

Research Article

Sitting Time and Cardiometabolic Risk Factors in African American Overweight Women

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Findings from previous research linking sedentary time with cardiometabolic risk factors and body composition are inconsistent, and few studies address population groups most vulnerable to these compromising conditions. The purpose of this paper was to investigate the relationship of sitting time to cardiometabolic risk factors and body composition among African American women. A subsample of African American women ($N = 135$) completed health and laboratory assessments, including measures of blood pressure, resting heart rate, cholesterol, triglycerides, glucose, body mass index, body fat, sitting time, and demographics. Simultaneous, adjusted regression models found a positive association between weekend sitting time and glucose and an inverse association between weekly sedentary time and cholesterol ($ps < .05$). There were no significant associations between sedentary behavior and body composition. The unexpected relationship between sedentary time and cholesterol suggests that the relationship of sedentary behavior to cardiometabolic risk factors may depend on existing characteristics of the population and measurement definition of sedentary behavior. Results suggest distinctly different relationships between weekend and weekday sitting time, implicating a need for careful measurement and intervention that reflects these differences.

1. Introduction

Diseases of the heart continue to be the leading cause of death in the United States [1, 2] and accounted for 24.6% of all deaths in 2009, down only 1.4% from 2006 despite several national campaigns and research strategies to reduce mortality [1, 2]. African Americans have poorer health outcomes compared to their white counterparts [1, 2], and African American women disproportionately suffer from heart disease, with nearly half (45%) of African American women having some type of cardiovascular disease compared to only 32% of white women [3, 4].

Cardiometabolic risk factors, such as high blood pressure and resting heart rate, elevated cholesterol and glucose levels, and high body fat percentage, are associated with cardiovascular diseases [5] and may result from lifestyle choices, such as physical inactivity and poor dietary habits [6, 7]. The prevalence of high blood pressure, or hypertension, among African Americans in the United States has increased from 35.8% to 41.4% between 1988 and 2002 and is particularly high among African American women (44.8% in 2006) compared to white women (31.1% in 2006) [8, 9]. Among

African Americans, the prevalence of high (≥ 200 mg/dL) and elevated (≥ 240 mg/dL) cholesterol is higher among women than men, with 54.9% of African American women having high or elevated cholesterol compared to 51.1% of African American men [8].

Body composition and obesity are also directly linked to cardiovascular diseases and other health compromising conditions, such as diabetes and cancer [10]. Over one-third (39.2%) of African American women are obese or have a body mass index (BMI) ≥ 30 kg/m², compared to only 21.8% of White women, 25.4% of White men, and 31.6% of African American men [11]. African American women also have greater adiposity or body fat compared to Caucasians [12, 13].

Regularly performed physical activity improves body composition and nearly all known health conditions; yet, self-reported measures suggest nearly 50% of the adult population fails to meet minimum physical activity recommendations [14], while objective measurement shows only 5% meet recommendations [15], suggesting that sedentary time comprises the largest portion of most people's days. African American women are less physically active than

white women, putting them at greater risk for chronic health conditions related to physical inactivity, including cardiovascular diseases [16], and leading to rising health care costs, which exceeded \$11 billion among morbidly obese adults in 2000 [17].

Several studies have looked at the relationship between sedentary behavior and disease risk, but few have looked at specific measured sedentary behavior, defining sedentary time as low physical activity during leisure time [18–20]. For example, increased sedentary time has been associated with increased BMI, mortality rates, high glucose levels, and insulin resistance, regardless of physical activity level among both men and women [21–25]. However, there have also been recent studies that did not demonstrate these relationships [26–28]. In addition, a recent literature review suggested that although there is not sufficient evidence to support significant relationships between sedentary behavior and body weight gain and sedentary behavior and cardiovascular disease biomarkers, there is evidence in the literature to support a strong relationship between sedentary behavior and mortality, suggesting that, while important, these relationships are not well documented or described [29].

Inconsistencies in the reported relationships between sedentary behavior and cardiometabolic risk factors and body composition suggest that specific population or measurement characteristics of studies may be contributing to findings. For example, one study showed that 27.3% to 95.9% of the association between sedentary behavior and health outcomes (e.g., blood pressure, cholesterol) was explained by BMI or waist circumference [30]. Most of the literature has included a majority of white participants [22, 27, 28, 30], and the relationship of sedentary behavior to cardiometabolic risk factors and body composition in ethnic minority women remains unclear. One study suggested that decreased occupational sitting time may decrease BMI and promote healthy behaviors among women [25], but few have explored the direct relationship between sitting time that includes both weekday and weekend, occupational and leisure time, or have distinguished between occupational and leisure sitting time and its associations with cardiometabolic risk factors and body composition. The purpose of this study was to investigate the relationship of weekday and weekend sitting time to cardiometabolic risk factors, including blood pressure, resting heart rate, cholesterol, triglycerides and glucose, and body composition among overweight and obese African American women. We hypothesized that increased sitting time would be associated with higher rates of cardiometabolic risk factors, obesity, and increased body fat and explored the issue of whether weekday (occupational) sitting time or weekend (recreational) sitting time would be more important in contributing to cardiometabolic outcomes.

2. Materials and Method

2.1. Participants. The current study was a secondary analysis using data from the Health Is Power (HIP) study (1R01CA109403). Four hundred ten community dwelling,

African American ($n = 263$), and Hispanic or Latina ($n = 147$) women participated in HIP, a multisite, longitudinal, community-based, randomized controlled trial to increase physical activity [31–42] in Houston and Austin, Texas. Eligible participants, self-identified as African American or Hispanic or Latina, were between the ages of 25 and 60 years old, able to read, speak, and write in English or Spanish, not pregnant or planning to become pregnant within the next 12 months, a Harris or Travis County resident, not planning on moving in the next 12 months, physically inactive or doing fewer than 30 minutes of physical activity per day on 3 or more days per week, and free from health conditions that would be aggravated by physical activity [43]. A subsample of Houston African American participants ($n = 135$) completed laboratory assessments at baseline, Time 1 (T1) [31, 41]. All HIP study assessments, measures and procedures were approved by the Committee for the Protection of Human Subjects at the University of Houston, and women provided written informed consent prior to participation.

2.2. Assessments. Women who met inclusionary criteria gave informed consent and completed a T1 health assessment, where they completed an interviewer administered questionnaire measuring physical activity and demographics, measures of blood pressure and resting heart rate, and anthropometric measures of BMI and body fat [36–38, 42].

The laboratory assessment included a venous blood sample and a whole body dual-energy X-ray absorptiometry (DXA) scan [31, 41]. Women completed these measures after fasting for 8 or more hours and wore metal-free clothing.

2.3. Cardiometabolic Risk Factors. Systolic and diastolic blood pressures were measured using manual aneroid sphygmomanometry by a trained research team member using established protocols. 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 obtained, separated by two minutes, and averaged for use in analyses. If the first two readings differed by more than 5 mmHg, a third reading was obtained and averaged.

Resting heart rate was assessed after participants sat quietly for two minutes. A trained assessor measured their radial pulse at their left wrist [44]. Assessors counted beats for one full minute and repeated the procedure for accuracy. An average of the two measurements in beats per minute was used in analyses.

A venous blood sample was collected from a peripheral arm vein into Vacutainers pretreated with either sodium heparin or K2 EDTA (Vacutainer; Becton-Dickinson, Franklin Lakes, NJ) after 8 or more hours of fasting [31] and analyzed for plasma total cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglyceride, and glucose concentrations using separate enzymatic assays in triplicate as described by the manufacturer (Pointe Scientific, Canton, MI). A ratio of total cholesterol to HDL (total cholesterol/HDL) was also used in analyses.

2.4. Body Composition. Anthropometric measures of BMI and body fat were collected by trained personnel using established protocols [36–38, 41, 42]. Individual height was measured using a standard stadiometer apparatus with participants' shoes being removed. Body weight and percent body fat were measured twice using bioelectrical impedance analysis (BIA) using a Tanita TBF-310 body composition analyzer (Tanita, Arlington Heights, Illinois). BMI was calculated using stadiometer heights and BIA body weights. All measures were collected twice, and the average of the two measurements was used in analyses.

Percent body fat was also measured by DXA. DXA measurements were completed by a trained staff member between 6:00 and 8:00 AM and took 10–15 minutes per participant. DXA scans were used to measure whole body fat mass, lean mass, bone mass and total percent body fat, as previously described [31, 41]. Only total percent body fat was used in current analyses.

2.5. Sitting Time. Sitting time was measured using items from the International Physical Activity Questionnaire (IPAQ) long form administered at the baseline health assessment. The IPAQ long form is typically used to measure work-related, transportation, domestic and leisure-time physical activity. In addition, the instrument measures time spent sitting over the last seven days by time spent sitting in a motor vehicle and time spent sitting during the week and weekend [18]. Sitting time was reported in terms of total minutes during the week and weekend. Adhering to the IPAQ protocol, data were cleaned and missing or spurious data were excluded from any analyses [36].

2.6. Sociodemographics. Items assessing ethnicity, household income, and education were adapted from the Maternal Infant Health Assessment (MIHA) survey [45], derived from the CDC's Pregnancy Risk Assessment Monitoring System (PRAMS) Questionnaire [46]. Items have shown good reliability and have been used with samples representing diverse ethnicities [47].

2.7. Statistical Analyses. All statistical analyses were conducted in SPSS version 19.0 (IBM SPSS Statistics for Windows, IBM Corporation, Somers, NY). The current study is limited to a subsample of African American women enrolled in Houston, TX, who were offered a laboratory assessment ($n = 135$) at baseline T1. Only participants with complete data for a particular measure were included in all analyses, which varied by assessment procedure/measure. Women in the subsample were slightly older ($M = 46.6$ years, $SD = 8.9$) than the total African American sample ($M = 42.9$ years, $SD = 9.6$; $t = -3.141$, $P = .002$) but were similar in education, income, BMI, and percent body fat. Bivariable correlations were conducted among cardiometabolic risk factor variables and body composition variables and between cardiometabolic risk factor and body composition variables. Simultaneous linear regression models were used to estimate the effect of weekday and weekend sitting time on cardiometabolic risk factors, including systolic and diastolic

blood pressure, resting heart rate, total cholesterol, HDL, LDL, triglycerides, the ratio of total cholesterol to HDL, and glucose, and on body composition, including BMI, BIA percent body fat, and DXA percent body fat, controlling for age, education, and income. Significance for all analyses was set at $P < .05$.

3. Results

3.1. Descriptive Characteristics. African American women were middle aged ($M = 46.6$ years, $SD = 8.9$) and obese (M BMI = 34.9 kg/m², $SD = 9.5$). Over half (52.7%) had graduated from college, and the majority (56.7%) reported an income 401% or greater above the Federal Poverty Level [48] or an income greater than \$82,807. Mean (and SD) cardiometabolic risk factors and body composition are presented in Table 1. Triglycerides varied by education ($F(1, 26) = 5.650$, $P = .025$); women who had not graduated from college had higher triglyceride values than women with a college education ($M = 73.2$ versus 37.9). There were no other significant differences in cardiometabolic factors or body composition by education or income.

3.2. Bivariable Correlations. Age was significantly positively correlated with systolic blood pressure ($r = .219$, $P = .011$) and glucose ($r = .288$, $P = .036$). Correlations between cardiometabolic factors and body composition are shown in Table 2. Total cholesterol was significantly negatively correlated with weekend sitting time ($r = -.374$, $P = .050$) and total sitting time ($r = -.376$, $P = .049$). LDL was also significantly negatively correlated with weekend sitting time ($r = -.425$, $P = .027$). Sitting time was not correlated with any other cardiometabolic risk factors or body composition variables.

3.3. Regression Models. There were no significant linear associations between weekday sitting time and either cardiometabolic factors or body composition. In contrast, linear regression models suggest a moderate association between weekend sitting time and glucose ($\beta = .266$, $t = 1.960$, $P = .056$), which may be significant with increased power.

Linear regression models mimicked bivariable correlations and indicated a surprising negative linear association for both weekend ($\beta = -.374$, $t = -2.058$, $P = .050$) and total ($\beta = -.376$, $t = -2.069$, $P = .049$) sitting time to total cholesterol, suggesting that greater sitting time was associated with lower total cholesterol levels. Greater sitting time during the weekend was also associated with lower LDL levels ($\beta = -.425$, $t = -2.347$, $P = .027$). Also of interest, there were no significant associations between sitting time and body composition.

4. Discussion

Based on previous research, we expected to find that greater time spent sitting was associated with poorer cardiometabolic indicator values. We found some limited support for this hypothesis with glucose; however, reduced

TABLE 1: Descriptive information for sample cardiometabolic risk factors and body composition.

	N	Mean	SD	Normal Ranges
Cardiometabolic risk factors				
Systolic blood pressure (mmHg)	135	126.4	14.4	<120
Diastolic blood pressure (mmHg)	135	79.7	10.2	<80
Resting heart rate (beats/min)	135	71.9	8.4	60–100
Total cholesterol (mg/dL)	30	181.3	28.5	<200
HDL (mg/dL)	30	46.6	12.5	≥60
LDL (mg/dL)	29	123.0	25.9	<100
Triglycerides (mg/dL)	29	58.3	46.9	10–150
Total cholesterol/HDL	30	4.0	1.2	
Glucose (mg/dL)	53	86.0	27.3	≤100
Body composition				
Body mass index (kg/m ²)	135	34.9	9.5	18.5–24.9
BIA body fat (%)	134	42.8	7.7	23–35*
DXA total body fat (%)	125	41.7	6.0	23–35*
Sedentary time				
Weekday sedentary time (min)	128	425.0	274.2	
Weekend sedentary time (min)	128	370.4	269.0	
Total sedentary time (min/week)	128	795.5	477.5	

* Normal range for body fat listed is not specific to measurement method and is for women 41 to 60 years old.

TABLE 2: Correlation coefficients between cardiometabolic risk factors and body composition.

	1	2	3	4	5	6	7	8	9	10	11	12
(1) Systolic blood pressure (mmHg)	1	.780**	.101	.111	-.010	.138	.020	.071	-.029	.381**	.313**	.220*
(2) Diastolic blood pressure (mmHg)	.780**	1	.201*	.163	-.082	.220	.091	.148	-.091	.423**	.370**	.267**
(3) Resting heart rate (beats/min)	.101	.201*	1	.367*	-.176	.393*	.352	.291	.016	.260**	.123	.027
(4) Total cholesterol	.111	.163	.367*	1	.258	.883**	.327	.283	.167	.113	.132	-.032
(5) HDL	-.010	-.082	-.176	.258	1	-.105	-.141	-.687**	-.144	-.396*	-.331	-.110
(6) LDL	.138	.220	.393*	.883**	-.105	1	.100	.454*	-.045	.327	.273	.028
(7) Triglycerides	.020	.091	.352	.327	-.141	.100	1	.589**	.712**	-.012	.069	-.164
(8) Total cholesterol/HDL	.071	.148	.291	.283	-.687**	.454*	.589**	1	.335	.389*	.282	-.079
(9) Glucose	-.029	-.091	.016	.167	-.144	-.045	.712**	.335	1	-.021	.120	.110
(10) Body mass index (kg/m ²)	.381**	.423**	.260**	.113	-.396*	.327	-.012	.389*	-.021	1	.783**	.775**
(11) BIA body fat (%)	.313**	.370**	.123	.132	-.331	.273	.069	.282	.120	.783**	1	.756**
(12) DXA total body fat (%)	.220*	.267**	.027	-.032	-.110	.028	-.164	-.079	.110	.775**	.756**	1

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

sample size limited our power to detect this effect. We did not find expected relationships between sitting time and body composition. It may be that since this sample was already overweight and obese, time spent sitting had little impact on this outcome. In contrast to our hypotheses, we found that greater time spent sitting on the weekend was associated with better cholesterol levels, suggesting that in this sample, there is some advantage to time spent sitting that may counteract the sedentary nature of sitting.

The curious relationship that we found between sitting and improved cholesterol suggests that something unexpected is driving this relationship. Perhaps women who have more sitting time are more relaxed and have more leisure time in general. The variables used to measure sedentary time included time spent sitting while driving. In this

sample, in sprawling Houston, we have found an inverse association between car ownership and physical activity (results not shown); perhaps more time spent sitting while driving led to more time doing physical activity either because the participant commuted to their physical activity destination or because the increased driving time led to a desire to be more active, which may have impacted these cardiometabolic factors. Another curious finding is that nearly all of the relationships reported here were between weekend sedentary time, rather than weekday time. During the week, perhaps time is more carefully scripted by work and family responsibilities, while weekends have more discretionary time. Future studies should continue to specify time spent during weekends and weekdays separately in terms of both measurement and intervention. In contrast, people

may feel that weekends are a time for rest and relaxation, that is, sedentary time. Thus, intervention strategies that decrease sedentary and sitting time during the week might be more sustainable, as they get integrated along with already ritualized weekday responsibilities.

Previous research exploring the relationship between sitting time and other cardiometabolic risk factors has yielded similar findings. For example, Yates et al. found that sitting time was positively associated with fasting insulin, C-reactive protein, and insulin resistance in women after adjusting for physical activity [49]. However, no other studies have found a relationship between sedentary time and cholesterol or lipoprotein measures in women [27, 50], warranting further investigation to elucidate study findings.

In our sample of community volunteers, we found slightly elevated blood pressure, with 60.1% of the sample exceeding normal ranges for both systolic and diastolic, somewhat higher than the national prevalence [8, 9]. This sample had relatively poor cholesterol levels, with most women having too low values of HDL and too high levels of LDL, similar to national samples [8]. Most of the sample was overweight or obese, which likely reflects not only very high prevalence of high body fat in the population [11–13] but also the nature of the study recruitment, which sought volunteers to enroll in a study to increase physical activity or improve dietary habits.

This study is among the first to investigate the relationship of weekday and weekend sitting time to cardiometabolic risk factors in African American women and includes a sizeable sample of African American women, who are most vulnerable to obesity and chronic health conditions. This study includes the use of validated and reliable measures for this population, including DXA- and BIA-measured percent body fat. However, this study was not without its limitations. A significant study limitation was the use of self-reported sedentary time. Accelerometry is considered the gold standard of physical activity and sedentary behavior measurement and may have enhanced study findings. In addition, this study was limited to the relationship between weekday and weekend sitting time and cardiometabolic risk factors and did not explore the relationship between physical activity and these risk factors, for which there is a known strong relationship. The use of cross-sectional versus longitudinal data limits us from making assumptions about causality in this study, and due to study population characteristics, findings may not be generalized to other non-African American populations. Missing data for laboratory assessments and measures also limits findings and may explain differences in findings between the current study and established literature.

Although this sample was generally representative of African American women in terms of health status, this sample was of higher socioeconomic status, as is often the case with community volunteers in health promotion studies. Future studies should investigate larger samples that represent the entire community and continue to account carefully for sedentary and sitting time. As others have suggested, these findings suggest that simply decreasing sedentary time may not be sufficient to improve cardiometabolic risk and body

composition [28]. These findings may have produced more questions than they answered but underscore the complexity of the relationships between sedentary behavior and health outcomes, particularly in more vulnerable groups in the population.

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