Determining the Influence of the Neighborhood Environment on Walking Among Older Adults: An Analysis of the Association between Perceived and Objective Environmental Factors

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A THESIS

Presented to the Department of Public Health

and Preventive Medicine

And the Oregon Health Sciences University

School of Medicine

in partial fulfillment of

the requirements for the degree of

Master of Public Health

June 2004

School of Medicine
Oregon Health Sciences University

CERTIFICATE OF APPROVAL

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Acknowledgements

I would like to acknowledge and thank my advisor, Dr. Yvonne Michael, for all of her wonderful guidance and inspiration during the whole process. I would also like to thank my committee members, Dr. Dongseok Choi and Dr. Stephanie Farquhar for their time and tremendous contributions to my project. I couldn't have asked for a better committee.

I also thank my mom, Joanne Beard and my finacé, Grant Hansel along with the rest of my family and friends for their patience and understanding while I have been working on this project. Special thanks to Aleksandra Sumic and Shelley Hansel for their help editing my thesis.

ABSTRACT

Context: As obesity rates in the US continue to rise and widespread adoption of an active lifestyle has yet to occur, public health advocates are looking beyond the individual to examine the physical and social environments that may be influencing physical activity levels. Recently, the built environment has been examined to assess its influence on physical activity. Much of the research uses self-reports to describe the built environment while recently audit instruments and Geographic information systems are being employed to characterize the built environment. The relation between objective and perceived measurement is not clearly understood. No research to date has examined the difference between perceived and objective views of the environment specifically for older adults and their relation to physical activity for this population.

Objective: To examine the degree of association between perceived and objective characteristics of the neighborhood environment for older adults and the relation of each type of measurement to neighborhood walking in this population. Environmental features examined include sidewalk existence, sidewalk obstructions, graffiti and vandalism, presence of malls, parks and trails.

Study Design: This cross-sectional analysis linked individual level data on walking and the perceived neighborhood environment collected as part of a neighborhood-based walking intervention trial, Senior Health and Physical Exercise (SHAPE) with a study of built environmental factors measured using GIS analysis and audit instruments, Senior Walking Environmental Assessment Tool (SWEAT). Both studies were conducted in Portland, OR in 2002 and 2003.

Study Participants: 105 participants aged 65 and older selected from 10 control neighborhoods in a walking intervention trial (SHAPE).

Methods: Comparison of perceived and objective measurements of the built environment was conducted using Pearson's chi-squared test and the kappa statistic. Two logistic regression models were created using self-reported measures of the built environment and objective measurements from an audit instrument.

Conclusion: Perceived and objective measurements of the built environment were not significantly associated with a low degree of agreement between the two measures. Logistic regression analysis controlling for socio-demographic variables indicated that objective and perceived presence of malls in the neighborhood were associated with an increase in neighborhood walking (Objective OR=4.122 (.609, 27.918) Perceived OR=2.099 (.849, 5.189)). Objective measurements of graffiti and vandalism in the neighborhood were associated with lower levels of neighborhood walking.

INTRODUCTION

Physical inactivity along with diet may soon replace tobacco as the most preventable cause of death.[1] Conversely research strongly supports the benefits of physical activity in reducing adverse health outcomes such as coronary heart disease, hypertension, non-insulin dependent diabetes, colon cancer and depression. However, 60% of American adults do not meet the Surgeon General's recommendations for physical activity.[2,3] As Americans age, they become less likely to be active and by age 75, nearly a third of all men and a half of all women do not participate in any form of physical activity.[4]

Epidemiologic studies involving physical activity have predominantly focused on the individual characteristics and individual interventions for behavior change. As obesity rates in the US continue to rise and widespread adoption of an active lifestyle has yet to occur, public health advocates are looking beyond the individual to examine the physical and social environments that may be influencing physical activity levels.[5] Taking a more ecological approach, public health researchers are turning to the impact of the built environment, traditionally the focus of urban planning and transportation disciplines, to assess its influence on physical activity.[6,7] Examining how the environment acts as a facilitator or barrier to physical activity may inform the design of policy interventions and influence urban designs that promote activity.[8] Features of the built environment that have been analyzed include land development patterns, transportation systems, and micro-scale urban design.[9,10,11,12,13,14,15] Examples of the measures used to study these features are given in Table 1.

Table 1: Dimensions of the Built Environment: Definitions and Examples

Dimension	Definition	Examples of measures
Land Development Patterns		
Density	Amount of people (jobs) per unit area	Persons per acre Jobs per square mile
Land use mix	Proximity of different land uses	Share of total land area for different uses Distance from house to nearest store
Transportation systems		
Street Connectivity	Directness and availability of alternative routes through the network	Intersections per square mile of area Ratio of straight-line distance to network distance Average block length
Micro-scale design		
Aesthetic qualities	Attractiveness and appeal of a place	Number of locations with graffiti per square mile Size and orientation of windows Percent of ground in shade at noon

Table Adapted from Handy and colleagues, "How the Built Environment Affects Physical Activity. Am J Prev Med 2002; 23 (2s)

Benefits of Physical Activity for Older Adults

The benefits of physical activity on health are supported by research. Higher physical activity levels have consistently been associated with lower mortality risk.[16,17] The lower risk of heart disease with increased physical activity is now widely accepted and several studies have indicated that inactivity may be the leading risk factor for coronary heart disease.[18] Studies have shown that exercise can lower blood pressure and decrease cholesterol. While the benefit of physical activity on reducing the risk of all cancers is currently unknown, exercise has been shown to reduce colon cancer and according to more recent evidence, breast cancer.[19,20] The risk of acquiring diabetes for those without the disease and the risk of secondary conditions for older adults with diabetes is lower among those with higher activity levels. Older adults may particularly benefit from exercise with a reduction in the risk of osteoporosis, hip fractures, and arthritic pain.[21,22,23,24] In addition, regular walking may reduce the risk of falls for older adults. One study reported a 58% decrease in falls among older women participating in an exercise program.[25] Studies have also shown that older adults who exercise have fewer depressive symptoms, better psychological health and increased functional capacity.[26,27,28] Recent research also suggests that exercise may reduce cognitive decline.[29]

Older Adults and the Built Environment

Walking is particularly important for seniors who may have limited transportation options and often select walking as the most accessible and affordable option for physical activity.[30] The built environment may be particularly influential for older adults in deterring or promoting walking. Finding safe and accessible locations for physical activity have been cited as important features of the physical environment for seniors.[31] Also, dramatic differences in walking between older Americans as compared with German and Dutch elders indicate that environmental factors may be influential. While walking increases with age in these countries, the percentage of people in the U.S. who walk for transportation decreases to an already extremely low level. Nearly half of all trips made by Germans and Dutch aged 75 and older are by walking and biking while only 6% of trips made by Americans aged 65 and older are by foot or bike.[32]

As part of the Alameda County Study, a prospective study with a cohort of nearly 7,000 adults, six potential neighborhood problems such as traffic, noise and litter were examined to determine their effect on physical functioning.[33] After adjusting for age, sex, baseline physical function, socioeconomic status, social involvement, health status and health practices, participants in neighborhoods with multiple problems were greater than two times more likely to experience incident loss of function than individuals without serious neighborhood problems (OR=2.23 95% CI: 1.08, 4.60). Loss of lower-extremity physical function was even greater among those reporting multiple neighborhood problems compared with individuals in neighborhood with no major problems. (OR 3.12 95% CI: 1.15, 8.51). While not measuring physical activity directly, this study provides support that the built environment influences health in older adults. In addition, the physical environment may have a direct effect as well on physical activity levels if the loss of lower-extremity physical function results in decreased physical activity.

Inconsistencies in Current Research

Epidemiologic studies have examined environmental factors such as street connectivity, land-use mix and population density of urban planning and transportation research to assess the relationship with physical activity levels.[10,34,35,36] Other studies included neighborhood aesthetics, traffic patterns, sidewalk quality and terrain features to describe the built environment.[11,13,15,37] Convenience to locations and access to nearby facilities have also been analyzed to determine their association with physical activity.[13,15] The results of these studies have been inconsistent, especially in the case of certain features such as sidewalks.[38] The discrepancies in the studies may be due to the variety of instruments used to characterize the environment. Defining the elements of the physical environment and constructing valid instruments for measuring them will be necessary to further examine how these factors influence physical activity. An important measurement issue in this field is the use of perceived versus objective measures of the built environment. Determining whether perceived or objective measures are more highly associated with physical activity is important for conducting future research and necessary to gain a clearer understanding of how to target interventions related to the built environment to increase physical activity. The following critical review of the related literature identifies limitations and inconsistencies that the current research will address.

Defining the Features of the Built Environment

The variety of methods used to describe the environment can create obstacles when trying to compare previous studies or developing interventions from them. Studies that analyze the relationship between physical activity and the environment using composite neighborhood walkability scores limit the ability to determine specific elements of the built environment that promote or deter activity. Craig and colleagues combined 18 characteristics of the physical environment including a variety of destinations, scenery, safety, availability of walking routes, and traffic and found a small positive association with walking to work.[39] Other studies include different combinations of features or facilities and destinations to assess their relationship with physical activity.[40] However, translation of the results of such studies into policy interventions is limited if the specific features and destinations or facilities that are the most influential are not known. The present study will assess both the presence of specific features and particular destinations to address the above issue.

While many other studies in this area did select specific features and destinations of the physical environment, the variables are often too general or subjective to be useful in creating policy and developing interventions. When comparing the environment's features associated with physical activity levels for 2,912 older women in the US, King and others found a positive significant association between self-reported enjoyable scenery and higher physical activity levels (OR=1.42 95% CI: 1.12-1.79).[41] In a study of 1,242 rural middle aged and older women, Wilcox and colleagues also found that the lack of enjoyable scenery was associated with sedentary behavior (OR=1.71 95% CI: 1.16, 2.053).[42] However, the variable, enjoyable scenery does not provide us with information on the specific characteristics of the environment that are considered "enjoyable," thereby impeding translation into policy. More detail on the micro-scale features contributing to "enjoyable scenery" would be necessary for creating policies related to the neighborhood environment. The present study will examine the presence of graffiti and vandalism in the neighborhood as one specific component of scenery.

A variety of instruments have also been used to determine the influence of sidewalks on physical activity with inconsistent results. King, AC and colleagues found no association between sidewalks and physical activity. Using a telephone survey of 1818 randomly selected individuals throughout the US, Brownson and colleagues had participants respond to questions on the physical environment including sidewalk existence, and their physical activity level.[43] Brownson, unlike King, AC and others, found a significant positive relationship between physical activity and the presence of sidewalks as well as heavy traffic and hills. Women living in rural areas were less likely to report presence of sidewalks and access to facilities compared to urban women, but these features of the physical environment were not associated with physical activity level in either population.[42] Most of the studies examining sidewalk presence and quality have used only self-reported, subjective measurements. In the present analysis, the effect of sidewalk existence and sidewalk obstructions will be examined using both perceived and objective measurements to help clarify the role of sidewalks in influencing walking and to explore the relationship between perceived and objective view of sidewalk features.

Physical Activity Measurement-Walking in the Neighborhood

Besides deciding how to measure the built environment, selecting a relevant measure of physical activity is also important and challenging. One potentially limiting aspect of previous studies is that overall physical activity is measured and not physical activity *in the physical environment* being characterized. This is important because people with undesirable neighborhood characteristics may find more suitable areas or places to be active, making overall physical activity less relevant to the influence of the neighborhood on the participant's physical activity level.[44] Also, some studies include only walking for exercise and may eliminate walking for transportation. Other studies examine walking for a specific purpose such as walking to work as the outcome of interest.[45]

King, W. and colleagues analyzed the relationship between convenience of several locations such as parks, trails, businesses and services and walking levels in older women.[14] In this study, an objective measurement of overall physical activity (using a pedometer) was compared with self-reported activity using the Paffenbarger Activity Questionnaire. They found that self-reported living within walking distance of a park, a biking or walking trail, and a department, discount or hardware store was significantly related to higher pedometer readings. However, when self-reported walking was examined instead of pedometer readings, the results were no longer statistically significant. The discrepancy between the physical activity levels suggests that perception of physical activity may differ from more objective measurements and that the relation of each to features of the built environment may vary. Also, the Paffenbarger Activity Questionnaire measures overall physical activity and not necessarily physical activity in the environment being characterized. Many types of activities would not intuitively be related to the neighborhood environment. Measuring overall physical activity is not a relevant outcome when studying the influence of the built environment.

By selecting "walking in the neighborhood" as our physical activity measurement, we limit our outcome to activity in the area being characterized, regardless of the reasons behind the walking, thereby more directly testing the association between the built environment and physical activity in that location.

Perceived versus Objective Measurement of the Physical Environment

Another challenge in selecting the features of the physical environment is deciding whether to use the perceived or observational measurements. Studies of perception versus more objective measurements indicate that the two may differ depending on the feature being measured. For example, perceived environmental risk is often found to diverge from objective risk assessments.[46] In studying physical activity in a neighborhood, examining both the perceived and objective view becomes particularly interesting. Certain perceived environmental features may be related to physical activity due to the increased awareness and familiarity of the environment among the physically active compared with less active neighborhood members. King, AC and colleagues found a positive association between physical activity and the presence of hills and unattended dogs.[41] As the authors explain, the surprising results on hills and unattended dogs may result if physically active participants observed these features while inactive members spent less time walking in the neighborhood and do not observe these elements of the environment. The level of exposure to the neighborhood environment could confound the association between unattended dogs and physical activity.

To address this issue, researchers are developing tools to characterize the environment in a more objective way. Audit instruments have been used in the transportation industry to examine the safety of the physical environment for walking and cycling. Factors such as crosswalks, traffic patterns and connectivity have been incorporated into these instruments. Recently developed audit instruments by Pikora and Michael (See Appendix A) have been designed specifically to study physical activity and the built environment.[47] Combining geographic information systems (GIS) data and assessments of neighborhood street segments by trained researchers, these instruments provide a means of objectively characterizing the physical features of neighborhoods. Despite the availability of these tools, few studies have been conducted examining the perceived and objective environments in relation to physical activity.

Objective measurements may reduce some of the subjectivity of the measurements but eliminate the role of an individual's perception that intuitively may be related to higher neighborhood activity level. For example, a resident may believe that their neighborhood is littered with graffiti and vandalism, signs of crime and disrepair, and therefore, not walk in the neighborhood. Here, the perception exerts more influence on physical activity levels than an objective characterization of the environment using audit instruments. Thus, assessment of both subjective and objective views of the neighborhood could produce different results and both must be analyzed to determine which is more influential.

One of the few studies comparing the relationship between perceived and objective measurements of the physical environment and physical activity was conducted by Troped and colleagues.[13] Physical activity was defined by use of a community rail-trail and three independent variables were examined including a steep hill barrier, a busy street barrier and distance to the bikeway via roads. Using self-reported survey responses, distance to bikeway and busy street barriers (in addition to demographic variables) were statistically significant variables associated with bikeway use in a logistic regression model. When the objective measures were used, only the steep hill barrier was significantly associated with bikeway use. This study illustrates that objective measurements may lead to different conclusions than perceived assessments of the physical environment. The discrepancy illustrates the importance of selecting an appropriate measure and the need for further research to compare self-reported and objective environmental factors. Several researchers have indicated the need for "multiple measurement strategies" including both perceived and objective measurements with the most appropriate choice depending on the physical feature examined.[44] The present study will provide a similar analysis to Troped et al with an expansion of the environmental variables studied.

Filling in the Research Gaps

The present analysis will expand the current research base by comparing objective measurements using a valid audit instrument with the perceived measurements obtained from survey responses. Examining how the different factors operate in relation to physical activity is achieved by creating two separate models, one using only self-reported survey data and the other using mainly objective GIS and audit instrument data.

The results of this study will add to existing research on the association between neighborhood walking and the subjective and objective views of a neighborhood. The results will be useful in future research to determine which type of measurement should be employed. Furthermore, the study will contribute additional knowledge on the effect of features inconsistently associated with activity in previous studies.

Because the influence of the built environment on physical activity may vary by age group, race and other yet unknown factors, this study is likely to be one of many studies conducted 1) comparing the association between perceived and objective measurements of the environment 2) determining which type of measurement is appropriate for each variable examined and 3) determining which variables are more strongly associated with physical activity level for a particular subgroup of the population.

Implications for Public Health

According to estimates by the US Bureau of Census, the U.S. population over the age of 65 will nearly double in the next 20 years.[48] The public health implications of an unhealthy aging population are substantial and physical activity is just one means of decreasing primary and secondary conditions in this aging cohort. Several studies on the built environment and physical activity to date have found that a small amount of the variation in physical activity is explained by the characteristics of the built environment. Even if the influence is small, the potential public health impact could be large, as the physical environment affects many people and the burden of physical inactivity has the potential to be very high. Research in this area will provide the knowledge needed to create more "walkable" communities and design appropriate policy interventions. The results of this study along with similar studies in the future will provide knowledge allowing land and transportation planners to design health-promotive environments and public health program planners to cater interventions for the given population. Research in this area will help focus the interventions on the features of the physical environment that are most important for increasing physical activity.

Specific Aims

1) To examine the degree of association between perceived and objective characteristics of the neighborhood environment for older adults.

2) To assess the association between both the perceived and objective environmental elements on neighborhood walking among older adults.

METHODS

Study design

This cross-sectional analysis linked data from a neighborhood-based walking intervention trial, Senior Health and Physical Exercise (SHAPE), and a study of built environmental factors associated with physical activity, Senior Walking Environmental Assessment Tool (SWEAT).

Datasets

SHAPE

The SHAPE project studied the effect of a randomized walking intervention involving 582 senior residents from 56 neighborhoods in Portland, Oregon. Each neighborhood had clearly defined boundaries and a neighborhood association registered with Portland's Office of Neighborhood Involvement. A map of Portland neighborhoods is included in Appendix A. Direct mail and telephone were used to recruit participants with a response rate of 30.5%. All participants in the SHAPE study met the following selection criteria: 1) 65 years of age or older 2) not participating in any formal physical activity in the past 30 days and 3) able to walk without an assistive device (such as walkers). Neighborhoods were randomly assigned to either a leader-guided neighborhood walking condition (N=28) or an education-only control condition (N=28). Data on demographic information, physical activity, and the neighborhood environment were collected from the study participants at three time points using 30- to 40-minute interviews. To minimize the effect due to study participation, only the baseline survey responses were used in the present analysis. For purposes of data linking, each neighborhood was assigned a unique numeric code.

SWEAT

The SWEAT study collected environmental and social capital data from 10 neighborhoods in Portland, Oregon. The neighborhoods were selected from the control neighborhoods in the SHAPE study to create a socio-demographically diverse subset of neighborhoods. A random sample of 10% of the street segments in each neighborhood was selected and analyzed using Geographic Information Systems (GIS). A segment is defined as the section of road between consecutive intersections. On each segment, an audit was conducted using the instrument in Appendix A. Trained research assistants collected the audit data from October to December 2002 and from May to August 2003. The number of amenities such as grocery stores, trails, schools, parks, open spaces, cemeteries and several other features within a quarter-mile radius of each street segment was compiled using GIS.

Study population

The present analysis involves the individual level data for 105 participants from 10 control neighborhoods in the SHAPE study. Objective features of the ten neighborhoods were obtained through the audit and GIS analysis in the SWEAT study. A total of 455 segments were included in this analysis.

Data management

Objective environmental data from the SWEAT study were transformed into dichotomous variable (feature present vs. feature not present) as described below and then aggregated to the neighborhood-level using SPSS Version 12.0. Data tables on the objective features were merged with the SHAPE dataset using the neighborhood code as the linking variable. Several perceived variables in the SHAPE study were also transformed into dichotomous variables in SPSS.

Study Variables

Outcome variable-Neighborhood Walking

Neighborhood walking and was measured using the response to the following question: "Over the past 12 months, how much have you done the following?: walked or strolled in the neighborhood?" Possible responses were anchored on a 5-point scale from 1 (not at all) to 5 (a great deal). Fifty-five percent of the participants responded not at all, a little bit, or a moderate amount and were classified as low walkers. Participants responding quite a bit or a great deal were classified as high walkers.

Covariates

Age, gender, race, income and education were selected demographic variables related to both neighborhood environment and physical activity levels. Analyses controlled for these variables either through restriction or statistical adjustment.

Selection of Independent Variables

Selection of the independent variables such as sidewalk quality and existence, neighborhood graffiti and vandalism (aesthetics), proximity to shopping malls, parks and trails were based on previous studies examining destinations, scenery and sidewalk features.[13,15,41,44] Each independent variable was assessed on the SWEAT audit instrument (objective) as well as on the SHAPE survey (perceived). Questions in their original form are included in Table 2. The transformation of each independent variable into dichotomous variables is described below.

Table 2: Original Questions from SWEAT and SHAPE for Built Environment Variables

Variable	Objective: SWEAT	Perceived: SHAPE
Sidewalk Existence	Are sidewalks continuous? (Responses for each side:) No=0, Yes=1 No sidewalks=98	How much do you agree or disagree that each of the following things is a problem in your neighborhood? J. no sidewalks (or footpaths) are a problem: Possible Reponses 1(strongly disagree) to 5 (strongly agree)
Sidewalk Obstructions	Sidewalk Obstructions: Side 1 and Side 2: mark all that create considerable obstruction/danger to pedestrian traffic. Question #20 in Appendix A	How much do you agree or disagree that each of the following things is a problem in your neighborhood? I.unsafe sidewalks (obstacles to walking) are a problem: Possible Reponses 1(strongly disagree) to 5 (strongly agree)
Graffiti and Vandalism	Can you see any litter, graffiti, broken glass, etc.? 0 None or almost none 1-Yes, but not dominant feature 2-Yes, dominant feature	How much do you agree or disagree that each of the following things is a problem in your neighborhood? B: graffiti is a problem: and D: vandalism is a problem: Possible Reponses 1(strongly disagree) to 5 (strongly agree)
Presence of Shopping Mall	GIS Analysis of shopping malls within a quarter-mile of each street segment	Please circle YES or NO if you have any of the following near your home: Shopping Mall
Presence of Park	GIS Analysis of Parks within a quarter-mile of each street segment	Please circle YES or NO if you have any of the following near your home: Public Park
Presence of Trails	GIS analysis of trails within a quarter-mile of each street segment	Please circle YES or NO if you have any of the following near your home: Trails for walking, hiking or running

Independent Variables-Objectively Measured Environmental Features

Objective Measure of Presence of Graffiti and Vandalism, Sidewalks and Sidewalk Obstructions

Trained research assistants assessed each street segment using the Systematic Neighborhood Observation Tool in Appendix A. Responses to questions about the presence of graffiti and vandalism, presence of sidewalks and sidewalk obstructions were used in the present study and transformed into dichotomous variables for each street segment. Sidewalks were considered present on the segment if any sidewalk was continuous on at least one side regardless of obstruction. Sidewalks were considered obstructed if any type of obstruction existed on either side or if the sidewalk was discontinuous on at least one side. If graffiti, litter and broken glass were identified on the street segment, even if not the dominant feature, then the segment was classified as positive for graffiti and vandalism.

The percentage of street segments with sidewalks present was calculated for each study neighborhood as well as all study neighborhoods combined. If the percentage of segments with sidewalks within an individual neighborhood was greater than the percentage of segments with sidewalks in all neighborhoods combined, the neighborhood was classified as having sidewalks. A yes or no value for presence of sidewalks was assigned to each individual in the given neighborhood. This procedure was repeated for graffiti and vandalism as well as sidewalk obstructions. All of the individuals within a given neighborhood share the same responses for the objective neighborhood characteristics.

Presence of Parks, Shopping Malls and Trails

GIS was used to assess the number of parks in a quarter mile radius of the observed segments and the number of parks was summed for an entire neighborhood. Neighborhoods with at least one park were classified as positive for presence of a park. The same procedure was used to determine the presence of shopping mall and trails in each neighborhood. The neighborhood level information was then merged with the individuals in SHAPE database as described under data management.

Independent Variables-Self-Reported Environmental Features

Presence of Perceived Graffiti and Vandalism, Sidewalks and Sidewalk Obstructions

Perceived neighborhood characteristics were self-reported from personal interviews as part of the SHAPE study. Participants were asked to respond from 1 (strongly disagree) to 5 (strongly agree) to the following statements: "graffiti is a problem", "vandalism is a problem", "unsafe sidewalks (obstacles) are a problem", and "no sidewalks are a problem". To allow for comparison with the objective characteristics, all survey responses that were on a Likert-scale were re-categorized into dichotomous variables. Responses of "strongly disagree", "disagree", or "neutral" for the statements on graffiti, vandalism and sidewalk obstacles indicated that the features were not a problem (i.e. not present) and were coded as 0. Responses of "agree" or "strongly agree" indicated that the problem was present and were coded as 1. For sidewalk existence, reverse coding was used. Responses of "strongly disagree" "disagree" or "neutral" were assumed to indicate "no sidewalks" was not a problem and were coded 1 for presence of sidewalks. Responses of "strongly agree" and "agree" indicated that lack of sidewalks were a problem and were coded as 0 for no sidewalks.

Perceived Presence of Park, Mall, or Trail

Participants could respond YES or NO when asked if they had any of the following near their home: Shopping Malls, Public Parks and Trails for walking, hiking or running. The responses were retained as dichotomous yes/no variables as asked on the survey.

STATISTICAL ANALYSIS

Analysis of Perceived and Objective Association

The kappa statistic was used to test the relationship between the self-reported and objectively derived measures. The kappa statistic is an appropriate method to quantify the degree of association between two categorical variables when an association is expected to exist.[49]

Logistic Regression Model Building

Two logistic regression models were created using the steps below for the 1) perceived measures while adjusting for age, race, gender, education and income and 2) objective measures with the same adjustments.

Univariate Analysis

For each model, contingency tables were created to test for zero cells and examine the Likelihood ratio p-value for all categorical variables. The more consistent likelihood ratio test was selected over the Wald test to determine which variables would be entered into the multivariate logistic regression model.[50] Logistic regression was performed for all variables individually against the outcome, walking in the neighborhood. All variables with a p-value of .25 in the univariate analysis were selected for the multivariate model.[51] Cross tabulations of control variables with each other were performed to assess for highly associated variables. To reduce redundancy in correlated variables, the less significant variable according to the univariate logistic regression was be eliminated from the multivariate model.

Multivariate analysis

Models were determined using the results of the univariate analysis including scientifically relevant variables. The beta coefficients were calculated for each variable in the multivariate model and compared with the univariate values to determine which coefficients changed noticeably. Large changes were examined further to detect important relationships within the model. Each feature of the built environment was examined in a logistic regression model with all of the control variables: education, race, income, age and gender. Then all eligible environmental features and all control variables were entered into the appropriate model (perceived or objective measurements). Variables that were highly correlated were examined to determine if one could be removed. Variables with large p-values (>.5) were removed from the model and the likelihood ratio test was used to determine if these variables could be permanently eliminated from the model. The resulting model served as the preliminary main effects model.

Linearity was assessed for continuous variables in the main effects model by categorizing these variables into quartiles and attempting several transformations of the variable. Logistic regression using the quartiles of the continuous variable was performed against walking in the neighborhood. Scatter plots of the beta coefficients for quartiles in the multivariate model against quartile midpoint were created. The pattern was assessed for linearity and, based on the plots, several transformations of continuous variables were examined to determine if the new variable improved the model. Improvement in model fit was determined by an increase in overall model significance and corresponding significant decrease in deviance. Possible interactions were tested for entry into the model using a forward automatic procedure based on the likelihood ratio.

Assessment of Fit

The final models were then assessed for fit by using the Hosmer and Lemeshow Goodness-of-fit test. The individual components of the data set were analyzed by visual assessment of the following graphs to determine outlying or influential statistics:

1) Change in Pearson's Chi-squared vs. Predicted Probabilities
2) Change in Deviance squared vs. Predicted Probabilities
3) Cook's Distance vs. Predicted Probabilities

RESULTS

Descriptive Analysis

Socio-demographics of Study Population

A total of 105 participants were included in the analysis. The mean age of all respondents was 75.1 (standard deviation = 6.29) and the range spanned from 65 to 92 with the majority of participants between 65 and 75. Approximately 67% of participants were female.

Despite a concerted effort to recruit a diverse study sample, participants were predominantly white making up 90% of the study population. African-Americans represented 5% of the study population and another 5% of participants were of other races including Asian-Pacific Islanders, American Indian/Alaska Native, or Hispanic. The study population is fairly representative of the Portland population with a slightly larger percentage of white participants in the study than in Portland (78%) and a lower percentage of African-American participants than in the Portland population (6.6%).

Participants were diverse in terms of education and income. Ten percent of participants had a household income of less than $10,000 and 30% had an income above $30,000. Only 15% did not have a high school degree. Thirty percent of participants reported some college education and 16% reported having a graduate degree.

Analysis by neighborhood revealed several areas whose population demographics differed from the overall study population. The Brentwood/Darlington participants were younger than the combined neighborhoods with forty percent of participants in Brentwood/Darlington under age 69. Nearly 80% of the participants in Creston-Kenilworth were male. St. John's neighborhood had the largest proportion of participants with graduate degrees (25%). Woodlawn was the most racially diverse neighborhood with African Americans representing 44% of the neighborhood participants.

Neighborhood Walking

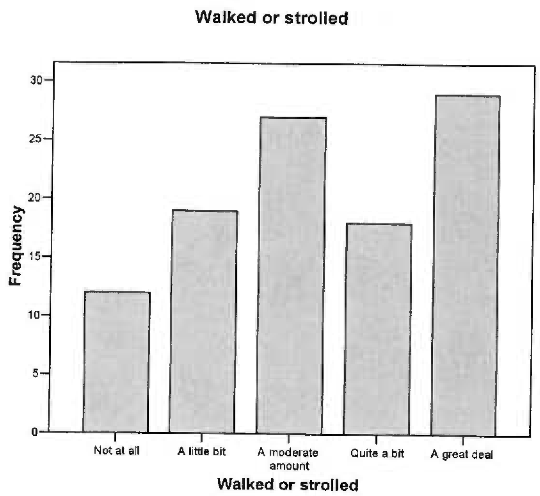

Figure 1: Frequency of Responses to "How often have you walked or strolled in you neighborhood in the past 12 months?

Nearly 30% of participants reported that they walked or strolled in the "neighborhood a great deal" while less than 12% reported not walking at all in the neighborhood. Based on the selected cut-off of above a moderate amount, 47 participants were placed into the high walking group. Individuals that walked a moderate amount, a little bit or not at all totaled 58 participants and were categorized as low (or inactive) neighborhood walkers. See Figure 1 for frequency of responses on neighborhood walking.

High and low walking groups were composed of approximately equal proportions of males and females. High walking participants were all white with participants of other races found only in the low walking group. About 26% of participants in the high walking group had a graduate-level education while only 9% of participants in the low walking group held graduate degrees. Twenty-nine percent of low walkers were 80+ years of age compared to 11% of the high walkers in this age group. Table 4 illustrates the demographic characteristics of the study population by walking level.

Table 3: Comparison of Demographic Characteristics of Inactive and Active Neighborhood Walkers

Variable		N	Low Walkers	High Walkers	X2 p-value
Gender					0.889
	Male	35	33%	34%	
	Female	70	67%	66%	
Age					0.032
	65-70	28	28%	26%	
	71-74	26	16%	36%	
	75-80	29	28%	28%	
	80+	22	29%	11%	
Race					0.011
	White	95	83%	100%	
	Black	5	9%	0%	
	Other	5	9%	0%	
Income					0.652
	$0-9999	10	10%	9%	
	$10000-19999	35	36%	30%	
	$20,000-29,999	28	29%	23%	
	$30,000-39,999	16	12%	19%	
	$40,000+	16	12%	19%	
Education					0.134
	< High School	15	16%	13%	
	High School degree	36	36%	32%	
	Some College/Undergraduate	37	40%	30%	
	Graduate degree	17	9%	26%	

Objective Neighborhood Characteristics

Background information on neighborhood population and number of participants and street segments included in the analysis by neighborhood are illustrated in Table 4. Data from the audit instrument on sidewalk quality, sidewalk obstructions and graffiti and vandalism were obtained for 9 of the 10 neighborhoods in the analysis. The total percentage of street segments with sidewalks, sidewalk obstructions and graffiti/vandalism for all neighborhoods combined was 80%, 60% and 33% respectively. These percentages were used as a cutoff to determine whether a given neighborhood was considered positive for the feature. Neighborhood objective characteristics are illustrated in Table 5. Parks were present in every neighborhood limiting the ability to determine their influence. The variable "objective parks" was therefore removed from all subsequent analysis.

Table 4: Neighborhood Demographics

Neighborhood	Population	% Seniors	# of participants	# of street segments in audit
Ardenwald	294	14.3	8.0	4.0
Brentworth/Darlington	11, 456	9.5	10.0	0.0
Buckman	7,923	4.9	10.0	43.0
Creston-Kenilworth	8,234	8.9	9.0	24.0
Cathedral Park	3,033	12.6	10.0	38.0
Montavilla	15,987	11.5	11.0	99.0
Richmond	11,320	10.4	13.0	61.0
St. John's	11,346	8.9	13.0	74.0
Sullivan's Gulch	3,043	18.9	12.0	14.0
Woodlawn	4,889	8.7	9.0	37.0

Table 5: Objectively-Measured Neighborhood Features

Neighborhood	Graffiti and Vandalism	Sidewalks	Obstructions	Parks	Trails	Malls
Ardenwald	No	No	Yes	Yes	No	No
Brentworth/Darlington*	N/A	N/A	N/A	Yes	No	No
Buckman	Yes	Yes	Yes	Yes	No	No
Creston-Kenilworth	Yes	Yes	Yes	Yes	Yes	No
Cathedral Park	Yes	No	Yes	Yes	Yes	No
Montavilla	No	No	Yes	Yes	No	No
Richmond	No	Yes	No	Yes	Yes	No
St. John's	Yes	Yes	Yes	Yes	Yes	No
Sullivan's Gulch	No	No	Yes	Yes	No	Yes
Woodlawn	No	Yes	Yes	Yes	No	No

*Not included in audit

Statistical Analysis Results

Degree of Agreement between Objective and Perceived Measures

Pearson's chi-squared statistic resulting from cross tabulation of the dichotomous perceived and objective measurements were not significantly associated for trails, graffiti and vandalism, sidewalk existence and sidewalk obstruction. The kappa values between perceived and objective measurements were low for all variables indicating a low degree of agreement and reproducibility between these measurements. See Table 6 for kappa results.

Table 6: Kappa Results for Crosstabulations of Independent Variables

	Kappa	Significance
GRAFFITI AND VANDALISM	0.018	0.864
SIDEWALK OBSTRUCTION	-0.031	0.773
SIDEWALK EXISTENCE	0.081	0.319
PARKS	n/a	
MALLS	0.195	0.002
TRAILS	-0.07	0.501

Logistic Regression Modeling Results

Contingency Tables of Control Variables

Control variables were entered into a univariate logistic regression modeling active neighborhood walkers to determine their association with walking (See Table 7). Cross tabulation of control variables with walking group indicated that only whites were found in the high walking groups. Race was significantly related to walking group (p=.011) with the crosstabulation shown in Table 8. To determine the influence of race, univariate logistic regression analysis was performed for each environmental feature including all participants and then including only non-Hispanic white participants in order to compare the variables eligible for entry into the multivariate model were compared.

Table 7: Estimated Odds Ratios and 95% CI from the Univariate Logistic Regression Model of Neighborhood Walking Group for Control Variables

Control Variable		OR	95% CI Lower	95% CI Upper
AGE		0.96	0.90	1.02
	Age (10 yrs)	0.64		
GENDER (males as reference group)		0.94	0.42	2.13
RACE	Race (White)			
	Race (African-American)	0.00	0.00	0.00
	Race (Other)	0.00	0.00	0.00
EDUCATION	< High School			
	Finished High School	1.07	0.31	3.66
	Some college/Undergrad	0.91	0.21	3.12
	Graduate	3.60	0.83	15.60
INCOME	<10,000			
	10,000-19,999	1.00	0.24	4.20
	20,000-29,999	0.97	0.22	4.24
	30,000-39,999	1.93	0.39	9.60
	40,000+	1.93	0.39	9.60

Table 8: Cross tabulation of Walking Group and Race

Race * Walking Group Crosstabulation

			Walking Group: Low walking group	Walking Group: High walking group	Total
Race	White, Non-hispanic	Count	48	47	95
		% within Race	50.5%	49.5%	100.0%
		% within Walking Group	82.8%	100.0%	90.5%
	Black, Non-hispanic	Count	5	0	5
		% within Race	100.0%	.0%	100.0%
		% within Walking Group	8.6%	.0%	4.8%
	Other	Count	5	0	5
		% within Race	100.0%	.0%	100.0%
		% within Walking Group	8.6%	.0%	4.8%
Total		Count	58	47	105
		% within Race	55.2%	44.8%	100.0%
		% within Walking Group	100.0%	100.0%	100.0%

Univariate Analysis of Independent Variables-All Races and White, non-Hispanic

In the univariate analysis with all races, sidewalk existence (OR=.52, p-value=.148) and malls (OR=2.77, p-value=.105) were eligible for entry into the multivariate model of objective measurements as illustrated in Table 9. Sidewalk obstruction (OR=1.90, p-value=.151), malls (OR=1.90, p-value .108) and trails (OR=1.96, p-value=.101) were eligible for entry into the multivariate logistic regression model using measurements of the perceived environment. The model is shown in Table 10. When only whites were analyzed, sidewalk existence was replaced by graffiti and vandalism (OR=.58 p-value=.204) in the objective model, illustrated in Table 11. In the perceived model, sidewalk obstruction was eliminated in the model for whites only malls and trails were retained. Differences in the variables eligible for entry into the multivariate model for the white participants compared to all races indicated separate analyses should be conducted by race. *Low sample sizes of participants other than white limited the ability to create separate models for each racial group and the remaining analysis was therefore performed for white, non-Hispanic participants only.* Ten participants of races other than whites were removed from the subsequent analyses.

Table 9: Estimated OR and 95% CI from Univariate Logistic Regression Model for Objective Neighborhood Features-All Races

Variable	**OR**	**95% CI for OR**	**Likelihood ratio p-value**
Graffiti and Vandalism	0.722	(.320, 1.631)	0.433
Sidewalk Obstruction	0.773	(.293, 2.040)	0.602
Sidewalk Existence	0.52	(.215, 1.261)	0.148
Parks	Eliminated from Analysis		
Trails	1.144	(.526, 2.489)	0.734
Malls	2.769	(.779, 9.850)	0.105

Table 10: Estimated OR and 95% CI from Univariate Logistic Regression Model for Perceived Neighborhood Features-All Races

Variable	OR	95% CI for OR	Likelihood Ratio p-value
Graffiti and Vandalism	0.79	(.366, 1.722)	0.558
Sidewalk Obstruction	1.9	(.782, 4.593)	0.151
Sidewalk Existence	1.22	(.402, 3.731)	0.72
Trails	1.96	(.873, 4.384)	0.101
Parks	1.24	(.33, 4.67)	0.754
Malls	1.9	(.864, 4.192)	0.108

Table 11: Estimated OR and 95% CI from the Univariate Logistic Regression Model for Objective Neighborhood Features-White-Non-Hispanic Participants

Variable	OR	95% CI for OR	Likelihood ratio p-value
Graffiti and Vandalism	0.58	(.245, 1.355)	0.204
Sidewalk Obstruction	0.87	(.318, 2.374)	0.784
Sidewalk Existence	0.68	(.276, 1.682)	0.404
Trails	0.96	(.425, 2.142)	0.91
Parks	Eliminated from analysis		
Malls	4.72	(.946, 23.536)	0.035

Table 12: Estimated OR and 95% CI from Univariate Logistic Regression Model for Perceived Neighborhood Features- White-Non-Hispanic Participants

Variable	OR	95% CI for OR	Likelihood Ratio p-value
Graffiti and Vandalism	0.63	(.279, .409)	0.257
Sidewalk Obstruction	1.48	(.581, 3.784)	0.408
Sidewalk Existence	1.54	(.5, 4.7)	0.449
Trails	1.64	(.709, 3.81)	0.245
Parks	1.22	(.307, 4.862)	0.777
Malls	1.75	(.771, 3.992)	0.178

Preliminary Objective Measurement Model

As discussed above and presented in Table 11, the presence of shopping malls and presence of graffiti and vandalism are eligible for entry into the multivariate model. In the unadjusted multivariate model, the odds ratio (OR) for malls was 3.58 (95% CI: .67, 19.24) and .732 (95% CI: .297, 1.81) for graffiti and vandalism. After adjustments for all covariates, the odds ratios weakened slightly. The results of the adjusted multivariate model are shown in Table 13 below.

Cross tabulation of education and income indicated a highly associated pair (Pearson's p-value =.005). To prevent inadequate model fit due to multicollinearity, removal of one of these variables was tested. Models eliminating either education or income were created to find an appropriate model. Models without income produced a better fit with only slight increases in deviance. Likelihood ratio test illustrated in Table 14 confirmed the removal of income from the model (p-value=.985).

While gender was not significant and had a p-value greater than .5, it was retained in the model to allow for comparison with other studies that have adjusted for gender. The preliminary objective measurement model contained graffiti and vandalism, malls, age, education, and gender. After adjustment for education, age and gender, the odds ratio were stronger and more significant at 3.55 (95% CI: .610, 20.656) for malls and .63 (95% CI: .23, 1.70) for graffiti and vandalism. See Table 15 for the preliminary objective model.

Table 13: Adjusted Multivariate Objective Features Logistic Regression Model

Variables	**OR**	**95% CI for Odds Ratio**		**Wald Sig.**
		Lower	**Upper**	
Education				0.482
Educat(1)	1.290	0.295	5.645	0.736
Educat(2)	1.041	0.238	4.557	0.958
Educat(3)	3.558	0.518	24.433	0.197
Age	0.913	0.836	0.996	0.041
Gender(1)	1.191	0.409	3.470	0.748
Income				0.985
Income(1)	0.783	0.148	4.126	0.772
Income(2)	0.757	0.126	4.530	0.760
Income(3)	0.961	0.133	6.953	0.969
Income(4)	1.144	0.157	8.342	0.894
Graffiti and Vandalism	0.613	0.215	1.748	0.360
Malls -objective	3.727	0.622	22.335	0.150
Constant	885.018			0.067

p-value of model =.206
Deviance = 104.52

Table 14: Likelihood Ratio Test for Objective Model

Model	-2 Log Likelihood	df (removed)	G= -2 log likelihood (Model 2-Model1)	Two sided p-value
1) Gender, Education, Income, Age Graffiti and Vandalism, Malls	104.518	11		
2) Gender, Education, Age Graffiti and Vandalism, Malls	104.889	7 (4)	0.371	0.985

Table 15: Preliminary Objective Feature Model

Variables	OR	95% CI for OR		Wald Sig.
		Lower	Upper	
Education				0.329
Educat(1)	1.252	0.296	5.288	0.760
Educat(2)	1.059	0.248	4.519	0.938
Educat(3)	4.073	0.679	24.424	0.124
Age	0.914	0.839	0.996	0.040
gender(1)	1.169	0.428	3.187	0.761
Graffiti and Vandalism(1)	0.627	0.229	1.711	0.362
Mall-objective(1)	3.550	0.610	20.656	0.159
Constant	688.365			0.059

p-value of model=.049
Deviance=104.889

Preliminary Perceived Measurement Model

Malls and trails were the only perceived environmental characteristics eligible for entry into the multivariate model of white participants. In the unadjusted model, the odds ratio for malls was 1.46 (95% CI: .626, 3.38) and the odds ratio for trails was 1.60 (95% CI: .689, 3.73). Each environmental variable was entered into a model with all control variables followed by entry of malls, trails and all control variables into one multivariate model (Table 16). Variables with non-significant p-values were examined. The variable "trails," had a p-value of .881 and was considered for removal. As in the objective model, income was tested for removal due to its highly significant association with education and minimal improvement to model fit. Both income (p-value=.920) and trails (p-value=.881) were eliminated from the model and their removal confirmed by the likelihood ratio test p-value of .381 as shown in Table 17. As with the objective features model, gender was retained as a control variable despite its non-significance. After adjusting for age, education, and gender and removing trails from the model, the odds ratio for malls increased to 2.01 (95% CI: .829, 4.85). The preliminary model is shown in Table 18.

Table 16: Adjusted Multivariate Perceived Feature Logistic Regression Model

Variables	OR	95% CI for OR		Wald Sign.
		Lower	Upper	
Malls perceived	1.762	0.668	4.650	0.253
Educat				0.315
Educat(1)	1.138	0.273	4.751	0.859
Educat(2)	0.618	0.153	2.503	0.500
Educat(3)	2.586	0.395	16.925	0.321
Age	0.925	0.849	1.008	0.077
Gender(1)	1.050	0.362	3.041	0.929
Income				0.920
Income(1)	0.655	0.110	3.893	0.642
Income(2)	0.522	0.083	3.283	0.488
Income(3)	0.758	0.093	6.167	0.795
Income(4)	0.973	0.122	7.757	0.979
Trail perceived	1.078	0.400	2.905	0.881
Constant	354.082			0.098

p-value of model=.373
Deviance=111.498

Table 17: Likelihood Ratio Test for the Perceived Model

Model	-2 Log Likelihood	df (removed)	G= -2 log likelihood (Model 2-Model1)	Two sided p-value
1) Gender, Education, Income, Age, Trails and Malls	111.498	11		
2) Gender, Education, Age and Malls	116.793	6 (5)	5.295	0.381

Table 18: Preliminary Perceived Feature Model

Variable	OR	95% CI for OR		Wald Sig.
		Lower	Upper	
mall perceived	2.006	0.829	4.852	0.122
Education				0.103
Education (1)	1.473	0.392	5.529	0.566
Education (2)	0.779	0.211	2.882	0.708
Education (3)	4.656	0.861	25.182	0.074
Age	0.941	0.872	1.014	0.111
Gender(1)	0.894	0.349	2.290	0.815
Constant	59.432			0.170

p-value of model=.059
Deviance=116.79

Assessing Linearity in the Logit of Age

Participants were divided into four groups by age quartiles. A univariate analysis of age quartiles and walking group revealed that age quartiles were more significantly related to active walking group than age as a continuous variable. Despite the increased significance, a transformation of age where the variable remained continuous was preferred in order to increase the number of covariate patterns. A scatter plot of age quartile midpoints against the corresponding beta coefficients (from both perceived and objective multivariate models including age quartiles) shown in Figure 2 indicated a nonlinear transformation of age was appropriate for both the perceived and objective measurement models.

Based on the shape of the curves, quadratic and cubic transformations were attempted in each preliminary model. The perceived model significance increased from .059 with age as a continuous variable to .018 with age- squared and to .009 with age-cubed. The transformation similarly affected the objective measurement model with increasing significance of .049 (age continuous), .02 (age-squared) and .01 (age-cubed). The coefficients and standard errors of age became extremely large when the cubic transformation was attempted in both models. The less significant and more stable quadratic transformation was selected for both the perceived (Table 19) and objective (Table 20) models and age-squared was added to the preliminary models.

Figure 2: Age Quartile Midpoints against Beta Coefficients from Multivariate Logistic Regression Model

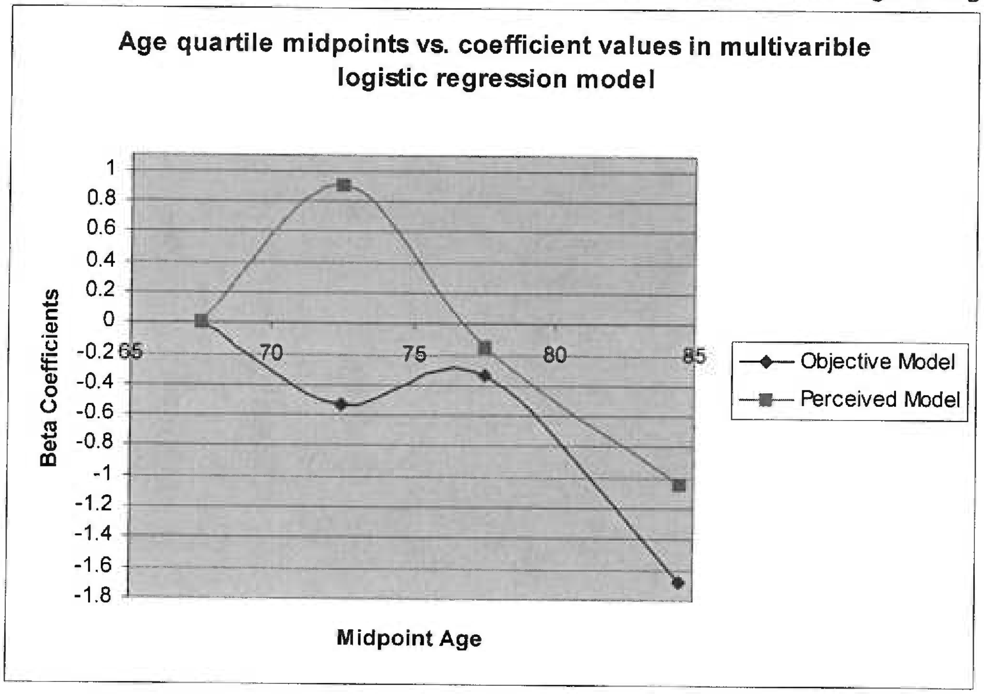

Table 19: Age-Transformed Objective Neighborhood Features Model

Variables	OR	95% CI for OR		Wald Sig.
		Lower	Upper	
Mall-objective	4.122	0.609	27.918	0.147
Graffiti and Vandalism	0.569	0.204	1.583	0.280
Education				0.292
Education(1)	1.502	0.342	6.599	0.590
Education(2)	1.186	0.269	5.226	0.821
Education(3)	4.805	0.767	30.088	0.094
Gender(1)	1.115	0.401	3.097	0.835
age	9.571	0.804	113.932	0.074
age-squared	0.985	0.969	1.001	0.064
Constant	0.000			0.085

p-value for model=.021
Deviance=101.062
Hosmer and Lemeshow Goodness of Fit p-value=.256

Table 20: Age-Transformed Perceived Neighborhood Features Model

Variables	OR	95% CI for OR		Wald Sig.
		Lower	Upper	
Mall-per(1)	2.099	0.849	5.189	0.108
Educat				0.083
Educat(1)	1.864	0.475	7.311	0.372
Educat(2)	0.951	0.251	3.596	0.941
Educat(3)	6.226	1.069	36.278	0.042
gender(1)	0.888	0.338	2.331	0.809
Age	8.908	1.058	75.034	0.044
age-squared	0.985	0.972	0.999	0.039
Constant	0.000			0.049

p-value for model=.018
Deviance=112.004
Hosmer and Lemeshow Goodness of fit p-value=.762

Interaction Assessment and Final Models

Variables representing interactions between control variables included age and gender, education and gender, and education and age. Possible interactions tested in the perceived model included the control variable interactions as well as three mall-control variable interactions (mall X age, mall X education and mall X gender). Objective model interactions included the control variable interactions, three mall-control variable interactions and three graffiti and vandalism-control variables interactions for a total of nine possible interactions. All interaction variables were created by multiplying the value of the two variables together.

Using the forward automatic conditional procedure based on the likelihood ratio in SPSS, no interactions were added to the perceived models. An interaction between graffiti, vandalism and age was entered into the objective model but the interaction was no longer significant when one outlying case (case 40) was removed as discussed in the next section. Because the influence of one case made the interaction term significant, it

Table 21: Outlying Case Description: Objective Measure Model

CASE #	Gender	Malls	G and V	age	education	walking
40	0	0	1	88	3	1

Table 22: Objective Feature Model Without Case 40

Variable	OR	95% CI for OR		Wald Sig.
		Lower	Upper	
Educat				0.237
Educat(1)	1.579	0.331	7.527	0.567
Educat(2)	1.061	0.220	5.118	0.941
Educat(3)	5.440	0.774	38.243	0.089
Graffiti and Vandalism(1)	0.455	0.155	1.337	0.152
Mall-obj(1)	6.548	0.624	68.705	0.117
gender(1)	1.294	0.441	3.794	0.639
Age	56.307	2.867	1105.910	0.008
Age-squared	0.973	0.954	0.992	0.007
Constant	0.000			0.010

p-value=.001
Deviance=91.355
Hosmer and Lemeshow Goodness of Fit p-value=.818

Perceived Measures Model- Outliers and Influential Cases

Plots of the change in deviance residuals and change in Pearson's residuals against the predicted probabilities for the perceived model indicated that 3 cases could be outliers Large Cook's distances confirmed that the cases were potential outliers as shown in Figure 4. Case 3, 40 and 56 are described in Table 23. Because it was difficult to determine if the cases were outliers due to small sample size, they were not removed from the model. An indicator variable "outlier" was created with these three cases coded as one for potential outliers. All other cases in the perceived model were coded as 0 for non-outlier. Entering the outlier indicated variable produced the model in Table 24. The odds ratio for malls increased by 14%. The most notable change in the model was an increase in the graduate education odds ratio from 6.23 to 10.31 (95% CI 1.41, 75.3). The odds ratio for age also increased.

Figure 4: Plot of Cook's Distance for Perceived Measure Model

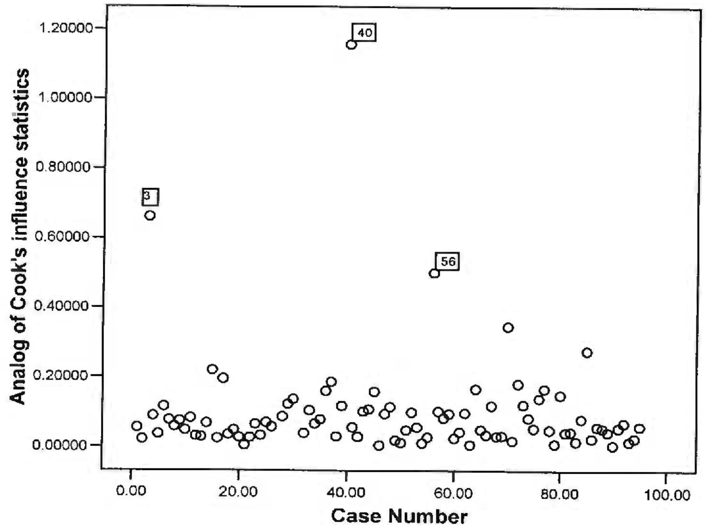

Table 25: Outlying Cases Description: Perceived Measures Model

CASE #	Gender	Malls	age	education	walking
3	0	1	76	4	0
40	0	1	88	3	1
56	1	1	71	4	0

Table 27: Perceived Model with Outlier Indicator

Variable	OR	95% CI for OR		Wald Sig.
		Lower	Upper	
Educat				0.053
Educat(1)	1.911	0.480	7.608	0.358
Educat(2)	0.964	0.252	3.687	0.957
Educat(3)	10.313	1.412	75.331	0.021
gender(1)	0.850	0.319	2.267	0.746
Age	10.997	1.131	106.887	0.039
Age-squared	0.984	0.969	0.999	0.035
Mall-per(1)	2.397	0.940	6.108	0.067
Outlier indicator(1)	0.061	0.002	1.629	0.095
Constant	0.000			0.042

p-value=.012
Deviance=109.352
Hosmer and Lemeshow Goodness of Fit p-value =.626

Goodness of Fit Tests and Diagnostics

The Hosmer and Lemeshow Goodness of Fit p-values are .256 for the objective logistic regression model and .762 for the perceived final model before adjustments for outliers indicating that the model fits the data well. Removing case 40 from the objective model and adding the outlier indicator variable improves the model fit with Hosmer and Lemeshow p-values of .818 and .626 for the objective and perceived feature models respectively.

DISCUSSION

Based on the results of the study, we conclude that the perceived and objective measurements of the built environment differ. Overall the perceived and objective features of the built environment had low kappa values and non-significant Pearson's chi squared p-values indicating a low degree of association between perceived and objective features. While the objective and perceived measurements are, in theory, measuring the same feature, the extremely low kappa values indicate that they could potentially be measuring different constructs of those features. Therefore, analyses in this study examined each set of features in separate models. Our results indicate that these features should be analyzed separately and that researchers should not assume that these features measure the same constructs.

The lack of an association between perceived and objective measurements of the same feature could also arise from misclassification of the environmental variables due to assessment of the neighborhood on different scales. Studies indicate that one's perceived neighborhood environment consists of an area within a ¼ mile of the person's residence.[52] In SHAPE, the self-reported features are likely to depict the area within a ¼ mile of the participant's home. However, the objective neighborhood environment was defined by arbitrary neighborhood-association boundaries resulting in measurements that encompass a much larger area than the perceived environment. A large neighborhood may vary greatly within its boundaries and the objective measurements may not capture the features of the neighborhood near the participant. Neighborhood size differed greatly in this study from Ardenwald with 119 acres to St. John's with 7,055 acres. This misclassification of the environmental objective features could result in the lack of association between perceived and objective measurements and the subsequent variations in the perceived and objective logistic regression models.

Our study supports the results of Troped and colleagues that self-reported and objective measurements of the environment may lead to different conclusions in models predicting levels of physical activity. The final perceived model using white participants included only one environmental feature, malls, while the objective model contained both malls and graffiti and vandalism as features associated with physical activity. In the final objective model, the presence of graffiti and vandalism was associated with lower levels of walking in the neighborhood, while malls were associated with increased neighborhood walking in both models. The difference in the models suggests that perception of graffiti and vandalism is not as influential in affecting physical activity levels as more objective measurements of this feature. The appearance of malls in both the perceived and objective measurement models indicates that they are both related to increased levels of neighborhood walking. However, objective measurements of malls are more strongly associated with high neighborhood walking than the perceived measurement of malls. Comparison of perceived and objective features between the two models suggests that perceived and objective measurement strategies should be considered separately as they produce different results in relation to physical activity.

Malls –Marker for a Warm, Safe, Social and Unobstructed Place to Walk?

The variable, malls, was included in both the perceived and objective-measurement-logistic regression models. Based on the perceived measures, participants reporting malls in their neighborhood were 2.10 times more likely to be active neighborhood walkers than those without malls. When GIS analysis was used, participants with malls in their neighborhood were 4.12 times more likely to report high neighborhood walking than participants in areas without a mall. When outlying cases were controlled for, the odds ratios increased to 2.40 for the perceived measures model and 6.55 in the objective measures model. The strength of the association between walking and malls should be explored further.

The study indicates that measuring malls with either self-reported or GIS analysis may produce similar results. Troped and colleagues found that while GIS analysis and self-reported measurements of features such as steep hills and busy streets were associated, the features behaved differently in logistic regression models.[13] However, in our analysis, there is an association, albeit low, between the perceived and objective measure of mall presence as well as an association between malls and active neighborhood walking in both models. Malls may be one of the few features examined to date where perceived and objective measurements are highly associated and act similarly in logistic regression models.

The one neighborhood with a mall (according to the objective measurements) was Sullivan's Gulch. Customer service in the mall was contacted and they explained that the mall opens early for walking geared towards senior citizens. In addition to providing a place to conduct daily shopping and purchase needed items, the mall may appeal to seniors by providing a comfortable, safe place to walk with a level-walking surface. Seniors can walk in the mall protected from the elements and potentially engage in social interactions that promote walking activity.

Socio-demographic Variables and Walking

The study also confirms the results of previous studies indicating that socio-demographic variables such as education and age are associated with physical activity.[30] Interestingly, participants in this study with an undergraduate degree or some college (OR=.97 95% CI=.25, 3.69) were less likely to walk than those with less than a high school degree but the results were not significant. Participants reporting a graduate degree were over 5 times more likely in the objectively-measured environmental feature model and 6 times more likely in the self-reported neighborhood feature model to be active neighborhood walkers compared with those without a high school degree.

Contrary to U.S. surveillance data where older females (over 65) are typically the most inactive segment of the population, females in the present analysis were more likely than males to be active neighborhood walkers.[53] This result may reflect the selection of neighborhood walking as the marker of physical activity as opposed to overall activity. Females may be more likely than males to participate in this type of activity: walking in the neighborhood. Without a measure of overall physical activity in the analysis, drawing conclusions on differences in activity levels between males and females is not possible. In addition, gender was highly non-significant in the both the perceived and objective models and the results should not be used to determine the effect of gender on physical activity.

Race, Physical Activity and the Built Environment

When only whites were included in the analysis, both the objectively measured and self-reported features of the environment included in the model changed. The change in the models when other races were excluded illustrates that race may play an important role in the relationship between environmental features and physical activity, using either perceived or objective measurements. Several previous studies have illustrated that the perceived measurement of the physical environment significantly associated with physical activity differ by race.[41,42,54]

While the sample size was too small to create models by race, the difference in the all race versus white participant model suggests a systematic difference by race in the neighborhood characteristics that influence physical activity. Of particular interest is the difference in the *objective* feature model between all races and white participant model. The objective features are measured using the same methods for all races and yet behave differently in their relationship to physical activity when modeling all races compared to white participants. Because the objective features are measured using the same methods for all races, the different results by races included suggest that certain environmental features are more influential for some races than for others. With the perceived measurements, difficulties arise in determining whether the concept of a certain feature, its influence on physical activity, or both vary by race. With the objective features, a difference in the concept of a certain feature is no longer likely because the methods of measuring the feature are the same for all individuals. Therefore, the difference in the models indicates more directly that the features influencing physical activity vary by race. Further investigation of the role of perceived and objective measurements by race should be conducted to explore this idea more thoroughly.

Other Variables Considered in the Analysis

Several other analyses were attempted to determine if spatial trends exist in neighborhood walking. When latitude and longitude were included as variables in the final model, no significant effect was noted. The models are included in Appendix B. All of the neighborhoods were on the east side of Portland, OR and the proximity of neighborhoods to each other may limit the ability to determine if spatial trends existed. Another variable was also entered to represent proximity to the waterfront promenade, a popular walking trail along the Willamette River in downtown Portland, OR. Two neighborhoods were considered to be within walking distance to the trail but no significant influence on walking levels was found in either the perceived and objective measurement models. Because only proximity to the waterfront trails was considered and not accessibility, other barriers such as heavy traffic and long stairways may be limiting the use of the trail. The lack of significant results between the waterfront promenade and walking levels could be due to the accessibility factor.

Because neighborhood-level socioeconomic status (SES) could also influence physical activity, each individual was assigned a neighborhood SES value that was entered into the final models. Neighborhood level SES was neither significant itself nor influential in changing the effect of the variables already present in the model. Therefore, neighborhood SES indicator was not added to the model. One possible explanation for the lack of an effect could be attributed to the low variability in SES between neighborhoods.

Dealing with Outliers

Because of the small sample size, the diagnostic results were difficult to interpret. Instead of eliminating three outlying cases in the perceived measures model, an outlier indicator variable was entered and produced similar results to the original model. Adjustment for outliers in the model using perceived measures and removal of case 40 in the objective measures model, resulted in stronger odds ratios in the same direction as the final models. Therefore, even with the outlier adjustments or removal, the conclusions drawn from the logistic regression models remain the same.

Limitations

One major limitation of the study is the cross-sectional design preventing us from drawing causal inferences between features of the built environmental and physical activity levels. Several other limitations in the study include a small sample size, a low response rate, a homogenous study population and low variability in environmental features between the neighborhoods in the study. Because the SWEAT study was conducted as a pilot study, only nine neighborhoods were included, limiting our study population to 86 white, non-Hispanic participants for the objective measurement and 93 for the perceived measurement model. Therefore, a larger sample size could reveal other significant features of the built environment that were related to physical activity. However, the variable malls was significant enough to be included in both the perceived feature and objective feature models despite the low sample size suggesting that this feature could be even more significantly related to walking levels in larger studies.

The lack of diversity among participants decreases our ability to assess physical activity barriers and promoters among a more sedentary population than whites such as African-American and Hispanic women. As discussed above, previous studies provide evidence that the features of the built environment influencing physical activity may differ by race. To increase internal validity, the analysis included only white participants. Therefore, the results may not be generalizable to more diverse populations and may not be representative of people beyond urban areas in the Northwest.

Furthermore, the response rate in the SHAPE study was low at 30.5%. Because of the low response rate, selection bias is possible particularly if people in neighborhoods with certain features were more likely to participate than others. Furthermore, the results would not be applicable to people in all types of neighborhoods.

Another limitation of the study was that all of the neighborhoods were in an urban area and relatively close to each other. While studying neighborhoods within the same city may reduce potential confounders, limited variability of built environment features among the neighborhoods may make them difficult to compare. Parks, a variable of interest in our study, could not be included in the analysis because all neighborhoods studied contained a park. Similarly, Portland is relatively consistent with the presence of sidewalks in almost all neighborhoods. Expanding the study to include neighborhoods in suburban and rural areas or looking at more diverse areas of a city could increase the variability in environmental features and increase the ability to detect their influence on physical activity. Also, the present analysis was limited because the two databases were not specifically designed to allow for the comparison of perceived and objective measurements. Transforming the responses into comparable, dichotomous variables could have resulted in decreased validity in the measurements.

Finally, the use of the observational assessment was limited due to its resource-intensive methods requiring two people and approximately 20 minutes per segment. Also, while more objective than perceived measures, the observational assessment may include some element of subjectivity on the part of the trained researcher. The standardization of the audit assessment and observer training were conducted as part of the SWEAT study to minimize the subjectivity in measurements and to reduce misclassification of the objective measurements. However, other elements such as weather, season, time of day, and neighborhood variability were not controlled for in the present analysis and may have influenced the results. If misclassification of the objective measurements did occur, it is unlikely that the measurement errors were related to our outcome, walking level. Therefore, nondifferential misclassification is most likely and would bias the results towards the null underestimating the association if one exists.

Strengths

The study provides additional knowledge on the relationship between features of the built environment that influence physical activity for older adults, an area with surprisingly little research. Because nearly 70% of the study population was women, we were also able to study one of the most sedentary populations in the country. Women experience the greatest increase in physical inactivity as they age with nearly 40% of women over 65 reporting no regular physical activity[55,56]

Another strength of the study was the ability to compare both the objective and perceived measurements of the environment and their relationship to walking levels. The study provides additional information indicating that perceived and objective views of environmental features may be measuring different constructs.

Implications for Public Health Policy and Programs

While the sample size in the current analysis limits our ability to make strong recommendations for policy and intervention design, the study does indicate that features of the built environment influence physical activity for older adults. Therefore, urban planners and designers should attempt to assess the walkability of urban designs before implementing their development. Policies should be formed that increase the aesthetic appeal of urban neighborhoods by decreasing graffiti and vandalism.

According to past and present results on malls, these destinations appear to appeal seniors due to their safe environment and covered area with a flat walking surface. When designing interventions for older adults, program developers should carefully consider the location of the intervention. Programs should be designed and tested to see if mall walking or an intervention in a similar setting increases physical activity levels.

Future Research

To better understand the relationship between perceived and objective measurements of the built environment, studies should be conducted that measure the objective environment within a quarter-mile radius of a participant's residence. Using self-reported and objective measurements designed to create more comparable variables would provide a more valid assessment of their relationship.

Because malls appeared in both the perceived and objective models with large odds ratios, this feature should be explored more thoroughly. Future research should examine the influence of malls by incorporating questions designed to determine if seniors are walking in the malls as well as to examine the features of mall walking that attract seniors. Determining if destinations with a similar atmosphere provide the same effect on walking will be important for designing interventions and policy. If areas such as malls are health-promotive environments for older residents, researchers and public health program planners may want to consider a similar location when designing an intervention for this target population.

In addition, studies should involve more participants of other races, particularly races with higher levels of inactivity such as Hispanic and African-American women. With more participants, the study would have more power to examine the relationship between the built environment and physical activity for different races.

In this study, only six features of the built environment were examined. Research should be conducted that expands upon the features and destinations of this study including both positive and negative characteristic to determine if other components are related to increased walking. Previous studies also suggest that the features of the physical environment related to physical activity differ for urban and rural participants. Because the effect of the built environment on walking could vary by area, more studies should be conducted that examine the relationship between physical activity and walking in rural, suburban and urban areas. Knowledge about important features would be helpful in designing policies and interventions to improve physical activity among older adults in these areas.

SUMMARY

Overall, this study supports previous findings that the perceived and objective measurements of the built environment differ. Logistic regression models of neighborhood walking for both the perceived and objective measurements of the built environment indicate that having a mall in the neighborhood (or perceiving a mall in the neighborhood) is associated with high levels of neighborhood walking. In the objective measurement model, graffiti and vandalism was also important and is associated with a decrease in neighborhood walking. The findings suggest that the perceived and objective methods may be measuring different constructs of the built environment and these features may differ in their relation to physical activity. Investigation of the role of malls should be explored in future studies and interventions designed accordingly to increase physical activity among seniors.

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APPENDIX A: Audit Instrument From 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	**NOTES:**

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

	Int 1	Int2
Green/WALK	________ sec	__________sec

Please circle what signal you observed.

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
_________	__________

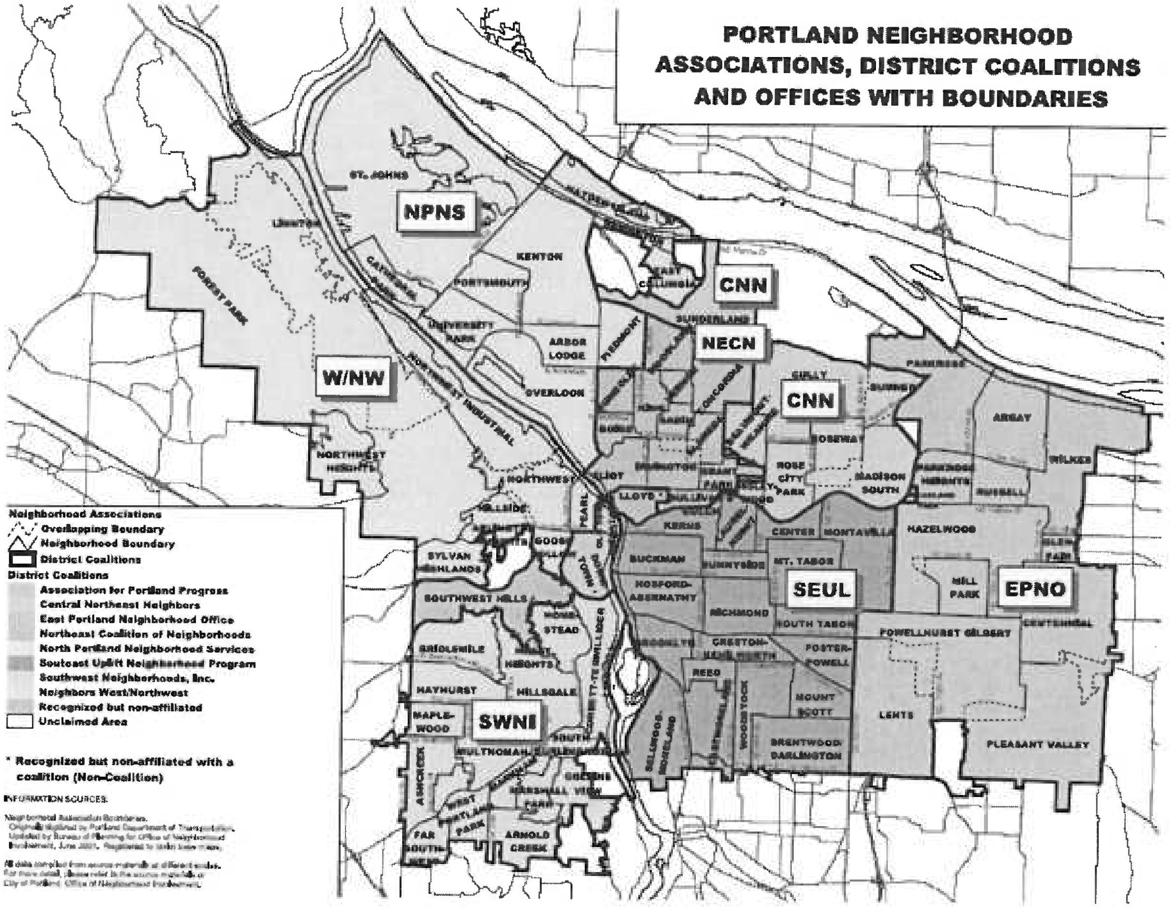
35. Count cars going in one direction for 2 minutes.

Repeat for other direction.

Dir 1	Dir2
___________	____________

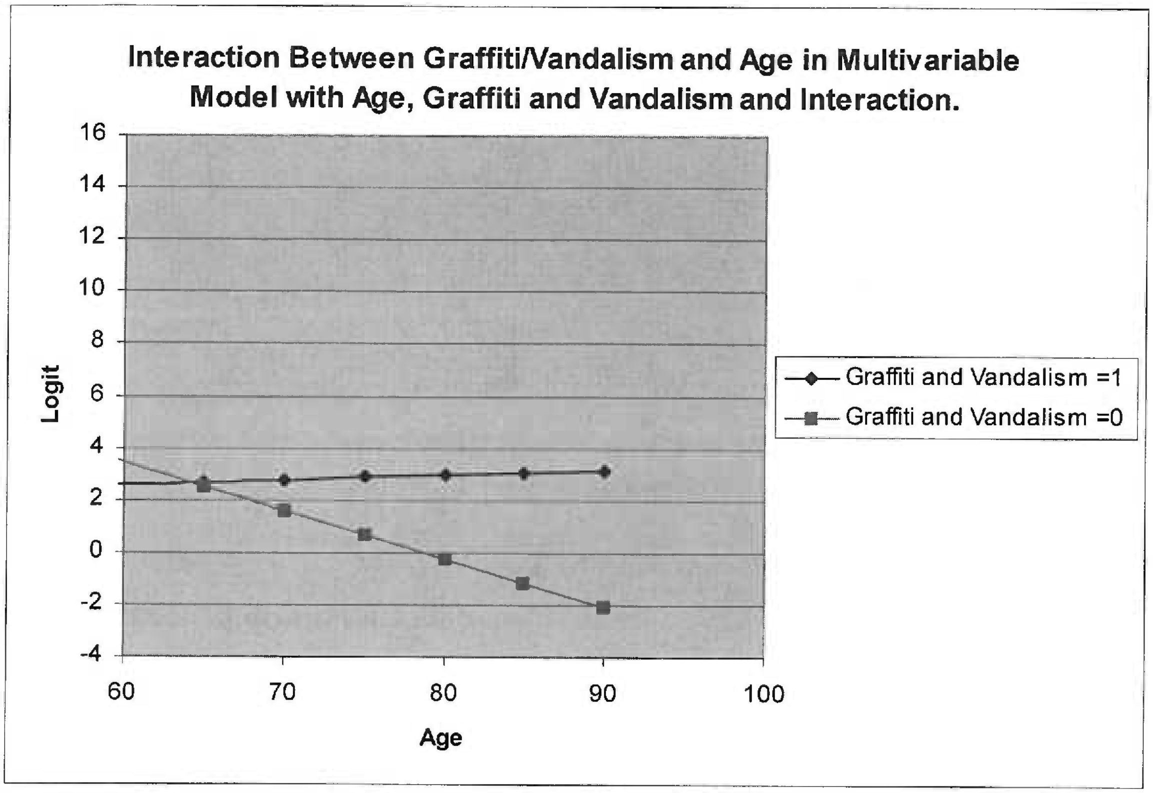
Enter end time__________
Segment Difficulty on a scale of 1(easiest) – 5 (most difficult) (please describe any specific difficulties you had in assessing this street in the notes section.):

Map of Portland Neighborhoods



APPENDIX B: Additional Analyses

Interaction Between Graffiti and Vandalism and AGE



Odds Ratio by Age

AGE	OR FOR GRAFFITI AND VANDALISM (presence=1)
65	0.072
70	0.212
75	0.629
80	1.861
85	5.507
90	16.297

Estimated OR and 95% CI for Objective Logistic Regression Model with Latitude and Longitude of Neighborhood as Continuous variables.

	OR	95% CI for OR		Sig
		Lower	Upper	
latitude	0.963	0.807	1.149	0.674
longitude	1.109	0.930	1.322	0.250
gender(1)	1.055	0.371	2.997	0.920
Educat				0.268
Educat(1)	1.618	0.360	7.284	0.531
Educat(2)	1.436	0.310	6.656	0.644
Educat(3)	5.634	0.871	36.441	0.070
mall	3.171	0.456	22.044	0.243
graffiti and vandalism	0.288	0.067	1.237	0.094
Age-squared	0.986	0.970	1.002	0.091
Age	7.854	0.650	94.839	0.105
Constant	0.000			0.096

Estimated OR and 95% CI for Perceived Logistic Regression Model with Latitude and Longitude of Neighborhood as Continuous variables.

Variables	OR	95% CI for OR		Sig.
		Lower	Upper	
lat	0.986	0.831	1.170	0.870
long	1.028	0.888	1.190	0.714
mallp(1)	2.148	0.861	5.357	0.101
gender(1)	0.899	0.341	2.371	0.830
Educat				0.083
Educat(1)	1.891	0.479	7.469	0.363
Educat(2)	0.969	0.254	3.693	0.964
Educat(3)	6.384	1.090	37.377	0.040
ayrr	8.390	0.949	74.202	0.056
age2	0.986	0.972	1.000	0.050
Constant	0.000			0.055

p-value for model=.047