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Neighborhood and PA: Neighborhood Factors and Physical Activity in African American Public Housing Residents

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Background: In the US, public housing developments are typically located in lower socioeconomic status neighborhoods that may have poorer quality street level conditions, placing residents in neighborhoods that are less supportive for physical activity (PA). This study investigated the relationship of detailed, objectively assessed street-level pedestrian features with self-reported and measured PA in African American public housing residents. ***Methods:*** Every street segment (N = 2093) within an 800 m radius surrounding each housing development (N = 12) was systematically assessed using the Pedestrian Environment Data Scan (PEDS). Participants completed an interviewer administered International Physical Activity Questionnaire (IPAQ) Short Form and wore a pedometer for 1 week. ***Results:*** Women reported significantly less vigorous (mean = 1955 vs. 2896 METs), moderate (mean = 733 vs. 1309 mets), walking (mean = 1080 vs. 1376 METs), and total (mean = 3768 vs. 5581 METs) PA on the IPAQ compared with men (all $P < .05$). Women took fewer pedometer steps per day (M = 3753 vs. 4589) compared with men, but this was not statistically significant. Regression analyses showed that for women, lower speed limits were associated with vigorous; higher street segment density was associated with more moderate PA; lower speed limits, fewer crossing aids, and more lanes were associated with more walking; and, fewer lanes was associated with more overall PA. For men, fewer sidewalk connections were associated with more moderate PA; lower speed limits were associated with more walking; and, lower speed limits was associated with more overall PA. ***Conclusions:*** Neighborhood factors influence physical activity; in particular, lower speed limits appear most commonly linked with increased physical activity in both men and women.

Keywords: environment, physical activity, African American, public housing

Although benefits of adopting physical activity are well publicized,[1,2] recent data show physical inactivity rates remain high.[3] Health research efforts continue to examine strategies for increasing physical activity by investigating neighborhood features that might influence physical activity rates.[4–7] Many forms of physical activity are done in convenient places, like neighborhood streets and sidewalks,[8–10] and have the advantage of better sustainability with minimal equipment or additional costs (eg, gym memberships).[6,11,12] Thus, scholars have suggested that interventions which focus on lifestyle physical activity, that can be done in convenient neighborhood locations[13] and that incorporate relevant neighborhood environmental factors have great promise;[5–7,14–17] however, better understanding of neighborhood factors is needed to inform these efforts.

Ecologic models posit that environments directly and indirectly shape and modify physical activity.[5,6,13] In the context of physical activity, residence in neighborhoods where people report streets that are safe, clean, and well connected with interesting things to look at for people walking or bicycling has been related to physical activity, particularly walking—the most commonly reported physical activity.[8,18–21] People who live near streets with minor traffic and trees, or streets with footpaths or sidewalks, are more likely to achieve recommended levels of physical activity, regardless of their individual income, education or ethnic background.[8] Government subsidized public housing developments, typically located in lower socioeconomic status neighborhoods, place residents in neighborhoods that are less supportive for physical activity.[12,22] People who reside in lower socioeconomic status neighborhoods continue to demonstrate less physical activity,[7,23–25] perhaps due, in part, to lower quality neighborhood environments.[15,26,27] Heinrich et al found that public housing residents with greater access to more physical activity resources with fewer incivilities and greater street connectivity were more likely to be physically active.[7]

Although research has begun to investigate the relationship between neighborhood factors and physical activity, few studies have been able to capture this relationship in more detail at the street-level. Street segment characteristics, hypothesized to be most influential,

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require detailed auditing and analytic strategies to combine aggregated environmental characteristics with resident physical activity patterns. Many associations between environmental variables and physical activity have been found. Various studies have shown that environmental factors influence particular types of physical activity (ie, recreational, transportation) differently; however, many of these findings are based on perceived or resident self-reported environmental variables[11,28] and self-reported physical activity,[29] with few studies using objective, in-person audits of the environment.[30] Earlier research suggests that perceived and objective measures of environmental attributes can relate to physical activity differently.[31–33]

The Healthful Options Using Streets and Transportation in Our Neighborhoods (HOUSTON) project was designed to investigate the relationship of detailed, objectively assessed environmental data with self-reported and measured physical activity among African American public housing residents. Data for the current study document the relationship between street-level pedestrian features collected for every segment in selected neighborhoods and physical activity among residents.

Methods

Design

Neighborhood- and individual-level, cross-sectional data were drawn from the HOUSTON Project, conducted in the city of Houston, Texas.[34–36]

Sample

Neighborhoods. Twelve public housing developments were selected for this study based on (1) receipt of federal funding (to enhance comparability to other public housing sites around the US), (2) wide geographical dispersion (at least 1 mile distance from the centroid of one housing development to another), and (3) willingness to participate in a research study. Selection procedures and neighborhood characteristics are described in more detail previously.[34,35] Neighborhoods were defined as the area within an 800 m radius Euclidean buffer surrounding the housing development that did not overlap with other neighborhoods. This definition captures a geographic area to which a resident may primarily be exposed to on a daily basis. During interviews with public housing residents, in a study described previously, one resident described neighborhood resources as being "within walking distance," which lends support to the use of an 800 m buffer to define neighborhood—a geographic distance within walking distance.[34] Furthermore, it reduces spatial dependence concerns.[37,38] Housing developments and surrounding neighborhoods were similar in ethnic representation and socioeconomic measures. At the time of the study, public housing developments in the city served a predominately African-American population (62.8%), and residents met the 2006 US Department of Health & Human Service's Poverty guidelines.[39]

Participants. Participants included 216 residents (64% women). Eligible participants were men and women who were residents of the particular housing development, between the ages of 18 and 89, who self identified as Black or African American, were able to walk unassisted, did not have an internal medical electronic device, such as a pacemaker, and were not pregnant. Most participants (72.5%) had not attended any college and 84.1% reported household incomes between 0% and 200% above the federal poverty level (consistent with public housing eligibility requirements), suggesting relatively low socioeconomic status. The majority of participants were US born (95.8%) and English speakers (98.6%).

Measures

Environmental Factors. The Pedestrian Environmental Data Scan (PEDS) instrument measures street segment environmental features and pedestrian facilities related to walking and cycling. It contains 40 questions that measure macro environment features, such as land use, segment type, and connectivity, and micro environment features, such as lighting, amenities, and articulation. Sidewalk connectivity is the total number of connections of one sidewalk to other sidewalks on each side of a street segment.[40] Additional measures include pedestrian facilities, road attributes, and the walking and cycling environment.[40] Total number of segments per neighborhood was counted as a measure of street segment density.

Demographics. Items assessing ethnicity, primary language spoken, household income, educational attainment, and parental educational attainment were adapted from the Maternal Infant Health Assessment (MIHA) survey,[41] derived from the CDC's Pregnancy Risk Assessment Monitoring System (PRAMS) Questionnaire.[42] Items have been used with samples representing diverse ethnicities and socioeconomic status.[43]

Physical Activity. Physical activity was measured using the International Physical Activity Questionnaire (IPAQ) short form and pedometers. The International Physical Activity Questionnaire (IPAQ) short form assessed vigorous- and moderate-intensity physical activity, walking, and total physical activity over a period of the last 7 days. Physical activity was reported in terms of days per week and minutes and/or hours per day and transformed per standardized scoring protocols to yield metabolic equivalent minutes (MET). The IPAQ short form instrument designed primarily for population surveillance of physical activity among adults, is widely used and reliable ($\alpha = 0.8$) and has shown modest validity ($r = .3$) in comparison with accelerometry.[44] It has also been used in low income minority populations.[45,46]

Pedometers, used as an objective measure of physical activity, measured daily steps over a period of 7 days. A total count of steps over the 7-day period was used in analyses. Pedometers are valid and reliable state of the art devices,[47,48] showing high validity in comparison with different accelerometers ($r = .8$) and strongly correlated with time in observed activity ($r = .8$).[49] These measures capture different dimensions of physical activity. The IPAQ captures self-reported physical activity duration and intensity, while the pedometer captures objectively measured physical activity duration only.

Procedure

Neighborhoods. Neighborhoods were mapped using Geographical Information Systems (GIS) technology. Every street segment, within the 800 m radius around each housing development, was counted and assessed using the PEDS.[40] A street segment is a portion of a street that is intersected by 2 cross streets, or by a cross street at one end and a dead end at the other.[38] Pedestrian facilities, path condition, path obstructions, curb cuts, crosswalks, path lighting, traffic buffers (eg, fence, trees, grass), sidewalk connections, vehicle lanes, traffic speed limit, traffic control devices, amenities (eg, benches, trash cans, street vendors), crossing aids, and bicycle facilities were some of the variables from the PEDS that represented pedestrian features. Selected pedestrian features were assessed for each street segment. All assessments were conducted by trained research staff in teams of at least 2 people following established data collection and safety protocols.[7,12,50,51]

Participants. Participants were recruited within each of their HDs. Permission from the manager of each housing development was obtained to conduct the study on housing development property. Flyers with the study's description, eligibility and contact information were distributed and posted in and around each of the housing development. Recruitment strategies included scheduled interview appointments and interviews conducted on the spot. HOUSTON project staff attended various HD events such as mangers', resident council or safety meetings, socials, and fairs where the study was explained and a list of interested participants and their contact information was collected. The HOUSTON project director and team members visited each of the 12 housing developments several times to recruit and assess volunteer residents.

Interested participants completed an inclusionary screener, which included a brief description of the study, the Physical Activity Readiness Questionnaire (PAR-Q) and inclusionary questions. All participants were informed of their rights as a volunteer research participant and given a consent form to sign which explained the purpose of the study and their participation in the study. All study procedures were approved by the University Internal Review Board.

Measures. Each participant completed a simple physical health assessment conducted by trained graduate students in kinesiology, public health, or social work and received a summary of his or her information. Participants' height and weight was measured, recorded, and used to compute Body Mass Index (kg/m^2). Physical health assessments also included measurement of resting blood pressure, resting heart rate, and body fat percentage using the Tanita integrated bioelectrical impedance body fat monitor and scale (Tanita Body Fat Analyzer 310). All assessments were done twice and values were averaged together for analyses. In addition, they completed an interview-administered health questionnaire. Participants were compensated $10 at the conclusion of their interview and assessment.

Upon completion of the health assessment, participants were invited to complete a take home packet of additional questionnaires and asked to return them 1 week later. The take home packet served as a measure of compliance to identify residents who might be interested in completing pedometer assessments. Of the 216 initially enrolled, 115 returned completed take home questionnaire packets and were invited to complete a pedometer assessment. Only those who returned a take home questionnaire received a pedometer. Of the 115 who participated in the pedometer assessment, 95 wore the pedometer correctly and had valid data. Valid data were defined as at least 1000 and no more than 20,000 steps per day on the days the pedometer was worn.[52] Participants were assigned a pedometer to wear and expected to wear the pedometer at all times for 7 days except while sleeping or showering. HOUSTON team members called participants everyday to remind them to wear the pedometers. Participants returned the pedometers assigned to them 1 week after receiving them. The pedometers were then checked for accurate data collection. The 95 participants who completed the take home questionnaire packet and had valid pedometer data were considered completers of the study. There were no significant differences in demographic, health or physical activity information between completers and noncompleters (all $P > .05$).

Data Management and Security. Environmental data collected on paper forms were secured in a locked file cabinet. Data collected on electronic devices (computer or pedometer) were downloaded upon return from the field to a password protected, nonnetworked project computer.

Analyses

To reduce data, continuous variables that had frequencies greater than 5 were used in data reduction techniques. Final selection of variables was based on significant relationships with other PEDS variables. Variables that were not correlated with other variables were selected and in cases where there was high multicollinearity, decisions were made based on consistency with previously hypothesized relationships and extensive field experience of investigators. The final variables selected included sidewalk buffers, sidewalk connectivity, travel lanes, speed limit, traffic control devices, pedestrian crossing aids, bicycle facilities, and pedestrian amenities.

Street level data and individual variables were aggregated to the neighborhood level using established protocols for ecologic analyses.[7,12,35] Regression analyses were used to estimate the effect of aggregated environmental factors on physical activity variables (as opposed to multilevel modeling), because the sample size of 12 neighborhoods would yield unstable estimates, and significant relationships demonstrating between neighborhood bias were not identified in preliminary analyses. Models were done separately by gender based on previous work suggesting differential sensitivity to neighborhood variables.[24,53,54]

Results

Descriptive Characteristics

Participants were healthy African Americans; more women (64%) participated than men. Demographic characteristics by gender are presented in Table 1. Physical activity varied by gender on questionnaires, but not on pedometer. Women reported less vigorous ($F(1,177) = 4.0$, $P = .046$), moderate ($F(1,177) = 7.1$, $P = .008$), and total ($F(1,177) = 5.6$, $P = .019$) physical activity than men. Mean physical activity by gender is presented in Table 2.

Bivariable Associations

Bivariate correlations among PEDS variables revealed numerous significant correlations (*r*s .059 to .529, *P*s .000 to .050) (results not shown). Intercorrelations among selected PEDS variables are presented in Table 3. Having more travel lanes in a neighborhood was correlated with a higher speed limit ($r = .475$, $P < .001$) and more crossing aids ($r = .462$, $P < .001$).

PEDS variables were significantly correlated with self-reported physical activity as measured by the IPAQ. Sidewalk connections were significantly correlated with objectively measured physical activity as measured by a pedometer but no other environment measures. Correlations between PEDS variables and physical activity are presented in Table 4.

Regression Models

Linear regression models were used to address the relationship between PEDS variables and physical activity in women and men. Regression models were adjusted for participant age and neighborhood street segment density. Analyses showed speed limit was associated with vigorous intensity ($P = .004$), walking ($P = .002$), and total physical activity ($P = .003$) in women. Speed limit was also associated with walking ($P = .002$) and total

Table 1 Participant Demographics by Gender

	Women (n = 139) mean (SD)	Men (n = 77) mean (SD)	Total (n = 216) mean (SD)
Age (years)	43.3 (16.1)	43.8 (18.9)	43.5 (17.1)
Body mass index (kg/m^2)	33.0 (8.9)	28.3 (7.7)	31.3 (8.7)
Systolic blood pressure (mmHg)	120.4 (17.9)	123.4 (16.8)	121.5 (17.5)
Diastolic blood pressure (mmHg)	74.3 (12.7)	73.5 (13.0)	74.0 (12.8)
Resting heart rate (beats per minute)	76.1 (10.8)	73.5 (11.2)	75.1 (11.0)
Body fat (%)	40.7 (9.7)	24.1 (10.9)	34.8 (12.9)
	% (N)	**% (N)**	**% (N)**
Completed some college or more	31.6 (42)	21.1 (16)	27.8 (58)
Parents completed some college or more	28.9 (35)	21.9 (14)	26.5 (49)
201% or more above Federal Poverty Level	16.3 (21)	15.5 (11)	16.0 (32)

Table 2 Physical Activity by Gender

	Women (n = 139) mean (SD)	Men (n = 77) mean (SD)	Total (n = 216) mean (SD)
IPAQ Vigorous	1954.9 (2743.3)	2895.9 (3293.7)	2259.8 (2956.8)
IPAQ Moderate	733.2 (1184.6)	1309.0 (1654.8)	919.7 (1376.9)
IPAQ Walking	1079.9 (1377.1)	1376.0 (1541.6)	1175.8 (1434.9)
IPAQ Total	3767.9 (4399.2)	5580.9 (5486.9)	4355.3 (4838.6)
Pedometer steps per day	3753.2 (1943.4)	4588.8 (3249.6)	3955.5 (2335.3)

Table 3 Intercorrelations Among PEDS Variables

	Sidewalk buffers	Connections	Travel lanes	Speed limit	Traffic control devices	Crossing aids	Bicycle facilities	Amenities
Sidewalk buffers	1	.243**	.073**	.045	.108**	.102**	.079**	.063**
Connections	.243**	1	.161**	.042	.154**	.221**	.086**	.069**
Travel lanes	.073**	.161**	1	.475**	–.083**	.462**	.140**	.159**
Speed limit	.045	.042	.475**	1	.017	.164*	–.051	–.052
Traffic control devices	.108**	.154**	–.083**	.017	1	.124**	.029	.012
Crossing aids	.102**	.221**	.462**	.164*	.124**	1	.204**	.205**
Bicycle facilities	.079**	.086**	.140**	-.051	.029	.204**	1	.123**
Amenities	.063**	.069**	.159**	-.052	.012	.205**	.123**	1

* $P < .05$, ** $P < .01$.

Abbreviations: PEDS, Pedestrian Environment Data Scan.

Table 4 Correlations Between PEDS and Physical Activity Variables

	Vigorous PA	Moderate PA	Walking	Total PA	Pedometer steps
Sidewalk buffers	–0.389	–0.578*	–0.077	–0.388	–0.285
Connections	–0.405	–0.588*	0.224	–0.313	–0.468
Travel lanes	–0.433	–0.356	–0.538	–0.488	0.319
Speed limit	–0.702*	–0.446	–0.846**	–0.75**	–0.134
Traffic control devices	–0.402	–0.533	–0.139	–0.402	–0.002
Crossing aids	–0.41	–0.491	–0.38	–0.465	0.238
Bicycle facilities	–0.412	–0.484	–0.438	–0.481	0.478
Amenities	–0.286	–0.321	–0.358	–0.346	0.504

* $P < .05$, ** $P < .01$.

Abbreviations: PEDS, Pedestrian Environment Data Scan; PA, physical activity.

Table 5 Regression Models Between PEDS Variables and Physical Activity in Women and Men

Predictor variables	Beta	*t*	Sig.
Women			
Vigorous PA			
Speed limit	–0.765	–3.761	0.004
Walking			
Speed limit	–0.797	–4.174	0.002
Total PA			
Total density	0.358	2.085	0.067
Speed limit	–0.703	–4.087	0.003
Men			
Moderate PA			
Connections	–0.744	–3.519	0.006
Walking			
Speed limit	–0.799	–4.199	0.002
Total PA			
Speed limit	–0.642	–2.647	0.024
Pedometer steps			
Connections	–0.660	–2.487	0.038

Abbreviations: PEDS, Pedestrian Environment Data Scan; PA, physical activity.

(P = .024) physical activity in men, and sidewalk connections were associated with moderate intensity physical activity (P = .006) and pedometer steps (P = .038). A summary of significant relationships described by the regression models is presented in Table 5, and suggest that neighborhood speed limit was the most consistent factor associated with physical activity.

Discussion

Results from this study indicate lower speed limits are most consistently related to walking and vigorous physical activity in both men and women. Neighborhood street-level pedestrian features have been reported to influence physical activity. In contrast to other studies, which have found that greater segment connectivity is associated with more physical activity,[55,56] no expected associations were found with this variable, potentially reflecting a more homogenous urban environment or differences with this population. Sidewalk connections were negatively correlated with moderate physical activity among men. Some studies have reported crime is highest in the most walkable low-income neighborhoods;[57,58] perceived safety issues such as crime rate and high traffic could be a possible explanation of this unexpected finding. Previous studies have reported a positive association between neighborhood traffic safety and walking and cycling.[59,60] Existing literature has shown it is essential that the built environment supports physical activity[61,62] and have further demonstrated that changing certain elements of the built environment can increase physical activity levels in a given population or community,[63] such as implementing of traffic calming devices,[64] which result in lower traffic speeds.In general, speed limits were important for physical activity for both genders. Few differences were found between men and women. Previous studies have suggested that girls and women may be more sensitive to neighborhood conditions compared with men as a result of domestic duties, participation in local organizations and individual preferences.[24,53,54] Perhaps the variables identified herein are more universal, and other types of environmental factors demonstrate greater variability by gender. Additional research is needed to understand how to strike a balance in promoting physical activity in both men and women; but it is clear that reducing speed limits transcends gender specific relationships of PA to the built environment. The current study primarily addressed correlations between street scale elements and PA. We chose to focus on street scale elements rather than land use elements such as proximity or density of commercial destinations since the former are more easily modifiable.[62] This is especially true in the city of Houston due to the absence of zoning regulations.[65]

Strengths of this study included systematic protocols, in person audits of the environment, detailed objective data collection, trained data collectors and a complete census of street segments. The study had a large population sample of residents from housing development neighborhoods located throughout the city of Houston maximizing geographic variability. Public housing residents do not choose their home location; therefore, this study provided a unique opportunity to investigate the influence of neighborhood characteristics without neighborhood selection bias. However, all selection bias was not eliminated as our sample consisted of volunteers; as it is illegal to compel all residents to participate in a study (as is the case of all human studies in the US). Our findings are generalizable to urban housing development populations and neighborhoods, but the quality of the data and consistency of the findings may inform research and practice among other populations and neighborhoods. Future studies should assess neighborhood crime to determine how it affects physical activity. Neighborhood characteristics may not directly affect physical activity; however, these features may influence crime and residents' perceptions of safety. Last, perceived neighborhood definitions have been found to differ from objective definitions often used in physical activity research,[66] and future research should investigate the concordance between resident reports and objective definitions of neighborhood boundaries.

Taken together with other studies, these findings support the need for built environment and transportation policies that facilitate environments which are safe from traffic to encourage physical activity. Lower neighborhood speed limits are a common feature of countries with high rates of active transport such as walking and cycling.[67] Addressing the risks associated with high speed traffic may lead to more walking and cycling. Lower traffic speeds in urban areas may contribute to increased rates of physical activity, both for leisure and for transportation.

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