The Influence of Sitting Time and Physical Activity on Health Outcomes in Public Housing Residents

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Objectives: Examine differences between levels of physical activity and sitting time for residents of public housing developments located in high vs low income neighborhoods, and whether physical activity or sitting time had a greater influence on health outcomes.

Design: Secondary data analysis from the Healthful Options Using Streets and Transportation in Our Neighborhoods (HOUSTON) project.

Setting: Public housing developments located in Houston, TX.

Participants: African American, adult males and females.

Main Outcome Measures: Self-reported PA and time spent sitting on weekdays were measured using the International Physical Activity Questionnaire (IPAQ) short form. Participants completed measures of BMI (kg/m^2), % body fat (%BF) and resting blood pressure to assess health outcomes. Neighborhood income was defined as the median household income at the census block group level, obtained from the 2006–2010 American Community Survey.

Results: All participants (N=216) had an annual household income of ≤$19,350, and neighborhood income ranged from $9,226 to $57,618. Participants reported an average of 4342.2 ± 4828.3 MET-min/wk of physical activity, and 4.5 ± 3.2 hours of sitting per weekday. Time spent sitting was associated with BMI (β=.50, t=2.4, P=.018), %BF (β=.87, t=3.6, P=.000), and diastolic blood pressure (β=.62, t=2.1, P=.041). Physical activity was not significantly associated with any health outcomes.

Conclusion: Our findings indicate that public housing residents' health statuses are vulnerable to sedentary behaviors regardless of the affluence of the neighborhood surrounding the housing development. (*Ethn Dis.* 2014;24[3]:370–375)

Key Words: African Americans, Physical Activity, Sitting Time, Socioeconomic Factors

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Introduction

It is well established that regularly performed physical activity improves body composition and nearly all known health conditions in a dose-response fashion.[1] Sedentary behavior has previously been considered the absence of physical activity, but recent data suggest that inactive behaviors, such as sitting, may be an independent risk factor for overweight and obesity, incidence of chronic disease, and mortality rates.[2–6] Despite the known health consequences of physical inactivity and sedentary behavior, only 20.6% of adults in the United States report meeting both aerobic and muscle-strengthening physical activity guidelines,[7] and on average spend 7.7 hours per day in sedentary behaviors.[8] Although physical activity and sedentary behavior have both been linked to important health outcomes and risk for chronic disease, the independent effects of physical activity vs sedentary behavior are still debatable. Some studies have found that doing moderate or vigorous physical activity has a greater influence on health regardless of sedentary behavior.[9,10] Others have found an independent effect of sedentary behavior on health outcomes and disease risk factors independent of physical activity.[11,12]

Understanding the impact of physical activity and sedentary behavior on health outcomes is particularly important in vulnerable populations, such as low-income ethnic minorities who exhibit a higher prevalence of health related chronic diseases. For example, African Americans have a greater prevalence of obesity, hypertension and cardiovascular disease compared to non-Hispanic Whites.[13–15] Although ethnic disparities in obesity and chronic disease may be directly related to differences in behaviors that contribute to these conditions, racial differences in physical activity and the amount of time spent in sedentary behavior may be minimized when indicators of socioeconomic status are accounted for.[8,16,17] In general, and at a population level, higher income has been associated with higher levels of physical activity.[18,19] However, the association of income status and sedentary behavior is not as well established. A recent study by Cohen et al found that higher household income was associated with increased sedentary time in Blacks and Whites, men and women.[16] In this study, income was measured at the individual level (household income), and it is unknown if neighborhood level income would impact sedentary behavior in the same way. A breadth of literature has shown that people who reside in lower income neighborhoods demonstrate less physical activity,[20,21] perhaps due, in part, to lower quality neighborhood environments,[22–24] but the relationship between neighborhood income and sedentary behavior is not well understood.

Although individual and neighborhood income have demonstrated associations with health outcomes and physical activity, it is not clear which is more influential, and if both levels of income have a similar relationship with sedentary behavior. These complex relationships are often difficult to tease apart, since those with low individual income typically reside in more

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affordable areas (ie, low-income neighborhoods). Public housing developments provide a unique opportunity to investigate the relationships among individual and neighborhood income and health behaviors and outcomes in ethnic minority groups. Public housing residents must have individual or family income levels below the poverty line, yet developments may be located in neighborhoods with varying income levels. It is unknown if neighborhood income may buffer the negative effects of individual income on physical activity and sedentary time, and the subsequent effects on related health outcomes such as body mass index (BMI) and body fat percentage and blood pressure. Further research is needed to examine the influence of both physical activity and sedentary time on health outcomes, particularly in groups at high risk for chronic disease, such as low income African Americans. An independent effect of physical activity vs sedentary time on health outcomes in low-income African Americans is not well defined, and it is not known if these relationships are affected by the income of the surrounding neighborhood.

The aims of our study were to: 1) explore differences in physical activity, sitting time, BMI, body fat percentage, and blood pressure in African American public housing residents whose developments were located in higher vs lower income neighborhoods; and 2) determine whether physical activity or sitting time had a greater influence on BMI, body fat percentage, and blood pressure in African American public housing residents after accounting for both individual income and neighborhood income.

METHOD

This study was a secondary analysis of data collected as part of the Healthful Options Using Streets and Transportation in Our Neighborhoods (HOUSTON) project conducted from 2005–2008 in Houston, Texas.[25–27] Twelve public housing developments were selected for the HOUSTON study based on: 1) receipt of federal funding (to enhance comparability to other public housing sites around the United States); 2) wide geographical dispersion (at least 1 mile distant from the centroid of one housing development to another); and 3) willingness to participate in a research study. Selection procedures and neighborhood characteristics have been described in more detail previously.[25,27,28]

Participants

The HOUSTON project director and research team members visited each of the housing developments to recruit residents to participate in the study. Interested participants completed an inclusionary screener. Eligible participants were men and women who were residents of the particular housing development, aged 18–89 years, self-identified as Black or African American, were able to walk unassisted, did not have an internal medical electronic device (eg, pacemaker) and were not pregnant. All participants were informed of their rights as volunteer research participants and given a consent form to sign that explained the purpose of the study and their participation in the study. All study procedures were approved by the University Internal Review Board.

Procedures

Each participant (N=216) completed a simple physical health assessment and interview-administered questionnaires conducted by trained graduate students in kinesiology, public health, or social work and received a summary of his or her information. Participants were compensated $10 at the conclusion of their interview and assessment.

Measures

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,[29] derived from the Centers for Disease Control and Prevention's Pregnancy Risk Assessment Monitoring System (PRAMS) Questionnaire.[30] These items have been used with samples representing diverse ethnicities and socioeconomic status.[31] Median household income at the census block group level for each housing development was obtained from the 2006–2010 American Community Survey.[32]

Health Outcomes

Each participant completed a physical health assessment conducted by trained research team members to measure BMI, body fat percentage and resting blood pressure. Participants removed shoes, socks and any heavy jewelry or items in their pockets. Height and weight were measured, recorded, and used to compute BMI (kg/m^2). Body fat percentage was measured using the Tanita integrated bioelectrical impedance body fat monitor and scale (Tanita Body Fat Analyzer 310). Measures were collected twice, and the average of the two measurements was used in analyses. Systolic and diastolic

blood pressures were measured using manual aneroid sphygmomanometry by a trained research team member using established protocols.[33] Participants were asked to sit quietly during measurement with their left arm bared and supported at heart level and their feet flat on the floor. Two readings were taken separated by two minutes and averaged for use in analyses. If the first two readings differed by more than 5 mm Hg, a third reading was obtained and averaged.

Physical Activity and Sedentary Behavior

Physical activity and sedentary behavior was measured using the International Physical Activity Questionnaire (IPAQ) short form.[34] The IPAQ short form assesses vigorous- and moderate-intensity physical activity, walking, total physical activity and time spent sitting on weekdays over the past seven days. Physical activity was reported in hours and/or minutes per day and days per week. Physical activity data were transformed and summed using standardized IPAQ scoring protocols to yield total metabolic equivalent minutes (MET-minutes) of physical activity per week. Total MET-minutes per week was computed by summing walking, moderate, and vigorous METminutes/week scores ([Walking MET-minutes/week = 3.3 * walking minutes * walking days] + [Moderate MET-minutes/week = 4.0 * moderate-intensity activity minutes * moderate days] + [Vigorous MET-minutes/week = 8.0 * vigorous-intensity activity minutes * vigorous-intensity days] = Total physical activity MET-minutes/week). Sitting time was reported as the amount of time in hours and/or minutes participants usually spent sitting on a weekday during the past seven days. The IPAQ short form instrument is designed primarily for population surveillance of physical activity among adults, is widely used, reliable (r =.8) and has shown modest validity (r = .3) compared to accelerometry.[34] It has also been validated for use in low-income minority populations.[35,36]

Statistical Analyses

All statistical analyses were conducted in SPSS version 19.0 (IBM SPSS Statistics for Windows, IBM Corporation, Somers, NY). Descriptive analyses were conducted to examine the frequency, distribution and normality of each variable. Due to a positively skewed distribution, total MET-min/week of physical activity was transformed using an exponential transformation in order to meet the assumption of normality. No other transformations were required. Neighborhoods were dichotomized into high- and low- income groups based on the median split ($32,478) of the annual median household income at the census block group level. Independent samples t-tests were done at the neighborhood level to explore differences in BMI, body fat percentage, blood pressure, physical activity and sitting time between high and low income neighborhoods. Main analyses were done at the individual level, and consisted of a series of linear regression models adjusted for covariates. Regression models examined the strength and direction of the associations between physical activity and sitting time and BMI, body fat percentage and blood pressure, with a separate model for each health outcome.

RESULTS

Individual Characteristics

Participants (N=216) were African American females (64.4%) and males (35.6%), who were aged 43.5 ± 17.1 years (mean ± SD), obese (BMI = 31.3 ± 8.7 kg/m^2, body fat % = 34.8 ± 12.9%), and had an average systolic blood pressure of 121.5 ± 17.5 mm Hg and diastolic blood pressure of 74.0 ± 12.8 mm Hg. All residents met the 2006 US Department of Health & Human Service's poverty guidelines of an annual household income of ≤$19,350 per year for a family of four (consistent with public housing eligibility requirements).[37] Most participants (72.5%) had not attended any college. Nearly all participants were US born (95.8%) and reported English as their primary language (98.6%). Participants reported an average of 4342.2 ± 4828.3 MET-min/week of total physical activity and spent an average of 4.5 ± 3.2 hours per weekday sitting (data not shown).

Neighborhood Characteristics

Neighborhood median annual household income ranged from $9,226 to $57,618. In the low-income group, median household income at the neighborhood level ranged from $9,926 to $32,478 and from $35,077 to $57,618 in the high-income group. There were no significant differences in any of the health outcomes for housing development residents by neighborhood income. Health outcomes by neighborhood income are presented in Table 1.

Main Analyses

Bivariate correlations indicated time spent sitting per weekday was associated with BMI (r=.142, P<.05), body fat % (r=.168, P<.05) and diastolic blood pressure (r=.143, P<.05). Time spent sitting and physical activity were not associated with systolic blood pressure. Regression models for BMI, body fat % and diastolic blood pressure were adjusted for covariates that were significantly correlated with the dependent variables (BMI, body fat % and diastolic blood pressure). These covariates were age, sex, individual income and neighborhood income. Time spent sitting per weekday was significantly associated with BMI (β=.50, t=2.4, P=.018), body fat % (β=.87, t=3.6, P=.000), and diastolic blood pressure (β=.62, t=2.1, P=.041). Physical activity was not significantly associated with any

Table 1. Health outcomes in high and low income neighborhoods[a]

	Low Income, *n*=120 Mean (*SD*)	High Income, *n*=96 Mean (*SD*)
BMI, kg/m^2	31.5 (9.5)	31.2 (7.8)
Body fat, %	35.1 (12.5)	34.5 (13.4)
Systolic BP, mm Hg	121.1 (16.9)	122.0 (18.4)
Diastolic BP, mm Hg	75.1 (13.4)	72.6 (12.0)
Total PA, MET-min/week	4890.2 (5118.4)	3687.3 (4398.4)
Sitting time, hours per weekday	4.6 (3.0)	4.3 (3.5)

BMI, body mass index; BP, blood pressure; PA, physical activity; MET, metabolic equivalent of task.
[a] No significant differences in outcomes by high- or low-income neighborhoods.

health outcomes. Regression models are shown in Table 2.

DISCUSSION

Our study explored differences in physical activity, sitting time, BMI, body fat %, and blood pressure between African American public housing residents in high- vs low-income neighborhoods and we found no differences between the two resident groups. Our study also examined the influence of physical activity vs sitting time on BMI, body fat % and blood pressure after accounting for individual and neighborhood income. Results indicated that more time spent sitting on weekdays was associated with higher BMI, body fat % and diastolic blood pressure. Physical activity was not associated with any health outcomes.

The absence of any differences in physical activity, sitting time, BMI, body fat percentage, and blood pressure between housing developments in high- or low-income neighborhoods suggests that income alone does not capture characteristics of a neighborhood that may influence health behaviors and outcomes. Previous studies have found that neighborhood characteristics such as walkability influence physical activity and BMI, but may not necessarily be determined by neighborhood income. In fact, some of these characteristics may actually be more favorable in low-income neighborhoods.[27,28,38] Alternatively, this finding of no differences between high- and low-income neighborhoods may indicate that the individual income in public housing residents is a primary determinant of health behavior or health status. Having amenities and resources that promote health (eg, fitness center, healthful eating options) available in a high-income neighborhood surrounding a public housing development may have no impact on behavior of the residents. A previous study by Lovasi et al found that built environment characteristics were less consistently associated with BMI among disadvantaged groups.[39] This pattern may be explained by other barriers encountered by disadvantaged groups, including perceptions that the neighborhood is unsafe,[40] a limited ability to access resources due to economic hardship (ie, no vehicle), or a lack of awareness of local neighborhood opportunities for physical activity or healthful eating.[25]

Results indicated that more time spent sitting on weekdays was associated with higher BMI, body fat % and diastolic blood pressure. Physical activity was not associated with any health outcomes.

In our study, more time spent sitting on weekdays was associated with higher BMI, higher diastolic blood pressure and higher body fat %. This finding is consistent with previous literature which has found sedentary behavior is an important influence on health and increases risk of many chronic diseases.[3,41] The magnitudes of these associations are also meaningful in a practical sense. Our study found that as sitting time increased by one standard deviation (about three hours per day); body fat % increased by 2.87%, BMI increased by 1.59 kg/m^2, and 3 diastolic blood pressure increased by 2.04 mm Hg. These values are clinically relevant for health. For example, a 1.7 kg/m^2 reduction in BMI is equivalent to a reduction of 5% body weight, which has been shown to significantly improve health outcomes and reduce disease risk.[42]

Table 2. Regression models predicting health outcomes[a]

Regression Models	Beta	Unstandardized β	*t*	*P*
BMI, kg/m^2, *n*=162				
Physical activity	.106	.568	1.35	.178
Sedentary time	.182	.501	2.38	.018
Body fat, %, *n*=162				
Physical activity	.053	.401	.836	.404
Sedentary time	.223	.868	3.62	.000
Diastolic BP, mm Hg, *n*=163				
Physical activity	.101	.760	1.27	.208
Sedentary time	.160	.624	2.06	.041

BMI, body mass index; BP, blood pressure.
[a] All models were adjusted for age, sex, individual and neighborhood level income.

Our study also found that self-reported physical activity was not associated with BMI, body fat %, or blood pressure. This contradicts extensive literature that has shown strong associations between physical activity and health outcomes. However, this finding is similar to a few previous studies that have found an effect of sedentary behavior on health outcomes and disease risk factors independent of physical activity.[11,12] One potential explanation for the lack of a relationship among physical activity and BMI, body fat %, and blood pressure may be due to the measurement of physical activity by self-report. Inaccurate reporting of physical activity may have led to the disassociation between physical activity and health outcomes.[43] When using self-report methods, the number of hours spent sitting may be easier to recall than the duration and intensity of physical activity, therefore, more accurately capturing sedentary behavior. More research is needed to determine the independent effects of sedentary behavior and physical activity on health and disease risks and should include objective measures of both, such as heart rate monitors, pedometers, accelerometers or other more technologically advanced methods. Further, longitudinal studies or interventions that compare the effects of decreased sedentary time vs increased moderate or vigorous physical activity are needed.

Our study included a large sample of a vulnerable population of low-income African Americans, in the unique circumstance of residing in public housing located in neighborhoods of widely varying income status. However, our study was not without limitations, including the use of self-reported physical activity and the measurement of sitting time only on weekdays. Previous work has found distinctly different relationships between weekend and weekday sitting time, implicating the need for specific measurement and the nature of sitting time (eg, driving, work-related, etc.).[2] In addition, the use of cross-sectional vs longitudinal data limits the ability to make assumptions about causality in this study, and due to study population characteristics, findings may not be generalized to other populations.

The findings from our study indicate that that sedentary behavior has a negative impact on health outcomes in low-income public housing residents, regardless of neighborhood income. Sitting time during the week typically reflects sedentary occupations, however in this sample, 66% of participants reported not having a job or paid work, and therefore sitting time may have also represented sedentary activities during a period of unemployment. Decreasing sedentary time is a challenging barrier in low-income, unemployed individuals such as public housing residents because although they may have time, they may not have the monetary means or resources available to support leisure time physical activity. Possible solutions could be taking the stairs, walking to the store, or getting off public transit one stop early. These activities may be perceived as a more achievable goal to reduce disease risk in low income populations rather than focusing on increased leisure time physical activity. Decreasing sitting time during the weekday in vulnerable populations such as low-income ethnic minorities is an important target for future research and community health programs.

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