition** ▪ **Building condition** ▪ **Yard maintenance** ▪ **Litter/graffiti** ▪ **Trees** >15 feet tall
Safety	
Personal	▪ **Streetlights** (at crossing areas, at transit stops, other areas) ▪ **Curb height; curb cuts** (ramps)
Traffic	▪ **Lanes of traffic** ▪ **Traffic volume** (cars per minute) ▪ **Traffic calming device** present ▪ **Bike lanes** ▪ **Crossing area** present ▪ **Pedestrian signal** (controllable, not controllable) ▪ **Crosswalk length**; **Signal time** (time to cross street) ▪ **Posted speed**
Destinations	▪ **Thruway** vs deadend/cul-de-sac

Covariates were included in analysis as potential confounders, effect modifiers, or mediators. The role of covariates was flexible in this analysis because their role has not been clearly established in the literature. For example, while Hoehner et al (2005) found little difference between perceived and objective environmental measures in their association with transportation activity, other studies have controlled for perceived measures as a proxy for self-selection (Handy, Cao & Mokhtarian, 2006). In addition, perceived environment measures have also been assessed as predictor variables (Kerr et al, 2006; Timperio, Salmon, Telford & Crawford, 2004). In addition, individual characteristics are primarily included in models as confounders (Jago, Baranoswski, Zakeri, & Harris. 2005; King et al, 2005), so interaction effects of individual characteristics are largely unknown. Because of this debate, an ad-hoc post-analysis classification was used to determine whether to adjust for a covariate or consider them mediators. This meant that we decided whether we would leave things adjusted or consider them mediators based on the results of the analysis.

Dependent Variables

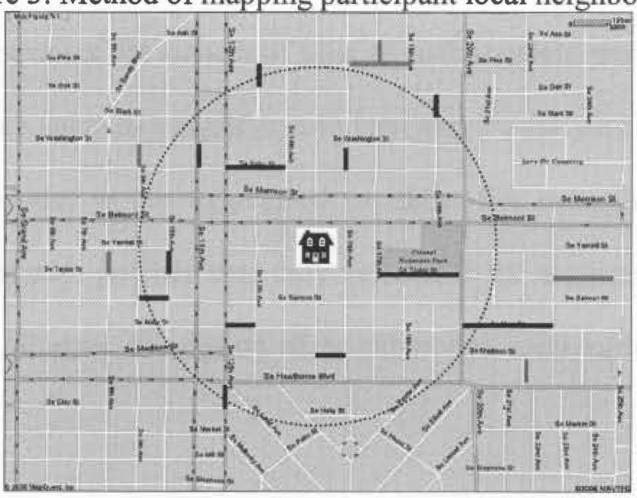
Use of walking as a primary mode of transportation was the outcome of interest in this analysis. In the structured household interview, participants were asked to self-report their primary modes of transportation. Up to three modes could be coded by the interviewer. For this analysis, participants are dichotomized as those who reported using walking as a primary mode of transportation and those who did not. There was no difference in the number of observed segments in the local neighborhood of those who reported using walking as a primary mode of transportation (mean: 10.43; s.d.: 3.04) and those who did not (mean: 10.47; s.d.: 3.43; $p = 0.950$).

Walking for exercise within neighborhood was assessed as a second outcome in a supplemental analysis. Participants were asked in the interview "How often in a typical week do you walk for exercise in your neighborhood." Participants selected from the responses: Not at all (0 times per week), A little bit (1-2 times per week), A moderate amount (3-4 times per week), Quite a bit (5-6 times per week), A great deal (everyday). For this analysis, the response categories were dichotomized to Never and At least once per week.

Data Management

Segment level data was aggregated to the local neighborhood level for each household and merged with amenities and interview data. To identify segments within participants' local neighborhoods, audited segments were mapped using mapquest.com, an online mapping tool. A segment was included in a participant's local neighborhood if any part of the segment fell within a quarter-mile of any point on the household's segment [Figure 3]. In situations where a participant's residence was not directly on the

Figure 3: Method of mapping participant local neighborhoods



audited segment (n=23), the audited segment still served as the center of the participant's local neighborhood because this was the location that they was selected to represent.

Segment level data was operationalized into neighborhood level variables in several ways. All neighborhood level variables were created to be continuous for use in the PCA. Continuous length data (such as curb height) were aggregated into neighborhood means. Count data (such as number of mixed-use buildings or number of segment sides with curbside parking) were aggregated as neighborhood percentages (such as the percentage of buildings on audited segments that are mixed-use or the percentage of audited segment sides with curbside parking). Other count data (such as number of trees) were used to calculate rates per 100 feet, with the exception of the number of restrooms, which was left as a count. Categorical variables were collapsed into dichotomous variables (such as continuous/non-continuous sidewalks and good/poor yard condition) and aggregated as percentages (such as the percentage of audited segments with continuous sidewalks or yards in good condition). Average time to cross at pedestrian signals was calculated in feet per second by dividing the length of the crosswalk, which was measured in paces and converted to feet, by the timed signal duration. Ordinal responses for amount of litter of each segment were averaged to create a "litter score," with a value of 1 signifying no litter and 0 signifying much litter. Missing values were not included in any aggregated variables. For example, the percentage of residential buildings with porches was only calculated for segments with at least one residential building. Further description of neighborhood level variables is provided in Appendix C.

Amenities counts were summed into four mutually-exclusive categories: Shopping (neighborhood grocery, convenience stores, supermarkets, malls); Medical (hospitals, medical offices); Services (libraries, pharmacies, banks, beauty shops, schools, senior services); Activities (community centers, senior centers, pools, parks/trails, community gardens). The square-feet of parks and trails was summed.

After review of frequency tables and histograms, four potential predictor variables were removed from analysis. Hard-Surface Sidewalks was removed due to lack of variability. All participant local neighborhoods contained 100% hard-surface sidewalks, which is a reflection of observing neighborhoods in the older and more established inner east side of Portland. Crossing Signals and Crossing Signal Time were removed because of high percentage of missing values (29.2% and 39.2% respectively), which is a result of the high percentage of audited segments that were residential and did not have a crossing signal. Park Area was removed due to presence of extremely high values, and because of conceptual similarity to the count of parks and trails (correlation: $r=0.21$ $p=0.02$), which was included in Activities.

An attempt was made to transform non-normal variables, because normality is an assumption of PCAs. The effect of transformations (logarithmic, inverse, squared, and square-root) on non-normally distributed predictor variables was tested. The log of Buffer Zone Width, inverse of Block Length, and square-root of Residential Density, Non-Residential Use, Traffic Load, and Services were retained for analysis.

Covariates were generally ordinal on a Likert scale. Exceptions were Residence Time (continuous), Gender (dichotomous), and Race (categorical). Due to low response of minority Races/ethnicities, the Race variable was collapsed into a dichotomous variable White/Non-White. Categorical covariates were dichotomized according to their association with the outcome. To do this, crosstabulation tables of covariates by Transportation Walking were examined for the point where the covariate was more prevalent among participants who walked for transportation than participants who did not walk for transportation. Extra-Neighborhood Exercise Walking, and Physical Activity Level were dichotomized as never vs at least once per week. Health Status was dichotomized into poor/fair vs good/very good/excellent. Perceived Sidewalk Quality was collapsed into very poor/poor vs. average/good/very good. Perceived Shopping Ease was dichotomized as Very Good vs. Good to Poor. Perceived Attractiveness was dichotomized as very poor to average vs. good/very good. Neighborliness was dichotomized as knowing none/few vs. knowing many/most. And Perceived Day Safety and Perceived Night Safety were collapsed into unsafe vs. safe. Several potential confounders had missing values: Gender (n=61), Perceived Night Safety (n=17), Race (n=9), and Health Status (n=1). To retain participants with missing data for analysis, a third category for "missing" was created for variables with substantial number of missing values: Gender, Perceived Night Safety, and Race.

A full list and description of variables in the analysis dataset is provided in Appendix C.

Statistical Analysis

Descriptive Statistics

Differences in potential predictor variables, all of which were continuous, between participants who walk for transportation and those who do not walk for transportation were assessed using t-tests. The association between covariates and Transportation Walking was assessed using odds ratio (dichotomous) and t-tests (continuous). Covariates with strong associations with the outcome (OR $\geq$2.0) regardless of statistical significance, or with conceptual importance regardless of association strength were evaluated as potential confounders and moderators in model building.

Principal Components Analysis (PCA)

A PCA was performed to group potential predictor variables into theoretical indices. Because a PCA assumes that data is normally distributed (Hatcher, 1994), only variables reasonably following a normal distribution were included in the PCA. Visual assessment of histograms and Q-Q plots showed that the following variables were not normal and were therefore not included in the PCA: Mixed-Use, Short Buildings, Restrooms, Curbside Parking, Lot Parking, Through Streets, Narrow Roads, Bike Lanes, Posted Speed Limit, Medical Facilities, and Activities. The distribution of these variables was characterized by the majority of observations having a single value; the absolute measure of skewedness ranged from 0.7 to 2.4. The twenty-six approximately normally-distributed predictor variables loaded into a PCA are given in Table 2.

The varimax rotated factor pattern matrix, scree plot, and Eigen value table were reviewed to determine the appropriate number of factors to retain. Variables were considered to load on a given component if the factor loading was 0.40 or greater. Variables loading on more than one retained factor were removed from all factors. A linear combination of variables loading on each factor was used to create factor scores.

Table 2: Variables included in principal components analysis

Potential predictor variables organized by *A Priori* hypotheses	
Functional Square-Root of Residential Density Square-Root of Non-Residential Use Porches Resting Place Density Continuous Sidewalks Sidewalk Width Well-Maintained Sidewalks Gentle Slope Unobstructed Sidewalks Buffer Zones	**Safety** Tree Density Streetlight Density Square-Root of Traffic Load Traffic Calming Devices Logarithm of Buffer Zone Width Curb Cuts Curb Height
Aesthetics Unbarred Windows Well-Maintained Yards Well-Maintained Buildings Litter Score	**Destinations** Restaurants Shops Square-Root of Services Inverse of Block Length Bus Stops

Creation of Factor Scores

Two composite scores were created. The first composite score was based on the four A Priori indices in SWEAT's conceptual model. The second composite score was created from the results of the PCA. Variables loading on the four retained factors were used to create PCA factor scores; therefore only variables loading in the PCA are incorporated in the PCA factor scores.

Factor scores were created by standardizing and summing continuous independent variables. Standardized variables were assigned negative values if the original (unstandardized) variable had a negative correlation with Transportation Walking of a magnitude of -0.15 or greater. Regression coefficients were not used in calculating scores for two reasons: they were unavailable for the A Priori scores to which they would be compared; and they are less robust across various data sets, while an aim of this study was to propose a robust system of scoring SWEAT.

To understand the effect of excluding non-normal variables from the PCA, a third composite score was created by expanding the PCA factors to include all neighborhood variables. Using the conceptual meaning interpreted from the PCA factors, the 11 non-normal variables excluded from the PCA were manually added to PCA factors. Variables in the expanded factors were then standardized and summed to create four expanded factor scores. Results of all subsequent analyses using this PCA-expanded composite score were similar but slightly less significant than results of the original PCA scores, suggesting that the additional variables added noise to the factor scores rather than improving upon them. Therefore, the PCA-expanded factor scores are not described in the results.

Individual Factor Analysis

For each of the two sets of composite scores, the following modeling was performed: Univariate logistic regression models were developed for each factor score to calculate odds ratios for the association with use of walking as a primary mode of transportation. Potential confounders and interaction terms were added to the models individually. Covariates that changed the factor score regression coefficient by more than 10% were identified. If the covariate was hypothesized to be in the causal pathway, it was considered a mediator; otherwise it was considered a significant confounder. A final adjusted model containing all significant confounders and interactions was created for each set of composite scores.

Factor Set Analysis

Multivariate logistic regression models were produced for each of the two sets of composite scores using manual backwards selection to assess the simultaneous effect of factors. Significant confounders and interactions from univariate analyses were included in the model. Factors significant to $p \leq 0.05$ and interaction terms significant to $p \leq 0.01$ were retained. A higher significance level for interactions was set to reduce the likelihood of finding significant interaction due solely to performing multiple comparisons. Confounders and interaction terms were dropped from the model when the variables they were associated with were dropped from the model.

In addition, the relative association of individual characteristics with walking for transportation was assessed by including significant covariates as potential predictor variables in multivariate logistic models with composite scores. Composite scores and individual characteristics were loaded into multivariate logistic regression models as potential predictor variables and reduced to significant variables using backwards selection. Interactions were not assessed.

RESULTS

Descriptive Statistics

Results of t-tests for built environment characteristics are given in Tables 3a. Residential Density, Mixed-Use, Porches, Resting Place Density, Continuous Sidewalks, Unbarred Windows, Restaurants, Shops, and Medical Facilities were significantly greater among participants who walked for transportation. Narrow Roads, Curb Height, and Short Buildings were significantly lower among those who walked for transportation.

Table 3a: Built environment characteristics by use of walking for transportation

Built Environment Characteristic	Transportation Walking Mean (s.d.)	
	Yes N = 35	No N = 85
Functional		
Residential Density	0.182 (0.148)	0.116 (0.116) *
Non-Residential Use	0.104 (0.086)	0.110 (0.153)
Mixed-Use	0.022 (0.034)	0.008 (0.017) *
Porches	0.611 (0.139)	0.515 (0.153) **
Resting Place Density	0.33 (0.13)	0.27 (0.16) *
Continuous Sidewalks	0.979 (0.047)	0.952 (0.056) *
Sidewalk Width	64.14 (3.47)	63.79 (4.26)
Well-Maintained Sidewalks	0.580 (0.188)	0.560 (0.199)
Gentle Slope	0.877 (0.931)	0.902 (0.134)
Hard Sidewalks	1.00 (0.00)	1.00 (0.00)
Unobstructed Sidewalks	0.483 (0.219)	0.437 (0.166)
Buffer Zones	0.901 (0.094)	0.894 (0.108)
Safety		
Tree Density	1.32 (0.42)	1.24 (0.46)
Streetlight Density	0.49 (0.14)	0.51 (0.12)
Traffic Load	3.33 (2.11)	3.10 (2.33)
Narrow Roads	0.893 (0.120)	0.939 (0.088) *
Traffic Calming Devices	0.352 (0.183)	0.288 (0.177)
Posted Speed Limit	0.972 (0.050)	0.971 (0.057)
Bike Lanes	0.073 (0.132)	0.063 (0.104)
Buffer Zone Width	60.64 (17.62)	62.07 (14.87)
Curb Cuts	0.444 (0.196)	0.460 (0.192)
Curb Height	4.75 (0.39)	5.07 (0.42) **
Crossing Signals	0.700 (0.412)	0.554 (0.454)
Crossing Signal Time	0.945 (0.499)	1.252 (0.710)
Aesthetics		
Short Buildings	0.855 (0.137)	0.944 (0.082) **
Unbarred Windows	0.880 (0.071)	0.825 (0.101) **
Well-Maintained Yards	0.834 (0.116)	0.820 (0.126)
Well-Maintained Buildings	0.902 (0.129)	0.882 (0.110)
Litter Score	0.740 (0.201)	0.676 (0.215)
Destinations		
Restaurants	5.66 (4.85)	2.88 (3.43) **
Shops	2.51 (1.62)	1.66 (1.60) **
Medical Facilities	1.00 (1.14)	0.58 (0.78) *
Services	3.69 (2.64)	2.88 (2.48)
Activities	0.25 (0.61)	0.52 (0.84)
Park Area	105579 (128506)	134295 (181065)
Through Streets	0.995 (0.038)	0.968 (0.058)
Block Length	314.9 (30.7)	319.6 (60.8)
Restrooms	1.03 (1.29)	0.99 (1.59)
Bus Stops	13.86 (5.21)	12.76 (6.36)
Curbside Parking	0.106 (0.093)	0.094 (0.116)
Lot Parking	0.070 (0.076)	0.080 (0.096)

*$p < 0.05$ **$p < 0.01$

Odds ratios (OR) of the association between covariates and walking for transportation are provided in Table 3b. Race, Physical Activity Level, Health Status, Gender, Perceived Shopping Ease, Perceived Attractiveness, and Neighborliness were strongly associated with walking for transportation (OR = 1.96-3.63) and were included in model building. Perceived Night Safety was also retained (OR = 1.19) for conceptual significance.

Table 3b: Potential covariates by use of walking for transportation

Covariate	Transportation Walking Yes N = 35	No N = 85
Race		
White	29	64
Non-White	2	16
Missing	4	5
Gender		
Male	5	16
Female	15	23
Missing	15	46
Residence Time	13.71 (17.13)	13.71 (14.86) †
Perceived Sidewalk Quality		
Good	19	40
Poor	16	43
Missing	0	2
Perceived Shopping Ease		
Very Good	24	34 **
Average	11	51
Perceived Attractiveness		
Good	26	43*
Poor	9	42
Perceived Day Safety		
Safe	33	77
Unsafe	1	3
Missing	1	5
Perceived Night Safety		
Safe	26	53
Unsafe	7	17
Missing	2	15
Neighborliness		
Many	25	41*
Few	10	44
Extra-Neighborhood Exercise Walking		
Ever	21	47
Never	14	38

Table 3b: Potential covariates by use of walking for transportation

Covariate	Transportation Walking Yes N = 35	 No N = 85
Physical Activity Level		
Ever	30	64
Never	5	21
Health Status		
Good	32	69
Poor	3	15

* $p < 0.05$ ** $p < 0.01$

† *Residence Time is a continuous variable. Mean (s.d.) are provided.*

Table 3c provides the association between the two outcome variables, walking for transportation and walking for exercise within neighborhood. Intra-Neighborhood Exercise Walking had a strong association with Transportation Walking (OR = 5.41). In contrast, Extra-Neighborhood Exercise Walking did not have a strong association (OR=1.21).

Table 3c: Association between walking for transportation and walking for exercise

Intra-Neighborhood Exercise Walking	Transportation Walking Yes N = 35	 No N = 85
Ever	33	64 **
Never	2	21

* $p < 0.05$ ** $p < 0.01$

Principal Components Analysis

Figure 4 and Table 4 summarize the results of the PCA. Eight components displayed Eigen values greater than 1.0. The results of the scree test suggested that fewer than five components were meaningful. Use of more than four components caused several variables to be dropped due to loading on multiple components. Use of fewer than four components did not appreciably alter factor loadings. Additionally, conceptual meaning could be interpreted from the first four components. Therefore, the first four components were retained. Combined, these four components accounted for 57.2% of the total variance in the built environment characteristics.

Figure 4: Scree plot

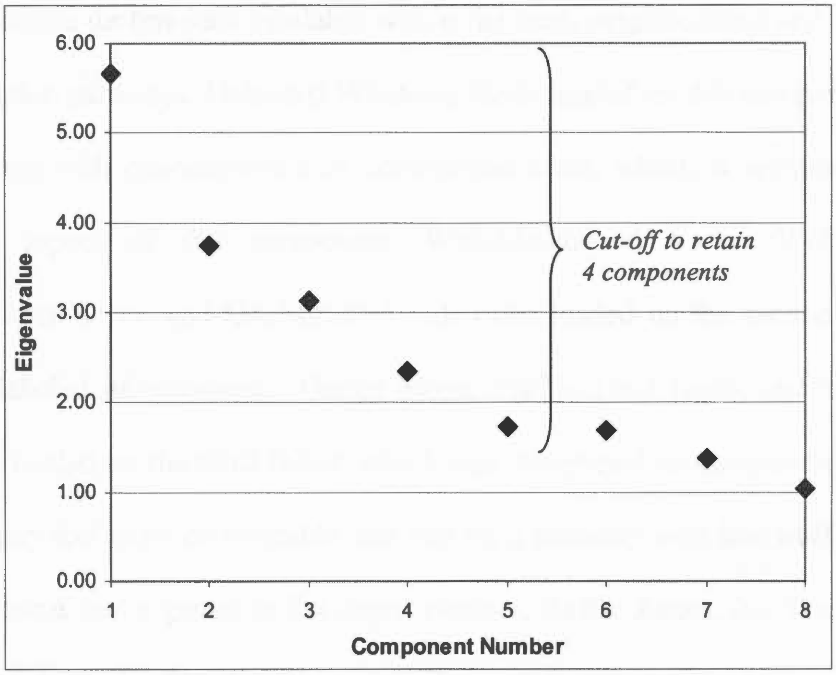


Table 4: Factor loadings, percentage of variance explained, and eigenvalues

Factor	Loading	Variance Explained	Eigenvalue
Factor 1 (Functionality)		22.0%	5.7
Unbarred Windows	0.57		
Sidewalk Width	0.52		
Bus Stops	0.71		
Restaurants	0.83		
Shops	0.66		
Square-Root of Services	0.83		
Factor 2 (Maintenance)		14.5%	3.8
Well-Maintained Yards	0.85		
Litter Score	0.54		
Well-Maintained Sidewalks	0.75		
Unobstructed Sidewalks	0.80		
Factor 3 (Comfort/Safety)		11.8%	3.1
Gentle Slope	0.78		
Logarithm of Buffer Zone Width	0.74		
Square-Root of Traffic Load	-0.79		
Factor 4 (Pleasantness)		8.9%	2.3
Porches	0.71		
Buffer Zones	0.44		
Traffic Calming Devices	0.90		

Variables loading on each component are shown in Table 4. Sidewalk Width, Bus Stops, Restaurants, Shops, Services (sqrt), and Unbarred Windows loaded on the first component labeled as *Functionality.* With the exception of Unbarred Windows, these variables describe destinations available within the local neighborhood and the presence of transportation pathways. Unbarred Windows likely loaded on this component because it is correlated with characteristics of commercial areas, which is appropriate for the destinations aspect of this component. Well-Maintained Yards, Well-Maintained Buildings, Litter Score, and Unobstructed Sidewalks loaded on the second component, which was labeled *Maintenance.* Gentle Slope, Traffic Load (sqrt), and log of Buffer Zone Width loaded on the third factor, which was interpreted as *Comfort/Safety*, since a pedestrian may feel more comfortable and safe on a pathway with low traffic volume, a wide buffer zone, and a gentle or flat slope. Porches, Buffer Zones, and Traffic Calming Devices loaded on the fourth component. Because the presence of these items on a pathway may serve to make a walking trip more serene or make the views more attractive, this factor was labeled as *Pleasantness*.

Creation of Factor Scores

Figure 5 summarizes the variables included in composite scores. Variables with a strong negative correlation with Transportation walking were assigned negative values in the factor score calculation: Narrow Roads ($r = -0.21$), Curb Height ($r = -0.33$), Short Buildings($r = -0.37$), and Activities ($r = -0.15$).

Mean, standard deviation, minimum, and maximum are provided in Table 5. Because predictor variables were standardized prior to summing factor scores, the mean of all factor scores is zero. However, the amount of variance within each factor scored differed, reflecting the varying number of variables summed over.

Figure 5: Composition of factor scores

PCA Factors			
Functionality	**Maintenance**	**Safety/Comfort**	**Pleasantness**
Destinations & facilities, pathways & transportation	*Condition of facilities and pathways*	*Walking comfort & safety, traffic condition & protection*	*Aesthetics & design, serenity of pathway*
Unbarred Windows Sidewalk Width Bus Stops Restaurants Shops Services (sqrt)	Well-Maintained Yards Well-Maintained Buildings Litter Score Unobstructed Sidewalks	Gentle Slope Buffer Zone Width (log) Traffic Load (sqrt)	Porches Buffer Zones Traffic Calming Devices
A Priori Factors			
Functional	**Safety**	**Aesthetics**	**Destinations**
Buildings, sidewalks, and street-life	*Personal & traffic safety*	*Views*	*Connectivity & facilities*
Residential Density (sqrt) Non-Residential Use (sqrt) Mixed-Use Porches Resting Place Density Continuous Sidewalks Sidewalk Width Well-Maintained Sidewalks Gentle Slope Unobstructed Sidewalks Buffer Zones	Tree Density Streetlight Density Traffic Load (sqrt) (-) Narrow Roads Traffic Calming Devices Posted Speed Limit Bike Lanes Buffer Zone Width (log) Curb Cuts (-) Curb Height	(-) Short Buildings Unbarred Windows Well-Maintained Yards Well-Maintained Buildings Litter Score	Restaurants Shops Medical Facilities Services (sqrt) (-) Activities Through Streets Block Length (inverse) Restrooms Bus Stops Curbside Parking Lot Parking

Pearson correlations between factor scores are provided in Table 6. All A Priori factor scores are highly correlated, suggesting that the scores may be measuring similar constructs. The correlation between PCA scores is low. This indicates that they are nearly orthogonal despite being simple linear combination and are not optimally weighted with regression coefficients from the PCA.

Table 5: Descriptive statistics of factor scores

Factor	Mean	Std Dev	Minimum	Maximum
PCA				
Functionality Score	0	4.520	-10.676	9.573
Maintenance Score	0	3.120	-9.042	4.831
Comfort/Safety Score	0	1.532	-3.581	3.873
Pleasantness Score	0	2.353	-5.499	4.454
A Priori				
Functional Score	0	4.347	-8.879	11.840
Safety Score	0	4.028	-10.025	11.772
Aesthetics Score	0	3.106	-7.081	6.593
Destinations Score	0	6.042	-11.427	16.146

Table 6: Pearson correlation between factor scores

PCA			
	Functionality Score	**Maintenance Score**	**Comfort/Safety Score**
Maintenance Score	0.01		
Safety/Comfort Score	-0.17	0.27**	
Pleasantness Score	0.15	0.02	0.02
A Priori			
	Functional Score	**Safety Score**	**Aesthetics Score**
Safety Score	0.66**		
Aesthetics Score	0.67**	0.49**	
Destinations Score	0.53**	0.43**	0.39**

* $p < 0.05$ ** $p < 0.01$

Individual Factor Analysis

Results of the univariate logistic regression models are given in Table 7. All A Priori scores were significantly associated with Transportation Walking. Of PCA scores, only Functionality and Pleasantness were significantly associated with Transportation Walking.

Table 7: Odds ratios for factor scores and walking for transportation, unadjusted

Factor	OR	95% CI	P-value
PCA			
Functionality Score	1.145	1.038-1.262	0.007
Maintenance Score	1.064	0.933-1.214	0.353
Comfort/Safety Score	0.932	0.720-1.205	0.590
Pleasantness Score	1.327	1.087-1.621	0.006
A Priori			
Functional Score	1.193	1.078-1.319	<.001
Safety Score	1.113	1.005-1.233	0.039
Aesthetics Score	1.256	1.084-1.455	0.002
Destinations Score	1.091	1.017-1.170	0.015

Significant confounders were variables that changed the factor score regression coefficients in the univariate models by more than 10% and were not hypothesized to be in the causal pathway. Perceived Shopping Ease, Perceived Attractiveness, Perceived Night Safety, Neighborliness, Health Status, Race, and Gender altered the coefficient by more than 10%. Table 8 provides significant confounders adjusted for each factor score.

Although Perceived Attractiveness adjusted the β-estimate of AP Aesthetics by ≥10%, it was not retained as a confounder for this factor score because it was hypothesized to be a mediator of the relationship between the A Priori Aesthetics score and walking behavior. Perceived Attractiveness was retained as a confounder for other factor scores. No meaningful interactions were found.

Adjusted models for each factor are given in Table 8. PCA Functionality and Pleasantness remained significant with ORs of 1.168 (1.056-1.293) and 1.404 (1.110-1.775), respectively. Maintenance (p=0.592) and Comfort (p=0.653) remained insignificant. All AP factors remained significant, with the following ORs: 1.176 (1.051-

1.315) for Functional, 1.150 (1.022-1.294) for Safety, 1.205 (1.037-1.401) for Aesthetics, and 1.108 (1.025-1.197) for Destinations.

Table 8: Odds ratios for factor scores and walking for transportation, adjusted for confounders

Factor	OR	95% CI	P-value
PCA			
Functionality Score [a]	1.168	1.056-1.293	0.003
Maintenance Score [b]	0.959	0.823-1.118	0.592
Comfort/Safety Score [c]	0.933	0.691-1.260	0.653
Pleasantness Score [d]	1.404	1.110-1.775	0.005
A Priori			
Functional Score [e]	1.176	1.051-1.315	<0.001
Safety Score [f]	1.150	1.022-1.294	0.021
Aesthetics Score [g]	1.205	1.037-1.401	0.015
Destinations Score [h]	1.103	1.019-1.193	0.015

[a] *Adjusted for: Gender.*
[b] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, Neighborliness, Perceived Night Safety, Health Status, and Gender.*
[c] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, Perceived Night Safety, Health Status, Gender, and Race.*
[d] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, and Race.*
[e] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, and Race.*
[f] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, Neighborliness, and Race.*
[g] *Adjusted for: Perceived Shopping Ease.*
[h] *Adjusted for: Perceived Shopping Ease and Gender.*

To put these results on a similar scale, we summarized a 1-s.d. increase in each factor [Table 5]. Among AP scores, the odds of walking for transportation is 2.1 times greater for a 4.5 point increase in AP Functional, 1.7 times greater for 4 point increase in Safety or a 3 point increase in Aesthetics, and 1.6 times greater for a 6 point increase in Destinations. For PCA factor scores, a 4.5 point increase in Functionality is associated with 2.0 times the odds of walking for transportation, and a 2.5 point increase in Pleasantness is associated with 2.3 times the odds of walking for transportation.

Factor Set Analysis

The simultaneous effect of factor scores in a combined model was assessed. Multivariate logistic regression models were produced for each set of factors after adjustment for significant confounders. Results are shown in Table 9. PCA Functionality and Pleasantness scores were significant in a single model, after controlling for measured confounders. The A Priori model was reduced to only containing the Functional score. No scores were significant in the full A Priori model with all factors and significant confounders (results not shown). This is likely due to the high correlation between A Priori factor scores.

Table 9: Odds ratios for factor scores modeled simultaneously with walking for transportation, adjusted for confounders

Factor	OR	95% CI	P-value
PCA [a]			
Functionality Score	1.137	1.016-1.273	0.025
Pleasantness Score	1.359	1.059-1.745	0.016
A Priori [b]			
Functional Score	1.176	1.051-1.315	<0.001

[a] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, Gender, and Race.*
[a] *Adjusted for: Perceived Shopping Ease, Perceived Attractiveness, and Race*

Factor scores and covariates were simultaneously modeled to assess the relative association of built environmental features and individual characteristics with walking for transportation [Table 10]. In the PCA model, Functionality (p=0.029), Pleasantness (p=0.006), and Perceived Shopping Ease (p=0.006) were retained. And in the A Priori model, Functional (0.003), Perceived Shopping Ease (0.022), and Neighborliness (0.030) were retained. Individual characteristics are significantly associated with walking for transportation after controlling for factor scores. These results suggest that individual attitudes and beliefs are associated with walking behavior independent of urban form.

Table 10: Odds ratios for factor scores and covariates modeled simultaneously with walking for transportation

Factor	OR	95% CI	P-value
PCA			
Functionality Score	1.131	1.013-1.263	0.029
Pleasantness Score	1.361	1.093-1.696	0.006
Perceived Shopping Ease (Good vs Poor)	3.510	1.424-8.652	0.006
A Priori			
Functional Score	1.170	1.054-1.299	0.003
Perceived Shopping Ease (Good vs Poor)	2.873	1.168-7.068	0.022
Neighborliness (Many vs Few)	2.762	1.104-6.944	0.030

Supplemental Analysis

To assess the potential usefulness of the two sets of factor scores in assessing associations with walking for recreation (strolling) or exercise, unadjusted univariate models were created for Intra-Neighborhood Exercise Walking, which was dichotomized as never walking within the neighborhood for exercise and walking within the neighborhood for exercise at least once per week. Results are provided in Table 11.

Table 11: Intra-Neighborhood Exercise Walking Univariate Logistic Regression Models

Factor	OR	95% CI	P-value
PCA			
Functionality Score	1.004	0.907-1.110	0.945
Maintenance Score	1.150	0.997-1.325	0.055
Comfort/Safety Score	1.327	0.980-1.796	0.067
Pleasantness Score	1.083	0.896-1.311	0.410
A Priori			
Functional Score	1.070	0.954-1.199	0.249
Safety Score	1.067	0.948-1.200	0.282
Aesthetics Score	1.214	1.038-1.420	0.015
Destinations Score	1.004	0.928-1.087	0.920

The only A Priori score significantly associated with Intra-Neighborhood Exercise Walking was Aesthetics (OR: 1.214; 95% CI: 1.038-1.420). Among associations between PCA scores and Intra-Neighborhood Exercise Walking, Maintenance (p = 0.055) and Comfort/Safety (p = 0.067) were borderline significant.

DISCUSSION

Two methods of creating neighborhood-level factor scores from segment-level built environment characteristics measured by SWEAT were compared in their association with walking for transportation using a sample of community-dwelling adults in Portland, Oregon. A Priori scores were created for the Functional, Safety, Aesthetics, and Destinations factors in the conceptual model behind SWEAT. A PCA created four factors interpreted as Functionality, Maintenance, Comfort/Safety, and Pleasantness. These factor scores were significantly associated with walking for transportation and walking for exercise, indicating that SWEAT is a valid instrument for measuring built environment features important for walking.

Factor Scores

The four PCA factors created in this study are different from that of the conceptual model used to create SWEAT. While presence of destinations within walking distance was its own factor in the conceptual model, the PCA placed it in the same index as pathway presence and land use type. Similarly, the pathway characteristics included in the Functional factor of the conceptual model were distributed by the PCA into other meaningful factors, suggesting that the presence and condition of pathways are separate constructs.

However, there is also consistency among the themes underlying the factor scores. The existence of pathways allowing for walking appeared in both factor sets. The concept of safety in pathway design, particularly traffic volume and buffer zone width, also was common between the factor sets. The Aesthetics factor in the conceptual model was notably similar to the Maintenance factor created by the PCA, substantiating that appearance of the neighborhood is an important determinate of walking behavior. And presence of destinations within walking distance appeared in both composite scores, under AP Destinations and PCA Functionality.

Association with Walking Behavior

All A Priori scores were significantly associated with use of walking as a primary mode of transportation before and after adjusting for confounders. In the Portland, Oregon neighborhoods studied, an increase of approximately one standard deviation in any single factor was associated a 70-110% increase in walking for transportation.

Of the four PCA scores, only Functionality and Pleasantness were significantly associated with walking for transportation before and after adjusting for confounders. Approximately one standard deviation change in Functionality was associated with twice the rate of walking for transportation; the increase in walking for transportation associated with an approximately one standard deviation increase in Pleasantness was slightly greater.

The usefulness of these factors for explaining walking for reasons other than transportation, such as strolling and fitness, was tested though unadjusted univariate models assessing the association between factor scores and walking for exercise within the neighborhood. Surprisingly, the only A Priori score associated with exercise walking was Aesthetics. In addition, among PCA scores, Maintenance and Comfort/Safety were borderline significant, while Functionality and Pleasantness were not associated. These results are the opposite of results for Walking for transportation, suggesting that two PCA factors are useful for explaining destination walking while two other factors may be useful for recreation/fitness walking.

A Priori factor scores were not significantly associated with walking for transportation when modeled simultaneously. This indicates that the indices are not orthogonal, which is substantiated by the large correlation between the scores. This suggests that A Priori indices measure similar or overlapping constructs. Both PCA factors that were individually significant – Functionality and Pleasantness – were also significant together. This is not surprising, since components created in PCAs are orthogonal by design in the analysis. And although the factor-based scores are not optimally weighted, it is expected that the resulting scores would also be nearly orthogonal.

Important Covariates

Participant perceptions of the ease of shopping within their neighborhood, the attractiveness of their neighborhood, and the safety of walking in their neighborhood were significant confounders of the association between the built environment and walking for transportation. How many neighbors a participant knew, health status, and gender were also important individual characteristics that confounded the role of urban form on walking behavior.

In addition, participant perception of neighborhood attractiveness appeared to be a mediator of the association between the A Priori Aesthetics score and walking for transportation. After adjusting for participant perception of neighborhood attractiveness, the objective measure of attractiveness created with SWEAT data was no longer significant. This suggests that SWEAT may be capable of measuring the subjective attribute of "attractiveness" using objective measures. This finding is consistent with Cunningham's (2005) finding that qualitative observations of environmental features did not provide unique or different assessments than were made with SWEAT.

Perceived ease of travel to local shopping and familiarity with neighbors were significantly associated with walking for transportation when included as independent variables in the full multivariate model. The resulting odds ratios for these two factors were larger than odds ratios for factor score. Participants who perceived local shopping to be convenient or knew many of their neighbors were roughly three-times more likely to walk. Because this is a cross-sectional study, it is unknown if these factors lead to or result from increased walking. However, these results highlight the importance of attitudes and beliefs, particularly perceived ease of travel, in transportation decisions. These results indicate that efforts to increase walking for transportation should include effort to change the built environment and individual attitudes related to the perceived environment, community, and transportation.

In this study, participants' perception of their neighborhood and other individual characteristics were important mediators and confounders of the association between the built environment and walking for transportation, but were also independent predictor variables of walking behavior after controlling for the built environment. This highlights the intricate web of association between the environment, individual characteristics, and transportation choices.

Relationship to Existing Research

Factor Scores

The PCA factors created here are also different from the results of a previous PCA using SWEAT data at the segment-level (Cunningham, 2005), which found indices described as Sidewalks, Safety, Street-life, and Density. Because GIS amenities counts were not included in Cunningham's segment-level analysis, her Density factor may be comparable to the destination items in the Functionality factor created here. Also, both her Safety factor and the Comfort/Safety factor created in this study contain the themes of traffic load and perceived sense of separation from traffic. However, unlike Cunningham, this study did not find a single factor describing sidewalks. Also, none of the items in her Street-life that were also included in this PCA loaded on any factor created here. The difference between Cunningham's segment-level PCA constructs and the neighborhood-level constructs created in this PCA suggests that environmental features important for describing a street may be different than environment features important for describing a neighborhood.

Interestingly, the PCA factors created here are similar to levels in Alfonzo's hypothesized Hierarchy of Walking Needs (Alfonzo, 2005). In this model, pedestrian needs progress from the most basic to higher-order, such that "an individual would not typically consider a higher-order need in his or her decision to walk if a more basic need was not already satisfied" (p. 818). In order, these levels are: Feasibility, Accessibility, Safety, Comfort, and Pleasurability [Figure 6].

Figure 6: Comparison of Alfonzo's Hierarchy of Walking Needs with PCA results

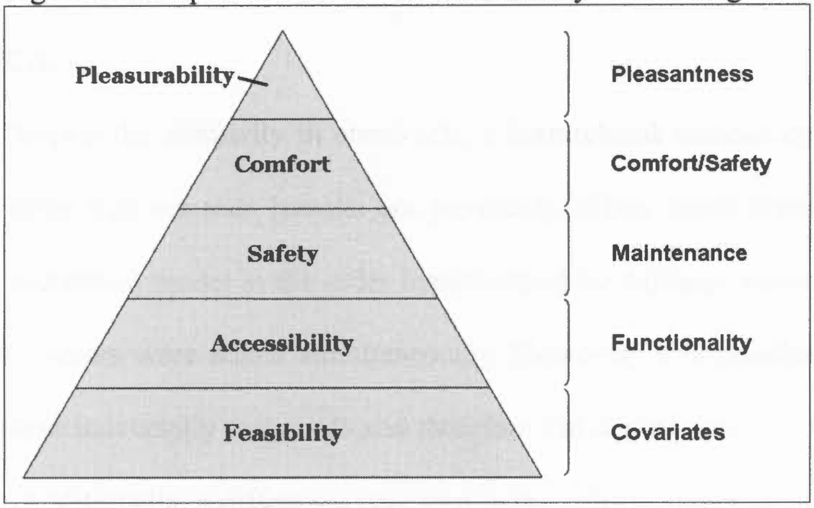


Figure adapted from Alfonzo, 2005.

Feasibility refers to individual characteristics affecting the viability of walking, such as mobility, time constraints, and physical condition. Individual characteristics like these were not directly assessed in this study, although relevant variables such as health status and physical activity level were assessed as covariates. Accessibility refers to the availability, connectivity, and interest of nearby activities. The PCA Functionality factor closely resembles this level, which included items for nearby amenities and pathways. The Safety level refers specifically to the threat of crime, rather than protection from traffic, as was included in both the PCA Comfort/Safety factor and the AP Safety factor. Also, items suggested as proxy measures of crime, such as litter, suggest that the PCA Maintenance factor may be more similar than PCA Comfort/Safety. Comfort refers to the pedestrian's ease, convenience, and contentment, which more closely resembles the PCA Comfort/Safety factor than did Safety. Both include concepts of wide and easy pathways, and reduced prominence of cars. Finally, Pleasurabilitiy refers to the setting's appeal to a potential pedestrian, associated with concepts such as complexity, scale, street-life, and aesthetics. This factor is nearly identical conceptually to the Pleasantness factor created in the PCA.

Despite the similarity in constructs, a hierarchical association between the PCA factor scores was not seen [results not provided]. When factor scores were added to a logistic regression model in the order hypothesized by Alfonzo, results were the same as when all factors were added simultaneously. However, it is possible that insignificant factors were universally met needs and therefore did not influence participants' decisions to walk. Additionally, a difference was seen in the relative importance of factors between transportation and exercise walking. While Alfonzo recognizes that "certain levels of need may be more salient… depending on the type of walk or purpose for the walk" (p. 823), her model does not adequately account for the difference. Results from this study and similar studies may help define the place for walk purpose in her model.

Association with Walking

The results of this study are consistent with previous work. Pikora et al (2006) found that functional factors, such as walking surface and traffic volume, and destination factors, such as nearby parks and shops, were significantly associated with walking near home in Australia using the Systematic Pedestrian and Cycling Environmental Scan (SPACES), an Australian environmental audit tool. An association between proximity to certain destinations and walking has been found in other studies as well (Alfonzo, 2005; King et al, 2005; Patterson & Chapman, 2004). Features of the sidewalk and streetscape were significantly associated light-intensity physical activity in adolescent boys (Jago, 2005). And Hoehner (2005) found that walking for transportation was influenced by slope, aesthetics, proximity to destinations, and access to public transit, while recreation walking was influenced only by aesthetics.

The relative importance of different environmental factors varied depending on the purpose of walking in this study. The importance of distinguishing the purpose of walking (ie, transportation/destination, exercise, recreation/strolling) is echoed by many researchers (Humpel et al, 2004; Saelens, Sallis & Frank, 2003; Suminski et al, 2005). Similar to this study, Handy, Cao and Mokhtarian (2006) found that proximity to destinations and neighborhood accessibility was associated with destination trips, but not strolling trips.

The results of this study suggest that individual characteristics and perceptions of built environment are independent predictors of walking behavior. Participant familiarity with neighbors and perception of the convenience of travel to local shopping were significantly associated with walking for transportation after controlling for objective built environment features. The importance of individual-level factors in the decision to walk has been shown elsewhere (Alfonzo, 2005; Bagely & Mokhtarian, 2002; Handy, Cao & Mokhtarian, 2006; Hoehner, 2005; Kitamura, Mokhtarian & Laidet, 1997).

Many existing studies use global measures of urban form rather than specific items of the built environment (Lee et al, 2006; Li et al, 2005). Walking was positively associated with some built environment factors in a cross-sectional study by King et al (2005) using GIS-identified counts of businesses/facilities within walking distance and median age of homes and as a proxy for urban form. Frank et al (2005) uses a Walkability Index created in a linear combination of standardized measures of land use mix, residential density and intersection density obtained with GIS. By using specific built environment items, such as sidewalk width and presence of buffer zones, the factors created with SWEAT provide specific recommendations for planners designing walkable communities.

LIMITATIONS

Audited segments were randomly selected from named neighborhoods, not randomly selected from participants' local neighborhoods. Because of this, the segments identified within local neighborhoods may not be representative of the true local neighborhood characteristics considered by the respondents. However, because households are located on randomly selected segments, and therefore randomly selected by proxy, this bias should be small. In addition, households without multiple audited segments in their local neighborhood will be excluded from this study to improve the validity of aggregated values.

Because the outcome of interest (walking as a primary mode of transportation) is not defined as occurring within the participant's neighborhood, it is possible that outcome misclassification was introduced if participants primarily walk outside of their local neighborhood rather than within the area assessed by this study, For example, a participant may commute by car or bus to work, but frequently runs errands near their office on foot during their lunch break. However, the strong association between the outcome of interest and walking for exercise within home neighborhood, and the weak association between the outcome and walking for exercise outside of home neighborhood, suggests that the outcome variable used in this analysis is mainly measuring walking near home. Also, this bias would most likely be non-differential and would attenuate an association between neighborhood built environment and walking behavior.

Canvassing typically occurred during the day on weekdays, when many adults are away from the home. Therefore, interviewed participants may not be representative of street segment residents. For example, this selection method may have over-sampled stay-at-home mothers, retirees, and disabled or ill individuals. Participants in this study were more likely to be white and female than the general population of the audited named neighborhoods, according to data from the 2000 Census. Selection bias may have been introduced if participants in the study differed from residents in their local neighborhood built environment or walking behaviors.

The generalizability of this study is limited. Observation was done within established, traditional neighborhoods in a northwestern city. It is likely that the built environment in these neighborhoods differ from that of cities in other regions of the United States, or even from that of other areas of the Portland metropolitan area. Since SWEAT is an extensive tool which assesses a wide range of items, it is unlikely that an important factor was overlooked. In addition, it is unlikely that the exclusion of subjective factors (such as "attractiveness") will overlook important features, because when compared to qualitative assessments SWEAT's assessments did not substantially differ (Cunningham et al, 2003). However, it is possible that a potentially important explanatory variable may not be included in the analysis because of lack of variability or simply not being present in this environment. The results of this study would be valid, but may not be generalizable outside of the Portland-metro area. In particular, the constructs identified in this PCA and related factor scores may not be generalizable. Another study using SWEAT in a different environment may find different significant factors. The external validity of study results may be further limited because participants may not be representative of the selected named neighborhoods. On the other hand, participants may actually best represent the individuals most affected by the local neighborhood's built environment characteristics because they remain in the local neighborhood for more of the day. In this way, the study population may be more sensitive, allowing the study to find truly significant associations that would be overlooked by a more representative population.

The ability of this study to control for potential confounders is limited to the questions obtained by interview. Some potential confounders controlled for in other studies were unavailable, such as age, socioeconomic status (SES), educational attainment, and BMI (Frank et al, 2005; Hoehner et al, 2005; Jago et al, 2005; King et al, 2005; Rutt et al, 2004; Suminski et al, 2005; VanLenthe et al, 2004). Named-neighborhood level comparisons of 2000 US Census data for percent of residents age 65 and older, median income, and percent of residents below the poverty line show little association with factor scores and walking behaviors among study participants. This suggests a weak effect of unmeasured confounders. Percent of residents below the poverty line was marginally associated with factor scores and walking behavior, suggesting that controlling for SES may have reduced the strength of the observed associations, but would not entirely attenuate them. Furthermore, gender was missing for half of participants, due to changes made to the interview format during data collection. Therefore, the adjustment for gender in this analysis is incomplete, leaving residual confounding. Because missing gender information was due to changes related to human subject protection policy rather than attributes of neighborhoods or participants, it is expected that there the gender distribution is the same among participants with gender data and those without. Because gender acted as a negative confounder with PCA Functionality and A Priori Destinations, complete adjustment would be expected to strengthen the observed association. In addition, this study assessed potential confounders not included in previous studies, such as safety and neighborliness, bringing new insight to the current literature.

An important methodological issue in research of the association of urban form is *self-selection*, the notion that an individual's attitudes and preferences about transportation behaviors influence the neighborhood in which they choose to reside. A common method for controlling for self-selection is by measuring attitudes and behaviors and including them as covariates in statistical models (Cao, Handy & Mokhtarian, 2006; Kitamura, 1997), which was done in this analysis. By controlling for perceived attributes of the environment, this study partly controls for self-selection. Also, models including perceived environment items as predictor variables found that attitudes and beliefs were significantly associated with walking for transportation, but that objective measures of the built environment were still important in determining walking behaviors.

Because the proposed study is cross-sectional, it is not possible to conclude a cause-effect relationship from the results. In particular, it is not possible to determine whether the built environment encouraged residents to walk, or if individual with a propensity for walking self-selected into more walkable neighborhoods. This study attempted to control for this effect by the inclusion of covariates such as length of residence and health status. A longitudinal study would be necessary to assess the temporal relationship of associations; this study offers tools for a longitudinal to assess that association.

FUTURE RESEARCH

This study establishes SWEAT as a valid and reliable environmental audit tool in a metropolitan area in the northwest. In addition, these results aid researchers of the association between the built environment and health by providing methods of measuring and scoring environmental features associated with walking.

It is important to study the use of SWEAT in other communities. Different communities have different variations in environment and behavior, and the repetition of studies like this one could highlight associations between additional built environment factors and walking and improve the design of SWEAT. In particular, SWEAT should be tested in a suburban or rural community. Studies using SWEAT should perform a PCA to assess if the constructs identified here are reproduced and therefore generalizable outside of this study population.

In addition, SWEAT should be used in a longitudinal study to assess the impact of built environment changes on resident walking. The current study, and much of the existing body of research, is limited by a cross-sectional design. It is important to conduct prospective and retrospective studies to overcome the limits of the current research to assess the temporal relationship between the built environment and behavior and to assess the possibility of changing community behavior and health through the design of the built environment.

Also, the difference in factor scores associated with exercise walking when compared to walking for transportation highlights the importance of distinguishing the reason for walking in future studies. Future research should fully examine the association between the factor scores created in this PCA with walking for exercise and leisure.

WORKS CITED

Alfonzo MA. (2005). To walk or not to walk? *Environment and Behavior, 37*(6):808-836.

Bagley MN & Mokhtarian PL. (2002). The impact of residential neighborhood type on travel behavior: a structural equation modeling approach. *Ann Reg Sci, 36*: 279-297.

CDC. (November 17, 2006a). *Overweight and Obesity*. Centers for Disease Control and Prevention Website. Accessed 11/18/06 http://www.cdc.gov/nccdphp/dnpa/obesity/

CDC. (October 9, 2006b). *Prevalence of Overweight and Obesity Among Adults: United States, 2003-2004*. Centers for Disease Control and Prevention Website. Accessed 11/18/06 from http://www.cdc.gov/nchs/products/pubs/pubd/hestats/obese03_04/ overwght_adult_03.htm.

Cao X, Handy S, & Mohktarian PL. (2006). The influences of the built environment and residential self-selection on pedestrian behavior. *Transportation, 33*(1): 1-20.

Cunningham GO & Michael YL. (2004). Concepts guiding the study of the impact of the built environment on physical activity for older adults: a review of the literature. *Am J Health Promotion, 18*(6): 435-43.

Cunningham, G.O., et al. (2005). Developing a reliable senior walking environmental assessment tool. *Am J Prev Med, 29*(3): 215-8.

Frank, LD, Schmid TL, Sallis JF, Chapman J, & Saelens BE. (2005). Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. *Am J Prev Med, 28*(2S2): 117-25.

Frank, LD, M.A. Andresen, and T.L. Schmid. (2004). Obesity relationships with community design, physical activity, and time spent in cars. *Am J Prev Med, 27*(2): 87-96.

Handy S, Cao X, & Mohktarian PL. (2006). Self-selection in the relationship between the built environment and walking. *Journal of the American Planning Association, 72*(1):55-74.

Hatcher L. (1994). *A step-by-step approach to using SAS for factor analysis and structural equation modeling*. Cary, NC: SAS Institute Inc.

Hoehner C, Brennan Ramirez LK, Elliott MB, Handy SL, & Brownson. (2005). Perceived and objective Environmental measures and physical activity among urban adults. *Am J Prev Med, 28*(2S2): 105-116.

Hu FB, et al. (2003). Television watching and other sedentary behaviors in relation to risk of obesity and type 2 diabetes mellitus in women. *JAMA, 289*(14): 1785-91.

Humpel N, Owen N, Iverson D, Leslie E, & Bauman A. (2004). Perceived environment attributes, residential location, and walking for particular purposes. *American Journal of Preventive Medicine, 26*(2):119-25.

Jago R, T. Baranoswski, I. Zakeri, & M. Harris. (2005). Observed environmental features and the physical activity of adolescent males. *Am J Prev Med, 29*(2): 98-104.

Kerr J, et al. (2006). Active commuting to school: associations with environment and parental concerns. *Medicine & Science in Sports & Exercise, 38*(4):787-794.

King, W.C., et al. (2005). Objective measures of neighborhood environment and physical activity in older women. *Am J Prev Med, 28*(5): 461-9.

Kitamura R, Mokhtarian PL & Laidet L. (1997). A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. *Transportation, 24*:125-158.

Lee, C., A. Vernez Moudon, & J.Y. Pip Courbois. (2006). Built environment and behavior: Spatial sampling using parcel data. *Ann Epi, 16*(5): 387-94.

Levine, J.A., et al. (2005). Interindividual variation in posture allocation: possible role in human obesity. *Science, 307*(5709): 584-6.

Li, F., K.J. Fisher, R.C. Brownson, M. Bosworth. (2005). Multilevel modeling of built environment characteristics related to neighborhood walking activity in older adults. *J Epidemiol Community Health, 59*: 558-64.

Lopez, Rl. (2004). Urban sprawl and risk for being overweight or obese. *Am J Public Health, 94*(9): 1574-9.

Office of Neighborhood Involvement. (n.d.). *2000 Portland neighborhood demographic data in Excel file*. Portland Office of Neighborhood Involvement Website. Accessed 4/13/07 from http://www.portlandonline.com/oni/index.cfm?c=28387.

Owen, N., et al. (2004). Understanding environmental influences on walking; Review and research agenda. *Am J Prev Med, 27*(1): 67-76.

Patterson P & Chapman N. (2004). Urban form and older residents' service use, walking, driving, quality of life, and neighborhood satisfaction. *American Journal of Health Promotion, 19*(1): 45-52.

Pikora, TJ, Giles-Corti B, Knuiman M, Bull FC, Jamrozik K, & Donovan RJ. (2006). Neighborhood environmental factors correlated with walking near home: using SPACES. *Medicine & Science in Sports & Exercise, 38*(4): 708-14.

Rutt, C.D., and K.J. Coleman. (2005). Examining the relationships among built environment, physical activity, and body mass index in El Paso, TX. *Prev Med, 40*(6): 831-41.

Saelens, B.E., J.F. Sallis, & L.D. Frank. (2003). Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Ann Behav Med, 25*(2): 80-91.

Sternfeld, B., et al. (2004). Physical activity and changes in weight and waist circumference in midlife women: findings from the Study of Women's Health Across the Nation. *Am J Epidemiol, 160*(9): 912-22.

Suminski RS., et al. (2005). Features of the neighborhood environment and walking by U.S. adults. *American Journal of Preventive Medicine, 28*(2):149-155.

Timperio A, Salmon J, Telford A, & Crawford D. (2004). Perceptions of local neighborhood environments and their relationship to childhood overweight and obesity. *International Journal of Obesity, 29*:170-175.

U.S. Department of Transportation. (2003). *National Highway Transportation Survey 2001 Highlights Report*, Washington, DC: Bureau of Transportation Statistics. BTS03-05.

Van Lenthe FJ, Brug J, & Mackenbach JP. (2004). Neighbourhood inequalities in physical inactivity: the role of neighbourhood attractiveness, proximity to local facilities and safety in the Netherlands. *Social Science & Medicine, 60*:763-775.

Wilkerson, A. (2006). *Neighborhood design and neighborliness.* Unpublished masters thesis, Oregon Health and Science University, Portland, Oregon, USA.

APPENDICES

APPENDIX A: Senior Walking Environmental Audit Tool (SWEAT)

Neighborhood ID ________
Segment ID ________
Primary observer ID __________
Secondary observer ID ________

Date________ **(Mo/Day/Yr)**
Start time __________
Temp in Fahrenheit ________
Is it raining? Yes _____ **No** _____

Please provide street and cross streets of block you are observing
Street: ______________________________
Cross1: ______________________________
Cross2: ______________________________
Record in notes names of bldgs other than residential.

1. Count buildings *(count number, 0 or greater)*

	Side 1	Side 2
Single Family	______	______
Apts/Condos	______	______
Row/town homes	______	______
Duplexes	______	______
Institutional	______	______
Retail	______	______
Commercial	______	______
Public	______	______
Religious	______	______
Mixed Use	______	______
Total	______	______

Describe mixed use (note vertical, horizontal attached or horizontal detached):
____
____
____
____

2. Record number of buildings with the following stories: (count number, 0 or greater)

	Side 1	Side 2	Total
1	______	______	______
2	______	______	______
3	______	______	______
4	______	______	______
5+	______	______	______

3. Number of buildings on the block with front porches or areas where residents can overlook the street and/or interact with other pedestrians or street users. *(Count number, 0 or greater)*

Side 1	Side 2	Total
______	______	______

4. Count residential or commercial buildings that have noticeable bars. *Count number, 0 or greater*

Side 1	Side 2	Total
______	______	______

5. Yard maintenance: (well-maintained = looks trim & clean)

- >75% well maintained ☐ 1
- 50-74% well maintained ☐ 2
- <50% well maintained ☐ 3

6. Condition of the buildings: (can you see broken windows, graffiti, litter or other signs of damage)

- 5% or less have damaged/need repair ☐ 1
- 5-25% have damage/need repair ☐ 2
- >25% have damage/need repair ☐ 3

7. Height of trees- *(count number, 0 or greater, with the following heights)*:

	Side 1	Side 2	Total
≤15ft	______	______	______
>15ft	______	______	______

8. Are there benches for individuals to rest on, if necessary, along the street of this block?

	Side 1	Side 2
No	☐ 0	☐ 0
Yes	☐ 1	☐ 1
If yes, count (1 or greater):	______	______

9. Conditions of benches:

- Clean and not damaged ☐ 1
- Some are dirty & damaged ☐ 2
- All in poor condition ☐ 3

10. Are there other places (e.g. ledges or retaining walls) for pedestrians to rest on or gather around?

	Side 1	Side 2
No	☐ 0	☐ 0
Yes	☐ 1	☐ 1
If yes, count	______	______

Describe:
____
____

11. Can you see any litter, graffiti, broken glass, etc.?

- None or almost none ☐ 0
- Yes, but not dominant feature ☐ 1
- Yes, dominant feature ☐ 2

12. Are there publicly accessible restrooms on this block?

- No ☐ 0
- Yes ☐ 1

13. Count streetlights *(0 or greater)*:

	Side 1	Side 2
At crossing areas	______	______
Other locations on street	______	______

14. Are public streetlights positioned at transit stops? *(if transit stops are present)*

- No ☐ 0
- Yes ☐ 1
- No transit stops ☐ 98

15. Commercial parking (check all that apply):

	Side 1	Side 2
Curbside parking	☐ 1	☐ 1
Behind buildings or underground	☐ 2	☐ 2
Between building front and street	☐ 3	☐ 3
Parking Lot independent of building	☐ 4	☐ 4
No commercial/retail	☐ 98	☐ 98

16. Are sidewalks continuous?

	Side 1	Side 2
No	☐ 0	☐ 0
Yes	☐ 1	☐ 1
No sidewalks	☐ 98	☐ 98

17. Sidewalk Slope:

	Side 1	Side 2
Flat/gentle	☐ 1	☐ 1
Steep slope	☐ 2	☐ 2

18. Sidewalk material *(check all that are present)*:

	Side 1	Side 2
Asphalt	☐ 1	☐ 1
Concrete	☐ 2	☐ 2
Bricks/Tile	☐ 3	☐ 3
Gravel	☐ 4	☐ 4
Dirt	☐ 5	☐ 5
Grass	☐ 6	☐ 6
Under repair	☐ 7	☐ 7
Private lawn	☐ 8	☐ 8
Other	☐ 9	☐ 9

List ______________________

19. Sidewalk condition & smoothness:

	Side 1	Side 2
Good (<10%has bumps, cracks, holes, weeds)	☐ 1	☐ 1
Moderate (10-50% has bumps, cracks, holes, weeds)	☐ 2	☐ 2
Poor (>50% has bumps, cracks, grates, holes, weeds)	☐ 3	☐ 3
Under repair	☐ 4	☐ 4

20. Sidewalk obstructions(mark all that create considerable obstruction/danger to pedestrian traffic):

	Side 1	Side 2
None	☐ 0	☐ 0
Bump/crack/hole	☐ 1	☐ 1
Weeds/leaves	☐ 2	☐ 2
Standing water/ice	☐ 3	☐ 3
Poles/signs	☐ 4	☐ 4
Tables/Chairs	☐ 5	☐ 5
Trees/shrubs	☐ 6	☐ 6
Parked Cars	☐ 7	☐ 7
Other	☐ 8	☐ 8

*Describe:*____

____

21. Permanent items in the buffer zone (mark all that are present).

	Side 1	Side 2
None	☐ 0	☐ 0
Bike Racks	☐ 1	☐ 1
Controller boxes	☐ 2	☐ 2
Fire hydrants	☐ 3	☐ 3
Grate/hatch cover	☐ 4	☐ 4
Mailboxes	☐ 5	☐ 5
Newspaper boxes	☐ 6	☐ 6
Parking meter	☐ 7	☐ 7
Planter or flowers	☐ 8	☐ 8
Public Garbage Cans	☐ 9	☐ 9
Signal poles	☐ 10	☐ 10
Signs	☐ 11	☐ 11
Street light	☐ 12	☐ 12
Street furniture	☐ 13	☐ 13
Telephone booth	☐ 14	☐ 14
Trees or Shrubs	☐ 15	☐ 15
Utility poles	☐ 16	☐ 16
Wall	☐ 17	☐ 17
Water fountains	☐ 18	☐ 18
Other	☐ 19	☐ 19

Please describe ____

____

____

22. Are signs (including directional signs for pedestrians and signs in front of retail, commercial stores) on this street clear and large?

>50% are clear & large	☐ 1
10-50%are clear & large	☐ 2
<10% are clear & large	☐ 3

23. Does this segment end in a cul-de-sac or dead end?

No	☐ 0
Dead end w/o pedestrian thruway	☐ 1
Dead end with pedestrian thruway	☐ 2
Cul-de-sac	☐ 3

24. How many lanes of traffic are there in this block?

1 ☐ 2 ☐ 3 ☐ 4+ ☐

*If any lane(s) is/are designated for other purposes at specific times, please describe*____

25. Is there a designated bike lane in the street?

Yes	☐ 1
No	☐ 0

26. What is the posted speed limit?

_______ **mph**

If none posted, enter 98.

27. Is there a traffic circle, roundabout or other traffic-calming device (e.g. signs, bumps, marked crosswalk)?

Yes	☐ 1
No	☐ 0

If yes, list:

____

____

____

28. Do intersections and crosswalks <u>WITH TRAFFIC SIGNALS</u> have pedestrian signals?

	Int 1	Int2
No pedestrian signals	☐ 0	☐ 0
Ped signals but not controllable	☐ 1	☐ 1
Ped signals & controllable	☐ 2	☐ 2

29. Time traffic signal (Green) or pedestrian signal if present (Walk):

	Int 1	Int2
Green/WALK	________ sec	__________ sec

Please circle what signal you observed.

NOTES:

30. If traffic signals exist, measure length of crosswalks *(in normal paces)*

Int 1	Int 2
________ paces	________ paces

31. Width of *paved* sidewalk (in):

	Side 1	Side 2
Max	________	________
Min	________	________

32. Do crossing areas have ramps or curb cuts?

	Side 1	Side 2
None	☐ 0	☐ 0
Yes, at some crossing areas	☐ 1	☐ 1
Yes, at all crossing areas	☐ 2	☐ 2

33. Measure height of curbs on this street (in.).

	Side 1	Side 2
1 crossing area	______	______
2 crossing area	______	______
3 crossing area	______	______

Enter 98 if not applicable (fewer than 3 crossing areas without ramps/curb cuts on either side)

34. Width of buffer zone (in):
See picture below for ONE example of a buffer zone.

Side 1	Side 2
________	________

35. Count cars going in one direction for 2 minutes.
Repeat for other direction.

Dir 1	Dir2
________	________

Enter end time__________
Segment Difficulty on a scale of 1(easiest) – 5 (most difficult) (please describe any specific difficulties you had in assessing this street in the notes section.):

APPENDIX B: Structured Household Survey

Household ID: ____________________
Start time: ____________
The questions on social capital

Questions 1-17 examine 'view of local area'

> This topic looks at the physical environment in which people live, the facilities in their area, and whether they feel safe in the area. People's feelings about their physical environment can relate to each of the other aspects of social capital.

Now I would like to ask you some questions about your local area. By area I mean within a 15-20 minute walk or a 5-10 minute drive from your home.

1. How many years have you lived in this area?
RECORD YEARS________________
IF LESS THAN 1, CODE AS 0 and go to 2.
IF 1 or greater, skip to 3.
0..97 Round up or down to nearest whole number

> Q1 is designed to find out how long the respondent has lived in the area, as defined in the preamble. So if someone has lived at their current address for 5 years, but previously lived two streets away for 3 years, they are coded as 8 years. If the answer is less than 1year, than they are coded as 0.

2. How many months have you lived in this area?

____
0..11

> Q2 is only asked of those who have lived in the area for less than a year.

3. Would you say this is an area you enjoy living in?

Yes.. 1
No... 2
Don't know............................. 3

> The following questions (Q4-14) ask about the facilities in the local area. The answer categories shown on the card include 'don't know or have no experience', which is usually excluded as an explicit response. It was felt it was important to include as some respondents would genuinely have no idea.

Now I'd like you to refer to Show Card A, the red card.

[*] Thinking generally about what you expect of local services and built environment, how would you rate the following:

4. [*] Leisure facilities for people like yourself
SHOW CARD A
1 2 3 4 5 6

> In Q4 the emphasis is on the social and leisure services the respondent wishes to use. Examples would include publicly and privately provided services, such as, community centers, pools, senior centers, parks, Eagle's lodge, Boys and Girls club, etc.

5. [*] Garbage removal
SHOW CARD A
1 2 3 4 5 6

6. [*] Local health services (a clinic or local hospital, for example)
SHOW CARD A
1 2 3 4 5 6

> A hospital should be considered local if it serves the local area, even if it is not physically within a 15-20 minute walk or a 5-10 minute drive.

7. [*] Local public schools
SHOW CARD A
1 2 3 4 5 6

8. [*] Community colleges and adult education
SHOW CARD A
1 2 3 4 5 6

9. [*] Local police service
SHOW CARD A
1 2 3 4 5 6

10. [*] Existence and upkeep of sidewalks
SHOW CARD A
1 2 3 4 5 6

11. [*] Ease of travel between your house and local market, shopping
SHOW CARD A
1 2 3 4 5 6

12. [*] Attractiveness of local area
SHOW CARD A
1 2 3 4 5 6

Now we're done with Show Card A.

13. What form of transportation do you use to get where you need to go? (Allow for spontaneous answer, only read options if respondent offers no answer. May include up to 3 responses.)

1. Car/motorcycle/moped
2. Public transport (buses/max)
3. Bicycle
4. Walking
5. Other
6. Never goes out

This question is trying to obtain the main form of transportation used by the respondent. If respondents ask for a reference period, suggest 'in a typical week.' If respondent spontaneously indicates more than one "main form" of transportation, up to 3 may be coded.

The code 'car/motorcycle/moped' includes lifts from other people, including ride share. The code 'public transport' includes the lift and street car.

14. [*] Would you say this area has good public transportation for where you want to go?

1. Yes
2. No
3. Don't know

15. [*] How safe do you feel walking alone in this area during daytime? (Read running prompt)
Do you feel...
RUNNING PROMPT

1. Very safe
2. Fairly safe
3. A bit unsafe
4. Very unsafe
5. Or do you never go out alone during daytime

16. [*] How safe do you feel walking alone in this area after dark?
Do you feel...
RUNNING PROMPT

1. Very safe
2. Fairly safe
3. A bit unsafe
4. Very unsafe
5. Or do you never go out alone after dark

Questions 17-23 examine 'civic engagement'

Indicators of civic engagement and trust of civic institutions and process are central to Putnam's understanding of social capital. Cognitive research in UK found that these concepts were the most difficult to operationalize in the form of survey questions. This difficultly stemmed from 2 issues: (i) trying to measure a community-level resource by means of individual-level questions; and (ii) the rarity of civic engagement, or knowledge of such processes.
Q17 and 18 are intended to capture how the R feels overall about most issues and most of the time. If R indicates "sometimes," "it depends", etc. ask "What would you say ***overall*** about whether you are well informed..." or "What would you say ***overall*** about whether you can influence decisions..."

These will be yes/no questions.
17. [*] Thinking of the same local area... Would you say you are well informed about local issues? (Probe if necessary: such as education, health, housing...)

1. Yes
2. No
3. Don't know

18. [*] Would you say you can influence decisions that affect your area?

1. Yes
2. No
3. Don't know

19. Please refer to Show Card B, the orange card.
To what extent do you agree or disagree with the following statements?
[*] By working together, people in my neighborhood can influence decisions that affect the neighborhood.
SHOW CARD B

1 2 3 4 5 6

20. [*] Newspapers are a reliable source of information about local issues.
SHOW CARD B

1 2 3 4 5 6

Now we're done with Show Card B.

21. Have you been involved in any local organizations over the past 3 years (while living in this area)?

1. Yes
2. No

IF no, go to Q24.

> Local organizations could include:
> - parent/teacher associations
> - school associations
> - religious organizations such as churches, mosques or temples
> - neighborhood or tenants' associations
> - neighborhood watch
> - support groups
> - local branches of national organizations
>
> However, it would exclude just being a member of a sport or social club which is included in Q24.

22. How many local organizations have you been involved with over the past 3 years?

____

23. In the past 3 years (while living in this area), have you had any responsibilities in this (these) organization(s), such as being a committee member, raising funds, organizing events or doing administrative or clerical work?

1. Yes
2. No

> Active involvement would include responsibilities such as:
> - taking minutes
> - being a committee member
> - organizing events
> - raising funds by collecting money
> - delivering and picking up donations envelopes
> - working in a charity shop
>
> However it would exclude just attending meetings

24. Have you been involved in any team sports or social groups over the past 3 years (while living in this area)?

1. Yes
2. No

If no, go to question 26.

> Team sports or social group would include hobby clubs (gardening, cards), soccer, softball, bowling team etc. but not simply membership in a gym or athletic club.

25. How many team sports or social groups have you been involved with over the past 3 years?

____

Questions 26-36 examine 'view of local area'

Please refer to Show Card C, the yellow card.

[*]Still thinking about the same area, I mean within a 15-20 minute walk or a 5-10 minute drive from your home, can you tell me how much of a problem these things are.

26. [*] The speed or amount of road traffic
SHOW CARD C
1 2 3 4 5 6

27. [*] Vehicles not stopping for pedestrians in crosswalk
SHOW CARD C
1 2 3 4 5 6

28. [*] Parking in residential streets (availability)
SHOW CARD C
1 2 3 4 5 6

29. [*] Property Crime (Probe if necessary: Breaking car window, for example)
SHOW CARD C
1 2 3 4 5 6

30. [*] Trash and litter lying around
SHOW CARD C
1 2 3 4 5 6

31. [*] Owners not picking up after their dogs
SHOW CARD C
1 2 3 4 5 6

32. [*] Graffiti or vandalism
SHOW CARD C
1 2 3 4 5 6

33. [*] Level of noise
SHOW CARD C
1 2 3 4 5 6

34. [*] Homeless people or vagrants hanging around on the streets
SHOW CARD C
1 2 3 4 5 6

35. [*] Alcohol or drug use
SHOW CARD C
1 2 3 4 5 6

> Problems associated with alcohol and drug use (Q35) could include people hanging around the streets drunk or affected by drugs, syringes littering the streets, or people openly buying or selling drugs.

36. [*] Increasing housing costs forcing out long-term neighborhood residents.
SHOW CARD C
1 2 3 4 5 6

Now we're done with Show Card C.

Question 37 examines 'civic engagement'

Please refer to Show Card D, the green card.

37. In the past 3 years, have you taken any of the following actions in attempt to solve a local problem?

CODE ALL THAT APPLY

SHOW CARD D

1 2 3 4 5 6 7 8

The emphasis in this question is taking action about a local issue. For example, 'contacted a local representative' would include writing to a representative about a local issue such as plans to close the accident and emergency unit of the local hospital, but excludes writing to rep about a national issue.

Question 38 examines 'view of local area'

We're done with that card, please refer to Show Card E, the light blue card.

38. Have you personally been a victim of any of the following crimes in the past 12 months?

CODE ALL THAT APPLY

SHOW CARD E

1 2 3 4 5 6

Now we're done with Show Card E.

As this question might be sensitive for some respondents, a show card is used, so the respondent only has to read out a number.

Questions 39-42 examine 'reciprocity and local trust'

Trust of strangers is a central dimension of Putnam's conception of social capital. It was found in testing in UK that respondents were unable or unwilling to answer questions concerning trust of others in relation to an a area that extended beyond their immediate neighborhood, or when applied to people the respondent did not know personally. Therefore, the next set of questions asks respondents to think about their neighborhood: that is, the street or the respondent's part of the street, the block of apartments, or whatever the respondent thinks of as their immediate area.

[*]Now I would like to ask you a few questions about your more immediate neighborhood by which I mean your street or block.

39. [*] Would you say that you know...

RUNNING PROMPT

1. Most of the people in your neighborhood
2. Many of the people in your neighborhood
3. A few of the people in your neighborhood
4. Or that you do not know people in your neighborhood?

Cognitive testing in UK found that the term 'know' was consistently understood as applying to neighbors whom the respondent knew by sight, which apartment or house they lived in, and well enough to have something of a conversation with. Knowing the neighbor's name was not a necessary requirement of knowing the person.

40. [*] Would you say that you trust...

RUNNING PROMPT

1. Most of the people in your neighborhood
2. Many of the people in your neighborhood
3. A few of the people in your neighborhood
4. Or that you do not trust people in your neighborhood?

41. [*] Would you agree this neighborhood is a place where neighbors look out for each other?

1. Yes
2. No
3. Don't know

42. In the past 6 months, have you done a favor for a neighbor?

1. Yes
2. No
3. Just moved into the area

Examples of favors are:

- taking in mail
- watering plants
- lending tools or garden equipment
- carrying things up stairs
- feeding pets when neighbors go away
- shopping

If people have just moved into area, interviewers can probe to see if the respondent has done or received a favor since they moved into the area. It may be that neighbors have helped them when they were actually moving in.

43. And, in the past 6 months, have any of your neighbors done a favor for you?

1. Yes
2. No
3. Just moved into the area

The following 2 sections on 'social networks' and 'social support' investigate measures of social capital relating to individuals.
The section on social networks attempts to address the quality of contact (closeness) as well as frequency.

Questions 44-52 examine 'social networks'

Please refer to Show Card F, the pink card. The next few questions are not limited to your local area, and are about how often you see or speak to your relatives and friends. Not counting the people you live with, how often do you do any of the following?

44. Speak to relatives on the phone...
SHOW CARD F
1 2 3 4 5 6 7 8

45. See relatives
SHOW CARD F
1 2 3 4 5 6 7 8

46. Email relatives
SHOW CARD F
1 2 3 4 5 6 7 8

47. Speak to friends on the phone...
SHOW CARD F
1 2 3 4 5 6 7 8

48. See friends...
SHOW CARD F
1 2 3 4 5 6 7 8

49. Email friends
SHOW CARD F
1 2 3 4 5 6 7 8

50. Speak to neighbors...
SHOW CARD F
1 2 3 4 5 6 7 8

Now we're done with Show Card F.

Q44-52 are about relatives or friends living outside the respondent's household. Interviewers may need to probe to ensure that respondents are not counting the same people twice; someone may be a friend and a neighbor, but should only be coded once.

Work colleagues should be counted as friends only if the respondent sees them outside working hours and outside the working premises. Similarly, if a student sees other students only at classes or lectures, they should not be included as friends.

51. Apart from the people you live with, how many relatives that you feel close to live within a 15-20 minute walk or 5-10 minute drive, if any?
RECORD NUMBER 0..15 ____________
IF MORE THAN 15 CODE AS 15.

52. How many close friends live within a 15-20 minute walk or 5-10 minute drive, if any?
RECORD NUMBER 0..15 ____________
IF MORE THAN 15 CODE AS 15

Questions 53-60 examine 'social support'

Hypothetical scenarios are used to explore individuals' social support. Cognitive testing in UK found that the strongly preferred response from some respondents was not to ask anyone for help. The questions were revised to ask first if respondents 'could' ask for help and, if so, who 'would' they ask. Answers are chosen from a card which includes 'would prefer not to ask for help' as an option.

The interviewer may need to probe to ensure that respondents are not counting the same people twice; someone may be a friend and a neighbor, but should only be coded once. If the respondent mentions only one person, the interviewer should probe by asking 'anyone else?'

I am going to read a list of situations where people might need help. For each one, could you tell me if you would ask anyone for help?

53. You urgently need a ride to be somewhere.
Could you ask someone for help?
1. Yes
2. No
3. Don't know

IF Yes or Don't know, go to 54.
IF No, go to 55.

54. Can you look at Show Card G, the purple card, and tell me who you would ask for help? (Please choose the three most important to you.)
CODE UP TO 3 ANSWERS
SHOW CARD G
1 2 3 4 5 6 7 8 9

In Q54 the category 'voluntary or other organization' would include voluntary or community organizations that transport people, such as Tri-Met The Lift.

55. You are ill in bed and need help at home. Could you ask someone for help?
1. Yes
2. No
3. Don't know

'Help at home' means help with domestic tasks such as cooking and cleaning.

IF Yes or Don't know, go to 56.
IF No, go to 57.

56. Can you look at the card and tell me who you would ask for help? (Please choose the three most important to you.)
CODE UP TO 3 ANSWERS
SHOW CARD G

1 2 3 4 5 6 7 8 9

57. You are in financial difficulty and need to borrow $100. Could you ask someone for help?

1. Yes
2. No
3. Don't know

IF Yes or Don't know, go to 58.
IF No, go to 59.

Loans from banks or other financial institutions should be excluded.

58. Can you look at the card and tell me who you would ask for help? (Please choose the three most important to you.)
CODE UP TO 3 ANSWERS
SHOW CARD G

1 2 3 4 5 6 7 8 9

Now we're done with Show Card G.

59. If you had a serious personal crisis, how many people, if any, do you feel you could turn to for comfort and support?
RECORD NUMBER 0..15 ____________
IF MORE THAN 15 CODE AS 15.

This question needs to be dealt with sensitively, as it can be upsetting for people who are socially isolated. Examples of personal crises include bereavement or a partner leaving.
If respondents have difficulty in giving a number for this and the following question (Q60), the interviewer should ask them to give an estimate.

60. How many of these people (Does this person) live within a 15-20 minute walk or 5-10 minute drive, if any?
RECORD NUMER 0..15 ____________
IF MORE THAN 15 CODE AS 15

Questions 61-64 examine 'walking for exercise' and 'health'
Please refer to Show Card H, the dark blue card.

On average, how often in a typical week do you:

61. Walk for exercise in your neighborhood.
SHOW CARD H

1 2 3 4 5

62. Walk for exercise outside your neighborhood.
SHOW CARD H

1 2 3 4 5

63. Exercise for 20 minutes or more at a level that increases your breathing rate enough to raise a sweat?
SHOW CARD H

1 2 3 4 5

Now we're done with Show Card H.

64. In general, would you say your health is...
RUNNING PROMPT

1. Excellent
2. Very good
3. Good
4. Fair
5. Poor

65. How do you find out about what's going on in your neighborhood? (record response verbatim)

66. For what age group or groups would you say this neighborhood is best suited?
You may choose more than one answer.
RUNNING PROMPT

1. Children
2. Teenagers
3. Young Adults
4. Middle Age
5. Seniors

67. What changes to the built environment (if any) would need to happen to make your neighborhood more suitable for people of all ages? (record response verbatim)
(By built environment we mean the features of your neighborhood that are not part of the natural environment, for example buildings, sidewalks, roads.)

Ask race/ethnicity question on cover sheet.
End time: _______________

Notes:

Card A

1. Very Good
2. Good
3. Average
4. Poor
5. Very Poor
6. Don't know or have had no experience

Card B

1. Strongly Agree
2. Agree
3. Neither agree nor disagree
4. Disagree
5. Strongly disagree
6. Don't have an opinion

Card C

1. Very big problem
2. Fairly big problem
3. Minor problem
4. It happens but is not a problem
5. Not at all a problem
6. Don't know

Card D

1. Contacted a local official (call, letter, email)
2. Worked on local political campaign
3. Started a service you felt was needed
4. Written to a local newspaper
5. Contacted the appropriate organization to deal with the problem, e.g., the neighborhood association or police
6. Participated in a clean up or beautification project
7. Provided financial support to local organization or campaign
8. None of the above

Card E

1. Theft or break-in to house or apartment
2. Theft or break-in to car parked in area
3. Personal experience of theft or mugging in the area
4. Physical attack in the area (e.g., hit or kicked in a way that hurt you)
5. Racist attack in the area (either verbal or physical)
6. None of these

Card F

1. Every day
2. 5 or 6 days a week
3. 3 or 4 days a week
4. Once or twice a week
5. Once or twice a month
6. Once every couple of months
7. Once or twice a year
8. Not at all in last 12 months

Card G

1. Husband/wife/partner
2. Other household member
3. Relative (outside household)
4. Friend
5. Neighbor
6. Work colleague
7. Voluntary or other organization
8. Other
9. Would prefer not to ask for help

Card H

1. Not at all (0 times per week)
2. A little bit (1-2 times per week)
3. A moderate amount (3-4 times per week)
4. Quite a bit (5-6 times per week)
5. A great deal (every day)

APPENDIX C: Complete Variable Description

Name	Description	Transportation Walking =Yes N = 35 Mean (s.d.)	Transportation Walking =No N = 85 Mean (s.d.)	Source
Outcome variable				
Transportation Walking	Walking used as a primary mode of transportation (Yes/No)	---	---	Interview
Potential predictor variables				
Residential Density (sqrt)	Percent of buildings that are multiple-family dwellings	0.182 (0.148)	0.116 (0.116) *	SWEAT
Non-Residential Use (sqrt)	Percent of buildings that are non-residential (institute, retail, commercial, public, religious)	0.104 (0.086)	0.110 (0.153)	SWEAT
Mixed-Use	Percent of buildings that are mixed-use	0.022 (0.034)	0.008 (0.017) *	SWEAT
Short Buildings	Percent of buildings less than 3 stories tall	0.855 (0.137)	0.944 (0.082) **	SWEAT
Unbarred Windows	Percent of buildings without bars on windows	0.880 (0.071)	0.825 (0.101) **	SWEAT
Porches	Percent of residential buildings with porches	0.611 (0.139)	0.515 (0.153) **	SWEAT
Well-Maintained Yards	Percent of segments with well maintained yards	0.834 (0.116)	0.820 (0.126)	SWEAT
Well-Maintained Buildings	Percent of segments with well/fair maintained buildings	0.902 (0.129)	0.882 (0.110)	SWEAT
Tree Density	Average number of trees > 15 ft per 100 segment feet	1.32 (0.42)	1.24 (0.46)	SWEAT
Resting Place Density	Average number of resting places per 100 segment feet	0.33 (0.13)	0.27 (0.16) *	SWEAT
Litter Score	Average litter score (1 = little litter, 0 = heavy litter)	0.740 (0.201)	0.676 (0.215)	SWEAT
Restrooms	Total number of restrooms	1.03 (1.29)	0.99 (1.59)	SWEAT
Streetlight Density	Total number of streetlights per 100 segment feet	0.49 (0.14)	0.51 (0.12)	SWEAT
Curbside Parking	Percent of segment sides with curbside parking (for retail)	0.106 (0.093)	0.094 (0.116)	SWEAT
Lot Parking	Percent of segment sides with parking lots in front of buildings (for retail)	0.070 (0.076)	0.080 (0.096)	SWEAT
Continuous Sidewalks	Percent of sides with continuous sidewalks	0.979 (0.047)	0.952 (0.056) *	SWEAT
Gentle Slope	Percent of sides with flat/gentle sidewalk slope	0.877 (0.931)	0.902 (0.134)	SWEAT
Hard-Surface Sidewalks	Percent of sides with concrete and/or asphalt sidewalks	1.00 (0.00)	1.00 (0.00)	SWEAT
Well-Maintained Sidewalks	Percent of sides with sidewalks in good/fair condition	0.580 (0.188)	0.560 (0.199)	SWEAT
Sidewalk Width	Average sidewalk width	64.14 (3.47)	63.79 (4.26)	SWEAT
Unobstructed Sidewalks	Percent of sides without sidewalks obstructions	0.483 (0.219)	0.437 (0.166)	SWEAT
Buffer Zones	Percent of sides with buffer zones	0.901 (0.094)	0.894 (0.108)	SWEAT
Buffer Zone Width (log)	Average buffer zone width	60.64 (17.62)	62.07 (14.87)	SWEAT
Through Streets	Percent of segments with thru-ways	0.995 (0.038)	0.968 (0.058)	SWEAT
Narrow Roads	Percent of segments with 1 or 2 lanes of traffic	0.893 (0.120)	0.939 (0.088) *	SWEAT
Bike Lanes	Percent of segments with bike lanes	0.073 (0.132)	0.063 (0.104)	SWEAT
Traffic Calming Devices	Percent of segments with traffic calming devices	0.352 (0.183)	0.288 (0.177)	SWEAT

Name	Description	Transportation Walking =Yes N = 35 Mean (s.d.)	Transportation Walking =No N = 85 Mean (s.d.)	Source
Posted Speed Limit	Percent of segments with speed limit ≤25 miles/hour	0.972 (0.050)	0.971 (0.057)	SWEAT
Crossing Signals	Percent of signaled intersections with pedestrian signals	0.700 (0.412)	0.554 (0.454)	SWEAT
Crossing Signal Time	Average time to cross crosswalk (feet per second)	0.945 (0.499)	1.252 (0.710)	SWEAT
Curb Cuts	Percent of segments with curb cuts at crossings	0.444 (0.196)	0.460 (0.192)	SWEAT
Curb Height	Average curb height	4.75 (0.39)	5.07 (0.42) **	SWEAT
Traffic Load (sqrt)	Number of cars per minute (both directions)	3.33 (2.11)	3.10 (2.33)	SWEAT
Bus Stops	Number of bus stops within 1/4 mile	13.86 (5.21)	12.76 (6.36)	GIS/RLIS
Restaurants	Number of restaurants within 1/4 mile	5.66 (4.85)	2.88 (3.43) **	GIS/RLIS
Shops	Number of retail/shopping businesses within 1/4 mile	2.51 (1.62)	1.66 (1.60) **	GIS/RLIS
Medical Facilities	Number of medical offices/services within 1/4 mile	1.00 (1.14)	0.58 (0.78) *	GIS/RLIS
Services (sqrt)	Number of services within 1/4 mile	3.69 (2.64)	2.88 (2.48)	GIS/RLIS
Activities	Number of activities within 1/4 mile	0.25 (0.61)	0.52 (0.84)	GIS/RLIS
Park Area	Square feet of parks and trails within 1/4 mile	105579 (128506)	134295 (181065)	GIS/RLIS
Block Length (inverse)	Average segment length	314.9 (30.7)	319.6 (60.8)	GIS/RLIS

* $p < 0.05$ ** $p < 0.01$

Name	Description	Transportation Walking =Yes N	Transportation Walking =No N	Source
Covariates				
Race	Minority status			Interview
	White	29	64	
	Non-White	2	16	
	Missing	4	5	
Gender	Gender			Interview
	Male	5	16	
	Female	15	23	
	Missing	15	46	
Residence Time	Years lived in the area	13.71 (17.13)	13.71 (14.86) †	Interview
Perceived Sidewalk Quality	Perceived existence and upkeep of neighborhood sidewalks			Interview
	Good	19	40	
	Poor	16	43	
	Missing	0	2	

Name	Description	Transportation Walking =Yes N	Transportation Walking =No N	Source
Perceived Shopping Ease	Perceived ease of travel between home and local shopping			Interview
	Very Good	24	34 *	
	Average	11	51	
Perceived Attractiveness	Perceived attractiveness of neighborhood			Interview
	Good	26	43	
	Poor	9	42	
Perceived Day Safety	Perceived safety of walking alone during day			Interview
	Safe	33	77	
	Unsafe	1	3	
	Missing	1	5	
Perceived Night Safety	Perceived safety of walking alone after dark			Interview
	Safe	26	53	
	Unsafe	7	17	
	Missing	2	15	
Neighborliness	Familiarity with neighbors			Interview
	Many	25	41	
	Few	10	44	
Intra-Neighborhood Exercise Walking	Frequency of walking for exercise in local neighborhood			Interview
	Ever	33	64 **	
	Never	2	21	
Extra-Neighborhood Exercise Walking	Frequency of walking for exercise outside local neighborhood			Interview
	Ever	21	47	
	Never	14	38	
Physical Activity Level	Frequency of exercise			Interview
	Ever	30	64	
	Never	5	21	
Health Status	Health status			Interview
	Good	32	69	
	Poor	3	15	

* $p < 0.05$ ** $p < 0.01$

† Residence Time is a continuous variable. Mean (s.d.) are provided.