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Perceptions of Neighborhood Environment for Physical Activity: Is It "Who You Are" or "Where You Live"?

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ABSTRACT *Lack of physical activity among American adults is a serious public health concern. Many factors influence activity levels, and most research has focused on either individual factors, such as race and income, or on characteristics of the physical environment, such as the availability of parks. Our study used a cross-sectional multilevel design to examine the influences of individual- and neighborhood-level characteristics on participant's perceptions of their neighborhood as an appropriate venue for physical activity. Study participants were 1,073 African American and white adults living in the St. Louis, Missouri, metropolitan area. Individual-level information was gathered from self-administered questionnaires; neighborhood-level data for these same individuals were obtained from the 2000 US Census. We found that both individual and neighborhood characteristics were significant predictors of how individuals perceived physical activity opportunities in their neighborhood, and that African Americans perceived their neighborhoods as less safe and less pleasant for physical activity than did whites, regardless of the racial composition of the neighborhood. We suggest that any evaluation of opportunities for physical activity within a neighborhood should include consideration of resident's perceptions of the safety and pleasantness of using them, and that the role of perceived and actual neighborhood conditions in explaining disparities in physical activity between African American and other populations should be examined further.*

KEYWORDS *Environmental determinants, Multilevel modeling, Physical activity, Racial disparities.*

INTRODUCTION

An estimated 200,000 to 300,000 premature deaths occur each year in the United States because of physical inactivity.[1–4] Despite the benefits of regular activity, only 31% of adults in the United States reported engaging in recommended amounts of physical activity (i.e., 30 minutes of moderate-intensity activity on 5 or more days per week or 20 minutes of vigorous-intensity activity on 3 or more days per week); and 38% reported no leisure time regular physical activity.[5] US trends in activity showed little improvement from 1990 to 1998,[6] and significant disparities exist in

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rates of inactivity across various population subgroups. Findings from large national surveys, such as the National Health Interview Survey, showed a lower prevalence of physical activity among women, ethnic minorities, persons with lower education levels, and older adults.[5,7] Accordingly, the goal of increasing physical activity is 1 of 10 Healthy People 2010 "leading indicator" areas.[8]

To address the problem of physical inactivity, programs and policies have begun to focus on the physical and social environment. Environmental and policy approaches may be especially indicated as a complement to more frequently used individual behavior and lifestyle modification strategies because they can benefit all people exposed to the environment rather than focusing on changing the behavior of one person at a time.[9–11] Specifically, the physical environment provides cues and opportunities for activity[12] and is positively associated with rates of physical activity in intervention studies and large population-based surveys.[10]

A review of 19 studies in the physical activity and health literature showed consistent associations of accessibility between physical activity in adults and accessibility of recreational facilities, opportunities to be active, and aesthetic qualities of the physical environment.[13] In the social environment, perceptions of neighborhood safety appear to be important in determining patterns of physical activity. For example, data from five states (Maryland, Montana, Ohio, Pennsylvania, and Virginia) documented a higher level of physical inactivity among persons who perceived their neighborhoods as unsafe.[14] In these data, the effect of unsafe neighborhoods appeared highest among older persons, women, racial/ethnic minorities, and persons with a high school education or less.

Taken together, the literature suggests that characteristics of both individuals and the neighborhoods they live in are important determinants of how the social and physical environment is perceived and how it affects physical activity. This study built on past research by using multilevel analyses to assess directly the effects of individual and neighborhood factors on individual's judgments about how conducive their environments are to physical activity. We examined how perceived pleasantness and availability of physical activity opportunities in one's neighborhood are influenced by personal and neighborhood characteristics and describe here the interaction of selected factors. Given national objectives to eliminate health disparities like those that exist in rates of physical activity[8] and recent recommendations to focus on environmental determinants of activity,[10,15,16] it is important that research elucidate this relationship.

METHODS

Study Population

Participants were 1,104 African American and Caucasian adults recruited from two public health centers and a work site in metropolitan St. Louis, Missouri. To be eligible, participants had to be African American or Caucasian, aged 18–65 years at the time of enrollment, have a working telephone and mailing address, be able to complete a self-administered questionnaire written at a sixth-grade reading level, and be willing to participate in two follow-up telephone interviews in the 4-month period following their enrollment. A further requirement because of the geographical nature of this analysis was that participants had to provide a street address in metropolitan St. Louis (i.e., not a post office box) so that information about their neighborhood

of residence could be drawn from the 2000 US Census. Of the original participants, 25 (2.3%) were excluded because they did not provide a street address, as were 6 (0.5%) who provided a mailing address outside the St. Louis metropolitan area. The remaining 1,073 participants (97.2% of original study population) made up the final sample.

Data Collection

Individual Level Participants completed a self-administered pen-and-paper survey while in the waiting area of two public health centers in St. Louis County or while in the cafeteria of the work site. At both the health centers and the work site, individuals were approached, given a description of the project, and offered the opportunity to participate. Individuals who were interested were screened for eligibility and asked to provide informed consent. Participants then received, completed, and returned the survey.

Neighborhood Level Participant addresses were geocoded and matched to data at the ZIP code level from the 2000 US Census by the Missouri Census Data Center. When addresses could not be geocoded and matched using this process, data at the ZIP code level were manually obtained from the Missouri Census Data Center Web site.[17] Participants lived in 99 different ZIP code regions in metropolitan St. Louis, which includes St. Louis City and County and nearby counties in Missouri and Illinois. The number of participants in a given ZIP code area ranged from 1 to 85, and 81.5% of the participants lived in a ZIP code shared by at least 10 other participants.

Measures

Individual Level The survey included questions assessing perceptions of neighborhood characteristics related to physical activity as well as demographic characteristics of the participants themselves. Measures of neighborhood perceptions focused on two areas: pleasantness and availability. Three items measured neighborhood pleasantness for physical activity ("pleasantness"). The first two items asked individuals how safe they felt it was to walk, run, or bike in their neighborhood in terms of (1) criminal activity and (2) traffic. Participants responded to both items on a 4-point scale (very safe to very unsafe). The third item asked how pleasant it was to walk, run, or bike in their neighborhood and was also answered on a 4-point scale (very pleasant to very unpleasant). Availability of physical activity opportunities ("availability") was measured with four dichotomous (yes/no) items asking about the presence of (1) walking or biking trails, (2) parks where one could walk or bike, (3) outdoor exercise facilities, and (4) indoor exercise facilities in the respondent's neighborhood.

Because items in the two scales had different ranges, they were standardized to a mean of 0 and a standard deviation of 1 before adding to form the scales. Internal consistency was acceptable for both the Pleasantness ($\alpha = .79$) and Availability ($\alpha = .69$) scales. LISREL[18] was used to perform a confirmatory factor analysis of a model with the three Pleasantness items loading on one scale and the four Availability items loading on the other, with correlation allowed only between the two scales. This model returned a χ^2 statistic of 51.06 ($df = 13$, $P = .0000$, RMSEA [root

mean square error of approximation] = 0.055, GFI [goodness-of-fit index] = 0.99). Modifying this model so that errors between the items asking about trails and parks were allowed to correlate (which is logically justified because walking and biking trails are often found within parks) improved the fit, so the χ^2 was 28.54 ($df = 12$, $P = .0046$, RMSEA = .038, GFI = 1.00). The low RMSEA and high GFI both indicate good model fit and support the two-scale structure (i.e., Pleasantness and Availability) of the environmental perception items.[19]

Participants also provided their date of birth, gender, race/ethnicity, annual pretax household income (in eight categories, ranging from less than $5,000 to over $60,000) and years of education (1–18+).

Neighborhood Level Variables characterizing the participants' neighborhoods were drawn from the 2000 US census, with aggregation at the ZIP code level. We included 11 census variables in initial analyses. Of these, 6 were eliminated because of limited range, high correlation with other predictors, or because they did not add predictive power to the analysis. The five census variables included in final analyses were percentage black (%black), percentage living in same house 5 years ago (%same house), percentage using public transportation to get to work (%pub. transp.), percentage who walked or cycled to work (%walk/cycle), and median house value (med. house value).

Analysis Plan

This study examined the relationships between sociodemographic characteristics of individuals and neighborhoods and residents' perceptions of neighborhood characteristics that promote or hinder physical activity. These data exemplify a naturally occurring hierarchical or nested structure in which individuals (level 1 units) lived within neighborhoods (level 2 units). We developed two models. The first examined the influence of predictor variables, some measured at the individual level and some at the neighborhood level, on individual's perceptions of their neighborhood's pleasantness for physical activity and availability of physical activity opportunities. The second model included these variables and allowed for interaction between an individual's race and the racial composition of their neighborhood. Because both models used variables measured at the individual and neighborhood level, ordinary regression procedures could not be used to test them. For this reason, we used HLM[20] to perform hierarchical linear modeling, a set of procedures that allows us to estimate regression equations simultaneously for each level and study their relationship to the outcomes of interest.[21,22]

Hierarchical Analysis

A two-level hierarchical linear model was used. The level 1 model (unit of analysis = individual) used individual-level variables (race and income) to predict standardized scores on the Pleasantness and Availability scales. Following Raudenbush and Bryk's terminology,[21] the level 1 equation is

$$Y_{ij} = b_{0j} + b_{1j}(\text{race}) + b_{2j}(\text{income}) + r_{ij} \quad (1)$$

where Y_{ij} is the individual's score on either the Pleasantness or Availability scale, *race* is the individual's race (0 = white, 1 = black), and *income* is the individual's income category.

The level 2 model (unit of analysis = neighborhood) used the five census variables to predict the level 1 intercept, and the level 1 slopes were not allowed to vary. The level 2 equations were as follows:

$$b_{0j} = g_{00} + g_{01}(\%\text{black}) + g_{02}(\%\text{same house}) + g_{03}(\%\text{pub. transp.}) + g_{04}(\%\text{walk/bicycle}) + g_{04}(\text{med. house value}) + u_{0j} \quad (2a)$$

$$b_{1j} = g_{10} + u_{1j} \quad (2b)$$

$$b_{2j} = g_{20} + u_{2j} \quad (2c)$$

Equation 2a predicts the intercept of Eq. 1 using five census variables measured at the ZIP code level. Equations 2b and 2c predict the coefficients b_{1j} and b_{2j} of Eq. 1; in this model, we did not use census variables as predictors of level 1 slopes, so these equations consisted of group means plus a random error term.

Because we were particularly interested in the relative effects of an individual's race and the racial makeup of their neighborhood on their perception of that neighborhood, we conducted additional analyses to examine the interaction of these two variables. In this model, the level 1 slope and intercept were allowed to vary, and the level 2 variable %black was used to predict the level 1 slope. This model was tested only on the outcome variable pleasantness, because it had greater variability and because the previous model had higher predictive power for pleasantness than for availability. The equations for this model were as follows:

$$Y_{ij} = b_{0j} + b_{1j}(\text{race}) + b_{2j}(\text{income}) + r_{ij} \quad (1)$$

$$b_{0j} = g_{00} + g_{01}(\%\text{black}) + g_{02}(\%\text{same house}) + g_{03}(\%\text{pub. transp.}) + g_{04}(\%\text{walk/bicycle}) + g_{04}(\text{med. house value}) + u_{0j} \quad (2a)$$

$$b_{1j} = g_{10} + g_{11}(\%\text{black}) + u_{1j} \quad (2b)$$

$$b_{2j} = g_{20} + u_{2j}$$

RESULTS

Participants

The hierarchical analysis included 1,073 individuals. Participants were approximately evenly divided between white (53.4%) and black (46.6%), and about two thirds (66.2%) were women. The mean age of the sample was 33.1 years. Participants averaged 12.9 years of education, and their average income was in the $20,000–30,000 range.

Perceptions of Neighborhood

The Pleasantness scale had a potential range of 3 to 12, with higher scores indicating perceptions of a more pleasant environment. The mean of this scale was 9.98, with a standard deviation of 1.94 and skewness of –1.03. The Availability scale had a potential range of 4 to 8, with higher scores indicating perceptions that physical activity opportunities were more available in their neighborhood. The

mean of this scale was 6.6, with a standard deviation of 1.31 and skewness of –0.64. The scales were standardized to facilitate comparison between them.

Characteristics of ZIP Codes

Participants came from 99 different ZIP codes in the metropolitan St. Louis area. As seen in Table 1, census characteristics varied widely among the ZIP code regions included in the study.

Variability of Neighborhood Perceptions Accounted for by Neighborhood Characteristics

The intraclass correlation coefficient was .196 for the Pleasantness scale and .079 for the Availability scale. Thus, neighborhoods accounted for a moderate amount of the variability of the two scales and explained more of the variability in pleasantness than in availability.

Effects of Individual and Neighborhood Characteristics

Table 2 shows the HLM estimates of the effects of individual and neighborhood characteristics on the Pleasantness and Availability scales. In this table, all predictor variables are centered on their grand mean, so coefficients are interpreted as the effect of a given variable on the outcome when all other variables are held at their mean value. The table shows that variables at both level 1 and level 2 had more predictive value for pleasantness than for availability. All variables contributed significantly to the predicted pleasantness rating. In contrast, although both level 1 variables were also significant predictors of availability, only %black was a significant predictor among the level 2 variables. Thus, on average, blacks rated their neighborhoods lower than whites on both pleasantness (.509 lower) and availability (.698 lower).

Individual-level income was associated with perceived neighborhood pleasantness: Each incremental change in income category (representing a $10,000 increase over most of the scale) added .1644 to the predicted pleasantness rating and .103 to the predicted availability rating. The improvement in fit over the null model (i.e., the model using ZIP code only as a predictor) was significant for both pleasantness ($\chi^2 = 131.9$, $P = .000$) and availability ($\chi^2 = 41.4$, $P = .000$). In addition, both the level 1 and level 2 variables contributed to prediction, although their contribution was greater for pleasantness ($R^2 = 0.218$ for level 1 and 0.418 for level 2) than for availability ($R^2 = 0.042$ for level 1 and 0.097 for level 2).[23]

TABLE 1. Characteristics of ZIP codes (n = 99) included in the study (US Census 2000) data

Census variable	Mean	SD	Median	Minimum	Maximum
%black	20.4	30.5	3.0	0.0	98.2
%same house*	58.9	8.5	58.1	34.7	88.5
%pub. transp.†	3.5	5.7	0.8	0.0	22.7
%cycle/walk‡	2.2	3.1	3.1	0.0	22.2
med. house value§	112.5	79.4	93.5	33.8	528.7

*Percentage of residents who were living in the same house 5 years ago.
†Percentage who take public transport or taxi to work.
‡Percentage who cycle or walk to work.
§Median house value, in thousands of dollars.

TABLE 2. Hierarchical model estimates of the effects of individual and neighborhood characteristics on perceived pleasantness of neighborhood for physical activity and perceived availability of physical activity resources

	Pleasantness			Availability		
Fixed effects	Coefficient	SE	*P*	Coefficient	SE	*P*
Dependent variable means						
Intercept, g_{00}	0.183	0.0687	.008	0.107	0.1121	.340
%Black, g_{01}	−0.012	0.0033	.000	−0.009	0.0044	.031
%same house, g_{02}	0.022	0.0108	.041	−0.014	0.0182	.442
%pub. transp., g_{03}	−0.086	0.0232	.000	−0.040	0.0380	.298
%walk/bicycle, g_{04}	0.122	0.0302	.000	0.176	0.1130	.118
med. house value, g_{05}	0.000028	0.000006	.000	0.000006	0.000013	.621
Individual race (1 = black, 0 = white)						
Intercept, g_{10}	−0.509	0.2170	.019	−0.698	0.2900	.016
Individual income						
Intercept, g_{20}	0.1644	0.0354	.000	0.103	0.0424	.015
Explained variance	R^2			R^2		
Level 1	0.218			0.042		
Level 2	0.418			0.097		

Note: All predictor variables are centered on their grand mean.

Effects of Individual Race and Neighborhood Racial Composition

Table 3 compares two models of effects of individual and neighborhood race on the perception of pleasantness. Estimates for model 1 were identical to those presented for pleasantness in Table 2. Model 2 included a cross-level interaction between individual

TABLE 3. Comparison of two HLM models examining the interaction of individual and neighborhood race on pleasantness

	Pleasantness (model 1)			Pleasantness (model 2)		
Fixed effects	Coefficient	SE	*P*	Coefficient	SE	*P*
Dependent variable means						
Intercept, g_{00}	0.183	0.0687	.008	0.020	0.0912	.828
%black, g_{01}	−0.012	0.0033	.000	−0.015	0.0034	.000
%same house, g_{02}	0.022	0.0108	.041	−0.015	0.0110	.181
%pub. transp., g_{03}	−0.086	0.0232	.000	−0.117	0.0235	.000
%walk/bicycle, g_{04}	0.122	0.0302	.000	0.145	0.0297	.000
med. house value, g_{05}	0.000028	0.000006	.000	0.000025	0.000005	.000
Individual race (1 = black, 0 = white)						
Intercept, g_{10}	−0.509	0.2170	.019	−0.429	0.1952	.028
%black, g_{11}				−0.022	0.0074	.004
Individual income						
Intercept, g_{20}	0.1644	0.0354	.000	0.162	0.0348	.000

Note: All predictor variables are centered on their grand mean.

race and neighborhood racial composition. The cross-level interaction was significant ($P = .004$). Model 2 was significantly better than model 1 in predicting pleasantness ($\chi^2 = 7.1$, $P = .008$) and reduced both the intercept difference between individual blacks and whites (from 0.183 to 0.020) and the slope for individual race (from –0.509 to –0.429). Addition of this cross-level interaction also reduced the unexplained variance in the intercept for individual race from 0.486 to 0.246.

Based on the model 2, predicted effects of individual race and neighborhood %black on pleasantness (holding all other predictors constant), the following summary prediction equations demonstrate the influence of individual race and neighborhood racial composition on perceptions of neighborhood pleasantness.

For whites,

$$\hat{Y}_{PR} = 0.02 + [-0.15(\%\text{black})]$$

For blacks,

$$\hat{Y}_{PR} = -0.409 + [-0.37(\%\text{black})]$$

The result, as illustrated in the Figure, is that blacks had a lower opinion of their neighborhood's pleasantness independent of its racial composition, and that their evaluation of pleasantness became negative more quickly than did whites' as their neighborhood's racial composition became more black. In fact, the slope relating neighborhood percentage black population to an individual's rating of neighborhood pleasantness was 146% greater for blacks (–0.037) than for whites (–0.015).

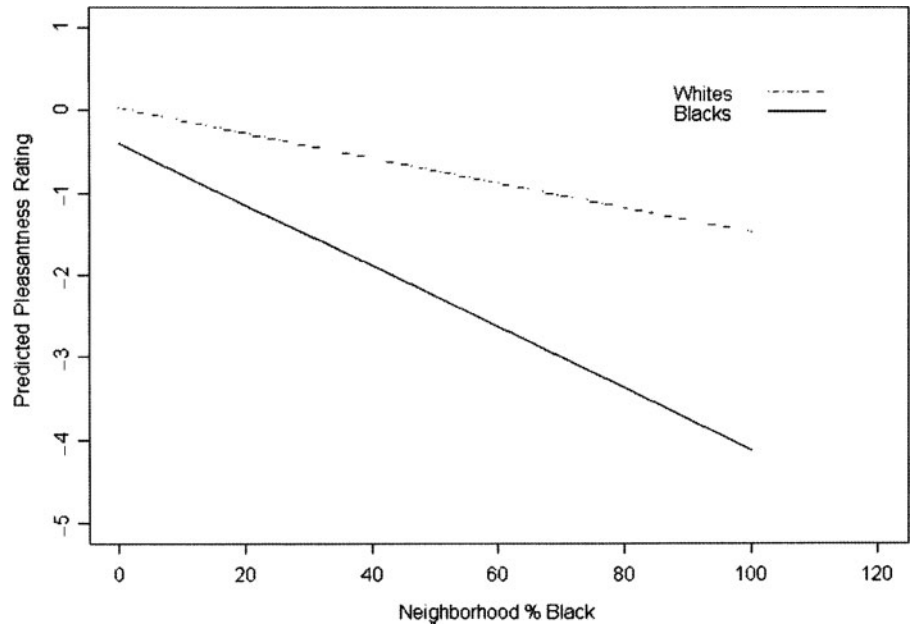

FIGURE. Perceptions of neighborhood pleasantness for exercise by neighborhood racial composition, for black and white adults.

DISCUSSION

Results from this study indicated that both individual and neighborhood characteristics are significant predictors of how a person perceives the pleasantness and availability of physical activity opportunities in his or her neighborhood. One practical implication of these findings is that both types of data (i.e., individual and environmental) should be included in community assessments that seek to identify and address environmental determinants of physical activity. Despite the fact that neighborhood-level data are becoming increasingly available, few studies in the physical activity literature have included both individual- and neighborhood-level data.

The finding that individual and neighborhood characteristics explained more about neighborhood pleasantness than about availability of exercise opportunities raises an interesting question about the focus of environmental interventions to promote physical activity. To date, such interventions have primarily sought to increase access to facilities and programs that are not currently available to a given population. Examples include developing walking and bicycle trails, funding public facilities, zoning and land use that facilitates activity in neighborhoods, building construction that encourages activity, and promoting policies and incentives that favor physical activity during the workday.[9,10,24,25] In this study population, however, it seems possible that enhancing the safety and aesthetic qualities of existing physical activity venues might be as important as introducing new opportunities for physical activity. Testing the relative effect of these two approaches is a topic for future research.

The study also contributes interesting new information to the growing literature on determinants of health disparities. In this population, blacks perceived their neighborhoods as less safe and less pleasant for physical activity than did whites regardless of the racial composition of the neighborhood. Moreover, as the racial composition of a neighborhood became increasingly black, blacks' ratings of pleasantness became more negative more quickly than did whites' ratings. It is beyond the scope of this study to determine the underlying mechanism of this finding. One possibility is that neighborhoods with a high percentage of blacks receive less attention from local governments regarding police protection and maintenance of roads, parks, and other public facilities that might be used for physical activity. This explanation would seem especially plausible in highly segregated cities such as St. Louis.[26] Another possibility is that most blacks do not live in segregated neighborhoods by choice, but because they face discrimination in the housing and mortgage markets that prevent them from moving to more integrated neighborhoods.[27–30] It is also possible that blacks hold their neighborhoods to higher standards than whites. These and other explanations should be examined in future research on health disparities.

Major disparities in health outcomes exist among different racial and ethnic groups in the United States, and there is increasing interest in examining how racial segregation plays a role in these disparities. Racial and economic segregation, which typify many American cities, have been shown to be a factor in numerous health outcomes, including infant mortality rates, childhood exposure to lead, homicide rates, cardiovascular disease, and tuberculosis.[27,31] Neighborhood characteristics have been shown to exert influence on people's decisions to be physically active or inactive, and activity level plays an important role in the health of individuals and communities.[12,14]

This study dealt with people's *perceptions* of their environment. Ideally, we would prefer to have objective data about neighborhood conditions and be able to link people's perceptions and objective neighborhood conditions to actual physical activity. In future studies, we will address these limitations. Also, the convenience

nature of our sample limits generalizability of the findings to other populations. However, although the parameter estimates may vary, we expect that our general finding that both individual- and neighborhood-level variables influence environmental perceptions will hold up for other settings and populations. Further, our sample did include a substantial proportion of African Americans and persons of low socioeconomic status, who are often not included in physical activity studies. The environmental variables included in this study were limited to those available through the US Census. Future work should use neighborhood characteristics more directly related to physical activity. Finally, equating ZIP code with neighborhood is not ideal because ZIP codes may have no relationship to the historical and sociological characteristics that define a neighborhood and because ZIP codes are typically larger and more varied than the common conception of "neighborhood."

Physical activity is important in health promotion and disease prevention, and examining how individual and neighborhood factors interact to influence physical activity is a relatively new, but much needed, area of research. This study provided initial findings that suggest areas for future research, including the importance of studying both the availability of physical activity facilities and the perceived safety and pleasantness of using them and the interaction between race at the individual and neighborhood levels. Next steps include collecting objective data on the condition of different neighborhoods and comparing them with the perceptions of residents, testing the influence of perception as a mediating variable between neighborhood and individual characteristics and actual physical activity, and looking at interactions between other predictors on the individual and neighborhood levels.

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