Published in final edited form as:

Am J Health Promot. 2012 ; 26(4): 239–244. doi:10.4278/ajhp.100715-QUAN-241.

Concordance and Correlates of Direct and Indirect Built Environment Measurement Among Minority Women

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Abstract

Purpose—To measure the concordance of directly and indirectly measured neighborhood attributes and to determine the correlates of the concordance between directly and indirectly measured built environment attributes.

Design—Environmental cross-sectional design.

Setting—Urban and suburban neighborhoods within Harris County, Houston, and Travis County, Austin, Texas.

Subjects—Community-dwelling African-American and Hispanic or Latina women.

Measures—Physical activity resource accessibility, path maintenance, and pedestrian and bicycle facilities were measured directly and indirectly. Directly or objectively measured neighborhood attributes were measured by the Physical Activity Resource. Assessment and Pedestrian Environmental Data Scan instruments. Indirectly measured or self-reported neighborhood attributes were measured by the International Physical Activity Prevalence Study environmental survey module.

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Analysis—Logistic regression was used to measure the concordance between directly and indirectly measured neighborhood attributes with ethnicity as a covariate. Residual values were calculated to determine the strength and direction of concordance.

Results—Participants' (N = 409) average body mass index (BMI) was classified as obese (MBMI = 34.5 kg/m^2, SD = 7.9), and the mean body fat percentage was 42.8% (SD = 7.1). The correlates BMI, body fat percentage, physical activity, and ethnicity were not significantly associated with any built environment attribute or concordance value, and none of our models significantly predicted indirectly measured built environment attributes.

Conclusion—Being less familiar with certain built environment attributes may not be associated with weight status or physical activity levels among African-American and Hispanic or Latina women. (Am J Health Promot 2012;26[4]:239–244.)

Keywords

Environment Design; Physical Activity; Health Promotion; Geographic Information Systems; Obesity Prevention and Control; Health Behavior; Prevention Research; Manuscript format: research; Research purpose: modeling/relationship testing; Study design: randomized trial; Outcome measure: behavioral; Setting: local community; Health focus: fitness/physical activity, social health, weight control; Strategy: skill building/behavior change, built environment; Target population age: adults; Target population circumstances: all education and income levels, neighborhoods in Houston and Austin, Texas, United States, African-Americans and Hispanics or Latinos

PURPOSE

Ecologic models suggest that individual, social, and environmental factors are interrelated and associated with health behaviors,[1–3] but empirical support varies based on the type of neighborhood assessment used.[4,5] Earlier research suggests that greater familiarity with one's environment may lead to higher concordance between reality and perceptions and greater incentive to be physically active in it.[5] Most studies have measured the associations between specific correlates and either direct or indirect built environment attributes,[6–11] but few studies have systematically associated these correlates with the concordance of direct and indirect built environment attributes. No known study has examined objectively measured physical activity (PA) as a possible correlate of concordance.

Using validated direct measures,[7,8,12–15] environmental attributes can be objectively defined and rated by field assessors based on independent definitions for each attribute's existence and/or a quality rating.[12,14,16] Evidence of the association between built environment attributes and PA is typically derived from indirect self-reported data or residents' perceptions of their environments and environmental attributes.[5,17] Although existing literature remains inconsistent,[4] built environment measurement concordance is the correlation between direct and indirect assessments of the built environment and is measured by the strength and direction of the correlation between directly measured and indirectly measured variables of the built environment.

No study has examined concordance among the vulnerable population of ethnic minority women, who report the lowest levels of PA[18] and are at higher risk for obesity, its comorbidities, and the costs associated with these conditions as compared to whites.[19–21] Further, studies suggest that, in conjunction with other intraindividual factors like ethnicity and gender, the strength and direction of the concordance of directly and indirectly measured built environment attributes might also be affected by body mass index (BMI), body fat percentage and PA.[5,9,22] The purpose of this study was to measure the strength, direction, and correlates of the concordance of directly and indirectly measured built environment attributes associated with PA. We hypothesized that women with lower BMIs and body fat percentages who were more physically active would demonstrate stronger concordance.

METHODS

Design

This study involved secondary analyses based on data from the Health Is Power (HIP) project. HIP was a 5-year, longitudinal study (5R01CA109403-4) to increase PA and improve dietary habits in African-American and Hispanic or Latina women in Houston and Austin, Texas. The HIP study was approved by the Committee for the Protection of Human Subjects at the University of Houston, and participants provided written informed consent to participate.

In the present study, environmental cross-sectional data were used to measure the relationships between directly and indirectly measured built environment attribute data among African-American and Hispanic or Latina women.

Sample

Participants were recruited via posted advertisements in local media and in announcements in bulletins of community partners to participate in a health promotion intervention aimed at increasing PA or vegetable and fruit consumption. To provide an ethnic and cultural context, HIP team members and health educators included female ethnic minority community members. Four hundred ten African-American and Hispanic or Latina women completed physical assessments and interviewer-administered questionnaires. The study was powered to answer the research questions of the parent project. Significant unexpected budget cuts resulted in truncated recruitment of Hispanic or Latina participants. Of those enrolled in Houston, 84.6% identified as African-American and 15.4% identified as Hispanic or Latina; all participants in Austin identified as Hispanic or Latina.[23]

Measures

Individual Measures

Indirectly Measured Built Environment Attributes: In order to indirectly measure each participant's neighborhood, the International Physical Activity Prevalence Study environmental survey module[24] was used. The International Physical Activity Prevalence Study (IPS) environmental module has 17 sets of carefully chosen items that reflect current thinking in this field, and in which the reliability and validity of each item has been assessed.[24] For this study, the following variables from the measure were analyzed and compared to objectively measured environmental data: PA resource accessibility, path maintenance, pedestrian facility density, and bicycle facility density.

Physical Activity Measures: The International Physical Activity Questionnaire (IPAQ) Long Form was used to assess self-reported PA levels. The total PA score at Time 1 (T1) was used, and all continuous scores were expressed in metabolic equivalent (MET) minutes.[25] Accelerometers (MTI Actigraph) were used to objectively assess the amount and intensity of PA participants did each day. Participants wore accelerometers on 7 consecutive days at T1 to assess typical PA for moderate and vigorous activity. As for the IPAQ, the total amount of moderate and vigorous accelerometer-measured PA (MVPA) was used for 7 consecutive days.

Other Individual Measures: Body composition was defined by both BMI and percentage body fat. Participants removed shoes and heavy outer clothing, and trained research assistants measured height, using a portable stadiometer (Seca 225 Hite Mobile Measuring Device; Seca Medical Sales and Measuring Devices, North Bend, Washington), and weight, using a bioimpedance monitor with scales (TBF-310 and TBF-300; Tanita Corporation of America, Arlington Heights, Illinois). Body fat was measured using the Tanita integrated bioelectrical impedance body fat monitor and scale (Tanita Body Fat Analyzer TBF 105; Tanita Corporation of America). Sociodemographic measures of years of education and income range were measured using the Maternal and Infant Health Assessment (MIHA). The MIHA is modeled on the Centers for Disease Control and Prevention's Pregnancy Risk Assessment Monitoring System, and items have been used with samples representing a diverse range of ethnicities and socioeconomic status categories.[26,27]

Built Environment Measures

Physical Activity Resource Measure: PA resources were assessed using the Physical Activity Resource Assessment instrument, which documents the accessibility (i.e., whether the resource is free to use), quantity, attributes, and quality of each available PA resource in each neighborhood.[7,8,15] In order to compare directly measured PA resource accessibility with indirectly measured PA resource accessibility, the accessibility variable was extracted from all collected PA resource data and the total number of accessible PA resources was calculated for each participant's neighborhood.

Pedestrian and Bicycle Facilities: To directly assess pedestrian and bicycle facility attributes for each neighborhood, the Pedestrian Environment Data Scan instrument[16] was used. The best pedestrian facility (e.g., sidewalk, trail, footpath), as determined by section B of the instrument, was chosen by the trained assessor(s). Path maintenance was assessed based on the amount of debris and/or the overall condition of the facility.[16] Pedestrian and bicycle facility density was calculated by counting the number of pedestrian and bicycle facilities within each predefined neighborhood.

Procedure

Individual Assessments—Participants completed an interviewer-administered environmental perception questionnaire at T1 and self-reported PA measures at T1.

Participants also completed a 7-day accelerometer protocol at T1 and received modest compensation for completing assessments at each time point.

Neighborhood Assessments and GIS Development—Participant street addresses were geocoded and plotted by a trained Geographical Information Systems specialist using the program Arc-GIS. Each participant's neighborhood was restricted to an 800-m, or approximately 1/2-mile, radius buffer. This predefined region allows for capture of the area to which most residents are likely to be exposed on a daily basis during foot, bicycle, and automobile travels.[28] Earlier studies have also used these boundaries to assess neighborhood features related to health behaviors and outcomes.[7,8,15,29,30]

Environment assessments were completed during the intervention and maintenance period to capture neighborhoods at the same time in order to avoid simultaneity bias.[31] Built environment features were mapped and integrated into each spatial display. All data collectors completed 1 full day of data collection training that included project description, instruction on variable definitions, field training, and reliability testing.[29]

PA Resource Assessments—PA resources were identified via an Internet search, vehicle windshield survey, and GIS data match for the area within an 800-m radius around each participant's physical address. Physical address and map location were then determined for each PA resource. Each PA resource was counted for the neighborhood density calculation, or the number of PA resources within an 800-m radius around each participant's physical address, and assessed.

Pedestrian and Bicycle Facility Assessments—To assess pedestrian and bicycle facilities, trained research assistants assessed all arterial and 25% of residential segments, as sampled by Arc-GIS, within every 400-m buffer around each participant's home. Earlier data have suggested that street segment features do not significantly differ between a 400-m radius buffer and an 800-m radius buffer,[32] allowing for more efficient and time- and cost-effective neighborhood street assessments.

Analysis

Appropriate descriptive analyses were performed to examine distributional characteristics for individual and environmental data. Individual measures were analyzed at T1, and bivariate analyses were conducted among all individual and neighborhood variables. Correlation coefficients appropriate to the scale of the two respective variables were estimated, including Cramer's V, Pearson's and Spearman's correlation coefficients, and η. All statistical analyses were conducted in SPSS Version 18.0 for Windows (SPSS Inc., Chicago, Illinois).

To measure the concordance between objectively measured and self-reported built environment attributes, logistic regression was used to assess the odds of African-American and Hispanic or Latina women choosing one indirectly measured built environment category (Disagree or Agree) over the other category, based on the directly measured built environment category. To examine differences among African-American and Hispanic or Latina women, ethnicity was included as a covariate in all models, and statistical significance was set at $p < .05$. The sample size was based on the primary aim of the HIP study, which was to increase PA. For the purposes of the current study, the HIP sample size was adequate for the logistic regression analyses to have 80% power to detect differences of 15% to 20% in the probability of selecting one indirectly measured built environment category over the other based on the directly measured built environment factors.

To measure the strength and direction of concordance between directly and indirectly measured built environment attributes, a residual value was calculated as the indirectly measured built environment attribute category that each participant chose minus the indirectly measured built environment attribute category predicted by the logistic regression model. Concordance was defined as a residual of 0, meaning that the predicted and the selected category were equal. Negative residuals indicated that the participants' indirect measure (i.e., perception) of the environment was worse than that predicted by the directly measure of the environment. These participants reported that PA resource accessibility in their neighborhoods were low when in fact PA resource accessibility was high. Positive residuals indicated that the participants' indirect measure of the environment was better than that predicted by the direct measure of the environment. These participants reported that PA resource accessibility in their neighborhoods were high when in fact PA resource accessibility was low. To examine associations between residual values and correlates, appropriate bivariate analyses were conducted.

RESULTS

Descriptive Characteristics

Participants' (N = 409) average BMI was classified as obese (MMBI = 34.5 kg/m^2, SD = 7.9), and the mean body fat percentage was 42.8% (SD = 7.1). Both total self-reported PA (MMET minutes = 2458.7, SD = 3533.0) and total accelerometer MVPA (M = 19.0, SD = 19.0) ranged widely. Eighty-nine percent of participants had graduated from college or completed some college, and almost 50% of participants reported an income 401% or greater above the federal poverty level for a family of four.[33] All descriptive characteristics have been reported previously.[23]

Directly Measured Built Environment Attributes

Most neighborhoods had one or more accessible PA resources (96.1%, N = 345), and 83% (N = 309) of neighborhoods had "good" sidewalk maintenance ratings. Seventy-nine (19.3%) neighborhoods had 14 or more pedestrian facilities, yet nearly 75% had no bicycle facilities (N = 284). Only one directly measured built environment attribute, bicycle facility density, varied significantly by ethnicity ($F[1378] = 13.1$, $p < .001$). Directly measured built environment attributes by ethnicity are presented in Table 1.

Indirectly Measured Built Environment Attributes

Most participants agreed that there were many free or low-cost PA resources in their neighborhoods, that there were paths on most of the streets, and that the paths were well maintained. Overall, African-American women agreed that there were PA resources and pedestrian facilities more frequently than Hispanic or Latina women, although this difference was not statistically significant. Indirectly measured built environment attributes by ethnicity are presented in Table 1.

Direct and Indirect Built Environment Attributes and Correlates

Bivariate analyses were conducted among directly and indirectly measured built environment attributes, BMI, body fat percentage, self-reported PA, accelerometry, sociodemographic variables, and ethnicity (Table 2). Ethnicity, BMI, body fat, and PA were not significantly associated with any built environment attribute.

Concordance of Direct and Indirect Built Environment Measurements

No regression model significantly predicted indirectly measured built environment attributes (PA resource accessibility $\chi^2[6] = 1.778$, $p = .939$; path maintenance $\chi^2[2] = .326$, $p = .849$; pedestrian facility density $\chi^2[8] = 14.714$, $p = .065$; bicycle facility density $\chi^2[4] = 1.272$; $p = .866$). Table 3 shows the concordance (residual) values for each indirectly measured built environment attribute.

A large percentage of participants misperceived their neighborhood, as indicated by nonconcordance between their perceptions and the actual attributes. Most of the nonconcordance values were positive, suggesting that most women perceived that their neighborhood built environment attributes were better than they actually were. Almost 60% of residents had a positive nonconcordance for pedestrian facility density and 48.5% demonstrated a positive nonconcordance for PA resource accessibility. These residual values were not significantly associated with any correlate ($p > .05$). Although the models were not significant, several participants' perceptions demonstrated concordance. Eighty-four percent (N = 277) of participants' perceptions demonstrated concordance for path condition. Almost 26% (N = 93) of participants had an accurate perception for PA resource accessibility, but only 20.2% (N = 68) of participants accurately perceived their neighborhood's pedestrian facility density. Most residents (74.3%, N = 275) perceived a negative nonconcordance for bicycle facility density, and only 12.2% (N = 45) demonstrated concordance for this attribute.

DISCUSSION

Overall, direct and indirect measures of environment attributes were not concordant, which is similar to findings of earlier studies.[4,34] Many participants overestimated built environment attributes, unlike in previous research,[5] suggesting that residents believed that built environment attributes were more supportive than they actually were. These results also might be due to overestimations of neighborhood features and PA levels, as has been previously observed specifically among women.[4,35] Our self-reported PA levels varied greatly, possibly affecting the perceptions and concordance of our built environment attributes. Unlike earlier studies,[5,22] BMI, body fat percentage, and PA were not significantly associated with any direct or indirect measure of the built environment attributes.

Participants overestimated PA resource accessibility and pedestrian facility density more frequently than any other built environment attribute. Higher socioeconomic status (SES) levels in this sample may have increased accessibility to PA resources and led to overestimation of the number of accessible PA resources for free. Overestimations of pedestrian facility density could be due to our sample's high level of educational attainment,[5] because most of our participants had completed some college or more.

The relationships between PA and attribute concordance might differ for this sample based on the types of neighborhoods: our participants lived in both suburban and urban areas. Most data describing the relationship(s) between concordance and BMI, body fat, and/or PA are derived from urban or highly walkable areas.[5,22] The variability among our neighborhoods could have affected the relationships among built environment attribute concordance and its correlates. It is possible that some high-SES minority women correctly perceive other built environment attributes not measured in our study, and correct perceptions of some attributes might be more relevant than correct perceptions of others depending upon various personal factors (e.g., proximity to place of employment, bike ownership).

To the best of our knowledge, no similar studies of minority women exist. Unlike other studies examining built environment attributes,[4,5,22] our study compared directly and indirectly measured built environment attributes among two different ethnic groups. Although African-American and Hispanic or Latina women have disproportionately high rates of obesity and physical inactivity as compared to Caucasian women,[19,20] they continue to be understudied in ecological literature.[36]

Many built environment studies have used either direct or indirect measures,[7,8,15,37,38] but few studies have measured the concordance between these two types of measurements.[4,5,39] We also assessed a wider variety of neighborhood types than were assessed in previous studies,[5,22] increasing the generalizability of our findings. This study also used both a self-reported PA questionnaire and accelerometry to measure PA, providing a more comprehensive assessment of PA. Our findings are limited to the population of African-American and Hispanic or Latina women of higher SES and may not generalize to the general public.[4,5,39] Because of compliance and logistic reasons, the number of participants who wore accelerometers was significantly lower than the number who completed the IPAQ questionnaire. Future studies should attempt to recruit and assess an equal number of participants for both PA measures to provide a more comprehensive PA assessment.

Being less familiar with one's neighborhood may not be associated with weight status, PA, and/or ethnicity for high-SES ethnic minority women. These findings do not support similar earlier findings among other populations, suggesting that further development and investigation is needed in both theory and supporting data. More studies of understudied populations, particularly vulnerable groups like ethnic minority women, are needed.

Acknowledgments

This research was funded by a grant awarded to Dr. Rebecca E. Lee from the National Cancer Institute of the National Institutes of Health (1R01CA109403).

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Table 1

Directly and Indirectly Measured Built Environment Attributes by Ethnicity

Directly Measured Built Environment Attribute	African-American, No. (%)	Hispanic or Latina, No. (%)	Indirectly Measured Built Environment Attribute IPS Question†	African-American, No. (%) Agree	Hispanic or Latina, No. (%) Agree
PA resource accessibility					
Not accessible	10 (4.2)	4 (3.4)	My neighborhood has several free or low-cost recreation facilities	197 (81.4)	98 (72.1)
Accessible	230 (95.8)	115 (96.6)			
Path condition					
Poor or fair	39 (15.9)	21 (16.9)	The sidewalks in my neighborhood are well maintained	172(70.8)	96 (72.2)
Good	206 (84.1)	103 (83.1)			
Pedestrian facility density*					
0–5	57 (22.5)	17 (13.4)	There are sidewalks on most streets of my neighborhood	202 (82.4)	108 (80.6)
6–8	51 (20.2)	26 (20.5)			
9–10	45 (17.8)	27 (21.3)			
11–13	52 (20.6)	26 (20.5)			
14+	48 (19.0)	31 (24.4)			
Bicycle facility density					
0	203 (80.2)	81 (63.8)	There are facilities to bicycle in or around my neighborhood	122 (51.9)	71 (55.5)
1	26 (10.3)	20 (15.7)			
2+	24 (9.5)	26 (20.5)			

† IPS indicates International Physical Activity Prevalence Study Environmental Module.

* $p < 0.001$.

Table 2

Bivariate Relationships Between Direct and Indirect Built Environment Attributes and Correlates and Ethnicity†

	Direct Measure				Indirect Measure				Correlates			
	PA Resource Accessibility	Pedestrian Facility Density	Path Maintenance	Bicycle Facility Density	PA Resource Accessibility	Pedestrian Facility Density	Path Maintenance	Bicycle Facility Density	BMI	BF	Acc. PA	IPAQ PA
Indirect measure												
PA resource accessibility	0.03	—	—	—								
Pedestrian facility density	—	0.08	—	—								
Path maintenance	—	—	0.07	—								
Bicycle facility density	—	—	—	0.07								
Correlates												
BMI	0.00	−0.05	0.08	−0.03	0.11	0.07	0.04	0.01				
BF	0.01	−0.07	0.12	−0.02	0.05	0.04	0.05	0.02	0.84*			
Acc. PA	0.11	−0.05	0.21	−0.11	0.09	0.07	0.11	0.11	−0.05	−0.04		
IPAQ PA	0.09	−0.05	0.10	0.03	0.07	0.06	0.07	0.02	0.00	−0.01	0.06	
Ethnicity	0.09	0.05	0.85	0.14	0.11	0.09	0.11	0.06	0.03	0.04	0.34	0.06

†PA indicates physical activity; BMI, body mass index; BF, body fat; Acc., accelerometer; and IPAQ, International Physical Activity Questionnaire.

*$p < 0.01$.

Table 3

Concordance Values for Indirectly Measured Built Environment Attributes*

Attribute	No. (%)
PA resource accessibility	
−2	14 (3.9)
−1	78 (21.7)
0	93 (25.9)
1	65 (18.1)
2	49 (13.7)
3	60 (16.7)
Pedestrian facility density	
−1	67 (19.9)
0	68 (20.2)
1	63 (18.8)
2	67 (20.0)
3	71 (21.1)
Path condition	
−1	52 (15.8)
0	277 (84.2)
Bicycle facility density	
−1	275 (74.3)
0	45 (12.2)
1	50 (13.5)

*−1, −2 = negative nonconcordance; 0 = concordance; 1, 2, 3 = positive nonconcordance. PA indicates physical activity.