BRIEF COMMUNICATION

Do Neighborhood Physical Activity Resources and Land Use Influence Physical Activity among African American Public Housing Residents?

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Abstract: Few studies have examined neighborhood influences on physical activity (PA) among low-income African Americans living in public housing. This study measured the associations of PA resources and land use with PA among 216 African Americans living in 12 low-income housing developments in Houston, Texas. Neighborhood measures included both detailed information from in-person audits and geographic information systems (GIS) data. Hierarchical linear regression models tested the associations of neighborhood PA resource availability and quality and land use density and diversity with individual-level, self-reported PA. Land use diversity was positively associated with walking among men after controlling for other neighborhood characteristics. Policies that promote land use diversity or improve the pedestrian environment in areas with diverse destinations may encourage PA among public housing residents.

Key words: Walking, urban, parks, neighborhood audits, land use density, land use diversity.

Increasing physical activity (PA) is a national priority.[1] It is important to understand the potential role of neighborhood environments in PA disparities.[2–23] Ethnic minority populations living in low-income housing report low PA,[10] and previous studies have shown associations between neighborhood PA resources (e.g., parks) and obesity[20–21] and between pedestrian environnments and PA.[10] Additional neighborhood characteristics, including PA resource availability and quality and land use density and diversity, warrant examination as potential PA influences among vulnerable populations. Physical activity resources and land use characteristics are important targets for PA-centric community planning[24] and may be particularly important among low-income housing residents with limited ability to select neighborhoods that support PA.

The availability and quality of neighborhood PA resources, such as parks, have

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been linked to higher PA among residents.[17,20,25] Previous research has focused on PA resource availability[17,25] or quality,[20] but not both. The quantity of destinations such as bus stops, grocery stores, and retail stores within neighborhoods, or land use density, may increase PA by promoting walking or bicycling for transportation.[3,11,14] The range of destination types in a neighborhood, or land use diversity, may also promote active transportation between locations.[11,26] Since use typically confers no direct costs, potential influences of PA resources and land use on PA among low-income and ethnic minority populations warrant examination.

Both PA resources and land use should be examined as potential PA influences, because they may support different domains of PA at different times. Further, PA resources and land use constitute only part of the PA environment. The availability and quality of pedestrian resources (e.g., sidewalks, connectivity, safety features) also influence PA[10] and may be important in relationships among PA resources, land use, and PA. Neighborhood crime[27,28] and traffic[7] may encourage or discourage walking, bicycling, and park use. Crime and traffic are understudied as potential PA influences among low-income and ethnic minority populations, although both may be common in their neighborhoods.[29,30] To our knowledge, no study to date has examined relationships among PA resources and land use and PA while accounting for neighborhood pedestrian environment quality, crime, and traffic.

The current study investigated associations among PA resources, land use characteristics, and PA among African Americans living in low-income housing developments in Houston, Texas. We hypothesized that PA resource availability, PA resource quality, land use density, and land use diversity would be positively correlated with PA after controlling for neighborhood pedestrian environment quality, traffic, and crime.

Methods

Study design. Data for this study were drawn from a 2005 cross-sectional, ecological study (HOUSTON study).[10,20]

Participants and neighborhoods. Study participants included 216 African American adults (18 and older) living in selected low-income housing developments in Houston, Texas. Housing development selection and participant recruitment have been described previously.[10,20] Using geographic information systems (GIS), neighborhoods were drawn based on 800-meter radial buffers surrounding the addresses of each housing development.[10,20,31] All study protocols were reviewed and approved by the University of Houston Committee for the Protection of Human Subjects. Certain previously-published participant and neighborhood characteristics are published in this article to facilitate interpretation of newly presented data.[10,20]

Measures. *Physical activity.* As described previously, trained interviewers administered the International Physical Activity Questionnaire (IPAQ) Short Form to each participant to assess moderate- and vigorous-intensity PA, walking, and total PA in the previous week.[10,32] Times were processed per standardized scoring protocols to yield metabolic equivalent (MET) minutes spent performing each type of PA.

Physical activity resources. As described previously, audits using the Physical Activity Resource Assessment (PARA) counted PA resources within neighborhoods and objectively assessed their features, amenities, and incivilities.[20,33] A composite quality index score (QPAR) was determined for each PA resource by subtracting total incivilities from the sum of feature and amenity scores.[33]

Land use density and diversity. Land use density and diversity were compiled using counts of 18 categories of non-residential neighborhood destinations: PA resources, bus stops, restaurants (fast food, table service, and other), supermarkets, grocery stores, gas stations, pharmacies, banks, pawn shops, check-cashing stores, liquor stores, bars, places of worship, salons, schools, and libraries. Bus stops were tallied using publicly-available geographic information systems (GIS) data.[34] Physical activity resources were tallied using the PARA, and counts of the remaining 16 destinations were obtained using the Goods and Services Inventory (GASI).[35] Trained field assessors used the GASI to conduct audits of goods and services available in each neighborhood.

Land use density was measured by the total count of nonresidential destinations within each neighborhood, regardless of type.[11] The result was a continuous variable with 0 as the minimum possible value and no theoretical maximum. Land use diversity was defined as the number of distinct, nonresidential land use categories in each neighborhood.[11] Multiple instances of the same land use category were counted only once.[11] The result was a continuous variable with 0 and 18 as the minimum and maximum possible values, respectively.

Pedestrian environment quality. As described previously,[10] Pedestrian Environment Data Scan (PEDS)[36] audits assessed pedestrian environment quality in each neighborhood. Assessors scored segments between 1 (strongly agree) and 4 (strongly disagree) based on attractiveness and safety for walking.[36] The sum of these scores was averaged across all street segments within each neighborhood, with higher scores reflecting higher attractiveness and safety for walking.[37]

Neighborhood traffic environment. Speed limits for each neighborhood street segment were recorded during PEDS audits and averaged.[38,39]

Neighborhood crime. Average monthly crime during 2006 was calculated for each neighborhood using publically-available counts[40] of violent and non-violent crimes in patrol areas containing housing developments.

Statistical analyses. Descriptive statistics and bivariate correlation coefficients (Spearman coefficients on account of skewed distributions) were computed for all variables. Hierarchical linear modeling assessed relationships between neighborhood characteristics and PA. Due to considerable variability among neighborhoods in both average participant age and average speed limit, both of which have demonstrated correlations with PA,[7,18,41] we included these characteristics as neighborhood-level covariates. Although the unconditional intraclass correlation coefficient (ICC) indicated a clustering effect of neighborhood, the conditional ICC was not significantly different from 0 after including neighborhood-level participant age and speed limit in the base model. Thus, average age and speed limit accounted for the clustering effect of neighborhood on PA so that subsequent variables added to each model could be interpreted as average effects on individual-level PA. We ran separate, sex-specific models (n=77 men and n=139 women) to assess relationships between each neighborhood (independent) variable and each PA (dependent) variable. Analyses were stratified by sex due to evidence of differential response to neighborhood characteristics in previous PA studies.[8,42] Street segment quality and attractiveness rating was also included as a covariate because of bivariate correlations with PA measures among men. Crime showed no bivariate correlations with PA and was not included in models to preserve statistical power. All statistical analyses were performed using SPSS Statistics Version 22.[43]

Results

Participants. Table 1 presents detailed characteristics of study participants by sex. The sample was predominantly female, middle-aged, and obese (BMI ≥ 30 kg/m^2). Income and education level were generally low. Participants reported, on average, the equivalent of 4342.2 MET minutes of total PA in the previous week.

Neighborhoods. Housing developments averaged approximately 800 total residents and 18.3 participants (SD=6.7). Development neighborhoods averaged 18 PA resources (SD=5.4), with average QPAR of 8.1 (SD=4.8). Mean land use density within neighborhoods was 72.7 destinations (SD=34.6), and mean land use diversity within

Table 1.

PARTICIPANT CHARACTERISTICS BY GENDER

	Women (n=139)	Men (n=77)	Total (n=216)
Age (years) [mean(SD)]	43.3 (16.1)	43.8 (18.9)	43.5 (17.1)
Body mass index (kg/m^2) [mean(SD)]	33.0 (8.9)	28.3 (7.7)	31.3 (8.7)
Body fat (%) [mean(SD)]	40.7 (9.7)	24.1 (10.9)	34.8 (12.9)
Systolic blood pressure (mm Hg) [mean(SD)]	120.4 (17.9)	123.4 (16.8)	121.5 (17.5)
Diastolic blood pressure (mm Hg) [mean(SD)]	74.3 (12.7)	73.5 (13.0)	74.0 (12.8)
Resting heart rate (beats per minute) [mean(SD)]	76.1 (10.8)	73.5 (11.2)	75.1 (11.0)
Completed some college (%)	31.6	21.0	27.5
Parents completed some college (%)	28.9	21.9	26.2
At least 201% above Federal Poverty Level (%)	16.3	15.5	15.8
IPAQ moderate PA (MET minutes per week) [mean(SD)]	733.2 (1184.6)	1309.0 (1654.8)	917.3 (1373.5)
IPAQ vigorous PA (MET minutes per week) [mean(SD)]	1954.9 (2743.3)	2895.9 (3293.7)	2251.2 (2950.7)
IPAQ walking (MET minutes per week) [mean(SD)]	1079.9 (1377.1)	1376.0 (1541.6)	1173.7 (1431.1)
IPAQ total PA (MET minutes per week) [mean(SD)]	3767.9 (4399.2)	5580.9 (5487.0)	4342.2 (4828.3)

neighborhoods was 12 distinct destination types (SD=3.6). Table 2 presents detailed characteristics of study neighborhoods.

Bivariate correlations. Table 3 shows bivariate correlations between study variables. Among men, PA resource availability and street segment attractiveness and safety had significant positive correlations with PA variables, and PA resource quality, land use diversity, and speed limit had significant negative correlations with PA variables. Participant age was negatively correlated with PA variables among both men and women.

Multivariate models. Table 4 presents multivariate hierarchical models measuring relationships among neighborhood characteristics and PA among men and women. There was a negative correlation between mean QPAR rating and moderate PA among men, with the model accounting for 3.2% of the variability in moderate PA. One additional unit in QPAR rating predicted 193.68 fewer MET minutes of moderate PA per week (p=.03). There was a negative association between PA resource availability and vigorous PA among men, with the model accounting for 27.4% of the variability in vigorous PA. One additional neighborhood PA resource predicted 248.28 fewer MET minutes of vigorous PA per week (p=.03). There was a positive correlation between land use diversity and walking among men, with the model accounting for 36.8% of the variability in walking. One additional, distinct neighborhood land use predicted 157.46 additional MET minutes from walking per week (p=.02). Among women, there were no significant correlations among neighborhood PA resource or land use characteristics and PA variables after controlling for participant age, street segment attractiveness and safety, and speed limit within neighborhoods.

Discussion

In this study, we tested correlations among neighborhood PA resources, land use characteristics and PA among African American residents of low-income housing developments. After controlling for neighborhood-level age, pedestrian environment quality, and traffic, we found that PA resource availability was negatively correlated with vigorous PA and that PA resource quality was negatively correlated with moderate PA among men. Land use diversity was positively correlated with walking among men, and there were no significant correlations among neighborhood characteristics and PA in women.

The positive correlation between land-use diversity and walking suggests that having diverse destinations within walking distance may support increased PA. For example, diverse neighborhood destinations may support walking for various daily tasks or recreational opportunities.[11,26] Land use diversity may be particularly important for increasing PA among populations with low vehicle ownership, such as those with low income or those living in dense urban environments. The lack of significant correlations between overall land use density and PA suggests that land use diversity may be more important for encouraging PA.

The negative correlations between PA resources and PA among men (i.e., PA resource availability and vigorous PA; PA resource quality and moderate PA) reflect the inconsistent nature of previous findings regarding PA resources and PA.[6,7] Men in these neighborhoods may perform moderate-to-vigorous PA outside of their neighborhoods.

Table 2.

NEIGHBORHOOD CHARACTERISTICS

ID	1	2	3	4	5	6	7	8	9	10	11	12
N[a]	23	27	22	26	8	19	9	14	19	14	12	26
Age[b] [mean(SD)]	41.9	35.0	35.1	50.1	37.7	36.5	72.0	71.2	39.5	48.5	50.4	32.3
	(14.9)	(13.0)	(11.1)	(12.5)	(14.3)	(16.5)	(6.6)	(6.1)	(13.6)	(14.0)	(12.0)	(13.9)
Percent Female	78.3	52	72.7	61.5	87.5	73.7	33.3	42.9	55.6	64.3	75	69.2
BMI [mean(SD)]	32.6	29.5	30.4	30.5	31.8	31.4	29.4	31.8	34.4	33.9	28.6	31.2
	(9.5)	(6.7)	(7.8)	(9.8)	(6.8)	(10.3)	(3.8)	(9.8)	(11.8)	(8.4)	(5.9)	(8.3)
Body fat % [mean(SD)]	35.4	30.9	34.4	34.3	39.8	35.1	28.9	34.9	37.1	41.2	34.1	34.2
	(14.6)	(14.3)	(10.8)	(12.7)	(12.1)	(15.1)	(10.0)	(13.1)	(13.1)	(10.4)	(9.2)	(14.3)
Total PAR[c]	6	3	8	18	17	8	4	2	5	14	13	7
QPAR[d] [mean(SD)]	17.3	4.3	6.8	4.3	7.4	1.0	9.8	12.5	4.0	14.4	9.2	5.9
	(14.3)	(4.9)	(6.9)	(11.5)	(5.2)	(4.1)	(2.9)	(4.9)	(2.9)	(6.8)	(8.2)	(9.6)
Land use diversity[e]	15	6	12	11	15	15	15	15	10	14	11	5
Land use density[f]	90	20	69	115	118	81	60	70	38	71	119	21
Pedestrian environment quality[g] [mean(SD)]	5.0	5.3	5.4	5.9	4.6	5.5	4.5	4.7	5.4	4.2	5.4	4.8
	(1.0)	(1.2)	(1.3)	(1.7)	(1.8)	(1.8)	(0.7)	(1.0)	(1.2)	(0.9)	(1.1)	(0.8)
Speed limit[h] (MPH) [mean(SD)]	24.8	27.5	26.7	26.7	25.6	27.7	32.5	33.4	31.5	27.7	26.0	28.6
	(6.5)	(10.6)	(7.5)	(4.9)	(5.1)	(9.0)	(10.4)	(5.5)	(4.7)	(4.7)	(5.8)	(7.8)
Crimes per month	149.3	54.1	113.5	119.2	223	187	259.1	111.8	111.8	139.5	176.7	114

[a]Participants in neighborhood.
[b]Participant age.
[c]Physical activity resources.
[d]Physical activity resource quality.
[e]Sum of distinct destination types within 800 m.
[f]Sum of all destinations within 800 m.
[g]Sum of street segment attractiveness and safety ratings.
[h]Speed limits of street segments within 800 m.

Table 3.

SPEARMAN CORRELATIONS BETWEEN NEIGHBORHOOD CHARACTERISTICS AND INDIVIDUAL-LEVEL PHYSICAL ACTIVITY

	Total PAR[a]	QPAR[b]	Land use diversity[c]	Land use density[d]	Pedestrian environment quality[e]	Age[f]	Speed limit[g]	Crimes per month
Females								
Moderate PA	.03	–.06	–.12	–.05	.05	–.16	–.02	–.03
Vigorous PA	.03	.08	–.06	–.04	–.08	–.22*	–.13	.04
Walking	.07	.06	–.06	–.02	–.01	–.13	–.11	.02
Total PA	.05	.06	–.05	–.02	–.04	–.18*	–.12	.05
Males								
Moderate PA	.26*	–.39**	–.28*	–.01	.38**	–.44**	–.44**	.02
Vigorous PA	.19	–.28*	–.19	–.05	.31*	–.40**	–.44**	.01
Walking	.42**	–.13	–.15	.21	.30*	–.36**	–.62**	.06
Total PA	.29*	–.30*	–.19	.04	.35**	–.44**	–.52**	.06

* $p<.05$.
** $p<.01$.
[a]Physical activity resources.
[b]Mean physical activity resource quality.
[c]Sum of distinct destination types within 800 m.
[d]Sum of all destinations within 800 m.
[e]Mean sum of street segment attractiveness and safety ratings.
[f]Participant age.
[g]Mean speed limit of street segments within 800 m.

Table 4.

HIERARCHICAL LINEAR REGRESSION MODELS BETWEEN NEIGHBORHOOD CHARACTERISTICS AND PHYSICAL ACTIVITY

	Beta	*t*	*p*
Women			
Moderate PA			
Total PAR[a]	−2.28	−.09	.93
Mean QPAR[b]	27.87	.73	.47
Land use diversity[c]	31.70	.86	.39
Land use density[d]	1.46	.24	.81
Vigorous PA			
Total PAR[a]	−5.04	−.08	.93
QPAR[b]	71.27	.82	.42
Land use diversity[c]	−20.21	−.24	.81
Land use density[d]	.76	−.91	.36
Walking			
Total PAR[a]	−9.38	−.31	.76
QPAR[b]	45.65	1.03	.30
Land use diversity[c]	2.87	.07	.95
Land use density[d]	−3.22	−.47	.64
Total PA			
Total PAR[a]	−16.70	−.17	.86
QPAR[b]	144.79	1.04	.30
Land use diversity[c]	14.36	.11	.92
Land use density[d]	−1.01	−.05	.96
Men			
Moderate PA			
Total PAR[a]	−53.15	−.94	.35
QPAR[b]	−193.68	−2.23	.03
Land use diversity[c]	−18.70	−.24	.81
Land use density[d]	−12.34	−.97	.34
Vigorous PA			
Total PAR[a]	−248.28	−2.26	.03
QPAR[b]	−17.76	−.10	.92
Land use diversity[c]	199.43	1.29	.20
Land use density[d]	−23.16	−.90	.37
Walking			
Total PAR[a]	−19.47	−.39	.70
QPAR[b]	132.01	1.68	.10
Land use diversity[c]	157.46	2.41	.02
Land use density[d]	16.58	1.49	.14

(*Continued on p. 1338*)

Table 4. (*continued*)

	Beta	*t*	*p*
Total PA			
Total PAR[a]	−320.89	−1.84	.07
QPAR[b]	−79.43	−.28	.78
Land use diversity[c]	338.19	1.40	.17
Land use density[d]	−18.92	−.47	.64

[a]Physical activity resources.
[b]Mean physical activity resource quality.
[c]Sum of distinct destination types within 800 m.
[d]Sum of all destinations within 800 m.

There were no significant associations between PA resources or land use characteristics and PA among women, demonstrating the importance of gender differences in examining neighborhood PA influences. Underlying contextual factors such as perceptions of neighborhood safety,[44] perceptions of PA resource quality, or lack of knowledge regarding nearby PA resources or commercial destinations may perpetuate differences in neighborhood-based PA between sexes.[42,45]

Paradigms for reducing and preventing obesity are shifting from changing individual behavior to enhancing environments and policies that affect behavior.[8,23] This study provides important insight regarding neighborhood PA influences among a high-risk population. Public policymakers may be able to use planning and policy strategies that increase land use diversity to facilitate PA among low-income housing development residents. Improving walkability in neighborhoods that already feature land use diversity may also help increase PA by encouraging trips to neighborhood locations. The lack of correlations between PA resource availability or quality and PA also indicates a potentially valuable area for public health practice. Residents may be unaware of neighborhood PA resources, or they may misperceive PA resource quality. Perceptions of pedestrian safety and crime may also limit PA resource use.[44] Public health practitioners may be able to increase PA among public housing residents through educational interventions or campaigns to increase awareness of neighborhood PA resources. Our findings highlight the importance of social and cultural context in relationships between neighborhood characteristics and PA. Influences may vary by population and location, and social and cultural contexts should drive interventions and policies to increase PA.

This study used detailed, in-person audits to measure PA resource and land use characteristics. The analyses accounted for neighborhood traffic, pedestrian safety, and crime. Our findings highlight the need to further explore neighborhood PA influences among low-income housing residents. Researchers, policymakers, and public health practitioners would benefit from future studies including more neighborhoods with greater variability in PA resource and land use characteristics. Future studies should also examine PA context, such as where it is performed, to assess neighborhood PA resource use more accurately.

Residence selection typically entails individual choice for people without socioeconomic limitations, and active people may choose neighborhoods that support PA. Therefore, it is often unclear whether supportive neighborhoods actually help increase PA for individuals who are sedentary or insufficiently active. In contrast, low-income individuals face limited residential options due to affordability, and they may require low-income, government-assisted housing. Such limitations on residential choice may increase susceptibility to environmental PA influences. This study is one of few to investigate neighborhood PA influences among low-income housing residents.[5,20,44]

This study included a large population of African American, low-income housing residents, but it has limitations. Although they help address questions that remain relevant, and recent longitudinal studies show only modest changes in neighborhood PA environments over time,[46] these data are more than 10 years old. Participants were volunteers, so participation bias was possible. Self-reported PA can also entail bias, with participants typically inclined to over-report.[47] The IPAQ Short Form is practical and reliable,[32] but it does not collect information regarding how individuals perform PA. Lack of PA context, such as where individuals walk or exercise, precludes determination of direct neighborhood influence on behavior. Perceived and objectively-measured neighborhood characteristics may differ, and both can influence PA.[48–50] Residents' perspectives and ratings of neighborhood characteristics (e.g., street segment safety and attractiveness) may differ from those of trained assessors. Future studies should collect contextual information and consider residents' perceptions of neighborhood PA environments and perhaps train and incorporate residents into neighborhood data collection. Further, future studies should include residents of diverse ethnic backgrounds to more thoroughly examine relationships among public housing neighborhood characteristics and PA.

Our findings both supported and contradicted our hypotheses. The positive correlation between land use diversity and walking among men was expected. The negative correlations between PA resource availability and quality and PA, and the lack of correlations in the case of women were unexpected. Unexpected findings reflect the complex relationships between neighborhood characteristics and PA and highlight the potential importance of context in these relationships. We provide evidence supporting public health initiatives that encourage PA among public housing residents by improving neighborhoods, particularly by diversifying destinations or improving pedestrian access to them. However, we also demonstrate that neighborhoods may influence PA differently between populations, or even between subpopulations in the same neighborhood. Potential misperceptions of PA resources or crime among low-income housing residents may necessitate support to increase use of neighborhood PA resources. Providing support may be more important among women than men, as evidenced by the lack of correlations between neighborhood factors and PA among women in this study.

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