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The impact of neighborhood on physical activity in the Jackson Heart Study☆

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ABSTRACT

Physical inactivity is an independent risk factor for many diseases. Most research has focused on individual-level factors for physical activity (PA), but evidence suggests that neighborhood is also important. We examined baseline data collected between 2000 and 2004 from 5236 participants in the Jackson Heart Study to determine the effects of neighborhood on 2 types of PA: Active Living (AL), and Sports and Exercise (Sport) in an all-African American cohort. Participants were georeferenced and data from individual baseline questionnaires and US Census were analyzed using descriptive, bivariate, and multilevel models. In both types of PA, neighborhood factors had an independent and additive effect on AL and Sport. Living in an urban ($p = 0.003$) or neighborhood with a higher percentage of residents with less than a high school education ($p < 0.001$) was inversely associated with AL. There was an inverse interaction effect between individual and lower neighborhood education ($p = 0.01$), as well as between age and urban neighborhoods ($p = 0.02$) on AL. Individual level education (OR = 1.30) and per capita income (OR = 1.07) increased the odds of moderate-to-high sports. Future studies should focus on what contextual aspects of urban or less educated neighborhoods are influential in determining PA, as well as longitudinal multilevel analyses of neighborhood effects on PA.

1. Introduction

Insufficient physical activity (PA) is an independent risk factor for cardiovascular disease (CVD), many cancers, premature death, and other chronic diseases (Ford et al., 2012). Differences in the type, amount, and frequency of activity may be a factor in the persistent health disparities that occur based on socioeconomic status (SES), race and ethnicity, sex, and geographic location. Limited attention has been given to measures of moderate activity, sports, and physical activity acquired during activities of daily life, or global, self-reported activity obtained from surveillance methods (Whitt-Glover et al., 2007).

Approximately 25% of American adults report inadequate leisure-time activity, and <21% of adults meet the federal physical activity guidelines for aerobic and muscle-strengthening activities during leisure-time activity (CDC, 2014), in spite of effective individually focused interventions aimed at increasing PA. Mississippi ranks first in the percentage of adults with no leisure-time activity (CDC, 2015b) and continues to have much higher age-adjusted CVD mortality rates compared to the U.S. among both whites (282.7; U.S. 217.6) and African Americans (353.2; U.S. 283.1) using 2012–2014 data (CDC, 2015a). Neighborhood context including the physical and social dimension of where a person lives, plays an influential role in determining individual health behaviors (Turrell et al., 2010; Wen and Zhang, 2009). Studies focusing on the relationship between neighborhood and PA in a large all-African American cohort are scarce (Hannon et al., 2012; Lee et al., 2012; Miles et al., 2008; Siceloff et al., 2014), and most are limited to walking behavior (Miles et al., 2008) or sports only (Diez Roux et al., 2007).

Using data from the Jackson Heart Study (JHS), we examined influences on two types of PA (Active Living and Sports & Exercise) with a primary interest in determining neighborhood impact using multilevel modeling and a socioecological framework in a large sample of southern African Americans. We expected independent

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association of neighborhood contextual variables with PA after controlling for individual-level predictors.

2. Methods

The JHS is the largest single-site, all-African American epidemiologic prospective study of CVD ever conducted in the U.S. The JHS recruited and examined 5301 African Americans from three counties (Hinds, Madison, and Rankin) in the Jackson, MS metropolitan area. Baseline data collection occurred between 2000 and 2004 with subsequent follow-up visits approximately every fourth year ending in 2013; for the current study only baseline data is included. Details of the study design, methods, and data collection protocols have been published elsewhere (Fuqua et al., 2005; Payne et al., 2005; Robinson et al., 2010; Taylor, 2005). Participants were 35–84 years old (younger and older participants were included as part of the family sample) and completed a home interview and baseline clinic visit (Fuqua et al., 2005). Participants responded to detailed interviews by trained interviewers. Institutional review board approval was received from Jackson State University, Tougaloo College, and the University of Mississippi Medical Center.

A cross-sectional, social epidemiological approach using a socioecological framework was used for this study (Institute of Medicine, 2002). The socioecological model incorporates factors from a variety of levels, including self, relationships, community, and the broader environment. The individual-level socioecological analytic data used for this study were collected during the home induction interview and first clinic examination. The neighborhood-level data from the 2000 U.S. Census was used as a proxy for the outer most level of influence of social, economic, and environmental conditions of the framework. Census tract was used to represent neighborhood, similar to other studies (Hickson et al., 2011; Krieger et al., 2003; Mujahid et al., 2008). Analyses were conducted using multi-level modeling to account for individual and neighborhood contributions to variance components, as well as clustering of nested data (Hearst et al., 2012; Sund et al., 2010).

2.1. Outcome variables

The two individual-level PA outcomes for this study were Active Living and Sports & Exercise (Sports). The JHS Physical Activity Form (JPAC), an interviewer-administered instrument with 30 items in 4 separate PA domains (active living; work; sports; and home and family life) (Dubbert et al., 2005), was modified from Atherosclerosis Risk in Communities measures and the Kaiser Physical Activity Survey (KPAS) (Ainsworth et al., 2000). Only Active Living and Sports were used in this analysis because they were hypothesized to be most influenced by neighborhood variables. The Active Living score is calculated using response from seven items to assess usual PA participation gained during daily living with questions about walking or bicycling to and from work, school, or errands; walking or bicycling for 15 min or more during leisure; and time spent watching television during the week (Dubbert et al., 2005). A scoring algorithm for the instrument is provided for the JPAC and was used to calculate individual Active Living scores, which ranged from 1 (no AL) to 4.75 (highest AL). The Sports domain measures up to three of the most commonly performed sports or exercise activities with the duration and intensity of each for the previous year. Again, the JPAC scoring algorithm was used with scores ranging from 1 (no Sports) to 5 (highest calculated as intensity × frequency × duration). Both outcome variables produce a rank order scale measure; forms are available at https://www.jacksonheartstudy.org/. Two-week test-retest reliability and validity using accelerometers and pedometers were previously established for the Active Living and Sports instruments (Smitherman et al., 2009).

2.2. Independent variables

2.2.1. Individual variables

Individual-level variables, the first level of the socioecological framework, included age, sex, education, per capita income (total family income divided by number of people supported), and wealth (cars, home ownership, liquid assets). Education was a standardized ordinal measure of years of education completed. Indicators of wealth were categorical and included: total number of cars that participants had access to (0–≥2), home ownership (Own/Pay Mortgage, dichotomized with other categories coded no), and liquid assets collapsed into four categories (refused, $0–9999; $10,000–49,999; $50,000–99,999; $100,000 or above).

2.2.2. Neighborhood variables

Neighborhood-level variables comprise the next level in the socioecological framework. Using geocoded residential address data for each JHS participant (Robinson et al., 2010), individual participants' residential addresses were geocoded and aggregated to the census tract, and merged with data from the 2000 U.S. Census (U.S. Census-Bureau, 2003). Median neighborhood income; neighborhood education (continuous variable % of residents with <HS education); neighborhood segregation (continuous variable % African Americans per neighborhood); and location type (rural or urban) were included. Census 2000 defined Urbanized Area and Urban Cluster block groups were classified as urban; all other block groups were considered rural (Barron, 2002). Since tracts are comprised of multiple block groups, some tracts had both urban and rural areas; if a larger percentage of the tract was comprised of urban block groups, it was classified as urban. The percentage of African Americans per neighborhood was used as a proxy for racial residential segregation.

Neighborhood safety, a proxy for crime, was assessed using an individual-level proxy from JHS participant self-report of neighborhood stress related to perceived safety ("Over the past 12 months, how much stress did you experience related to living in your neighborhood? This would include crime, traffic, events affecting your personal safety, etc.") with four potential response categories of not stressful to very stressful. For analysis, responses were collapsed to create a dichotomous variable of any level of perceived stress versus no stress. Individual neighborhood safety stress responses were aggregated to compute a measure of mean neighborhood stress for each tract similar to methods used in other studies (Wen et al., 2003); this aggregated score was used at the neighborhood level.

2.3. Analytic approach

Statistical analyses were conducted using SPSS 19 (IBM, 2012) for descriptive and bivariate analyses prior to using HLM 6 (Raudenbush et al., 2004) for hierarchical multi-level modeling. Because the distribution of Sports activity scores was zero-inflated, we dichotomized Sports into none or low sports activity versus moderate or high sports activity to facilitate fitting statistical models. Restricted maximum likelihood estimates were obtained for the model parameters for the continuous outcome Active Living. Restricted PQL (penalized quasi-likelihood) approach was used to estimate the parameters for the dichotomized Sports activity. Following exclusions for missing outcome data at the individual level (Active Living = 18; Sports & Exercise = 217), the sample used for all analyses included 5236 participants. The range of missing data on the remaining variables was low (0 − 33). In addition to tests of statistical significance, effect size estimates were reported as slopes (standard errors) for continuous outcomes and odds ratios (95% confidence intervals) for dichotomized sports and exercise outcomes.

A four-step modeling strategy was used for analysis of each PA outcome. For both outcomes, the same individual and neighborhood variables were tested but based on results and fit of each successive model for each outcome, several variables were removed as described