PATTERNS OF SEDENTARY BEHAVIOR IN OVERWEIGHT AND OBESE WOMEN

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Objectives: Few studies have objectively quantified sedentary behavior, particularly in special population subgroups. This study quantified the volume of and breaks from sedentary behavior in a sample of overweight and obese, primarily African American, women.

Design: Cross-sectional.

Setting: 18 census tracts in Columbia, South Carolina with higher than state and national poverty levels.

Participants: 197 overweight/obese women (87% African American). Mean age 38.3 ± 7.6 years, mean body mass index 40.6 ± 8.8 kg/m^2.

Main Outcomes Measures: Using a cut point of <100 counts/minute, estimated daily averages of: 1) total volume, 2) ≥10, 30, and 60-minute bouts, and 3) patterns of sedentary behavior according to time of day and day of the week were computed. Total breaks, or interruptions, in sedentary time were also calculated.

Results: Participants were sedentary 64.1% of the day, engaging in 10.5 ± 2.8 daily bouts of sedentary behavior per hour of sedentary time; each bout lasted ~6.4 ± 1.7 minutes. All participants engaged in ≥1 daily bout of sedentary behavior ≥10 and ≥30 minutes, and most (83%) engaged in ≥1 bout ≥60 minutes. Participants were slightly more sedentary during the evening (6 pm–midnight) and on weekdays. On average, participants took 90.9 ± 16.0 breaks from sedentary behavior; each break lasted 3.3 ± .8 minutes.

Conclusions: Women engaged in more sedentary behavior than that reported in national data sets. In an effort to improve public health, efforts should not only focus on increasing physical activity, but also on decreasing time spent sedentary. (*Ethn Dis.* 2013;23[3]:336–342)

Key Words: Physical Activity, Accelerometer, Measurement, African American Women, Public Health

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INTRODUCTION

The health benefits of a lifestyle that includes regular physical activity are well established.[1,2] In recent years, an increasing number of studies have measured sedentary behaviors in an effort to quantify it and examine its effects on health. Sedentary behaviors are activities that do not increase energy expenditure substantially above resting level (ie, 1.0–1.5 metabolic equivalent units [METS]), and include activities such as lying down, sitting, and watching television.[3,4] There is emerging and compelling evidence pointing to the detrimental health effects of a lifestyle that includes high amounts of sedentary behavior, independent of moderate to vigorous intensity physical activity levels.[5] Research has found sedentary behavior to be associated with mortality[6–10] and chronic disease conditions such as type 2 diabetes,[10–12] cardiovascular disease,[10,13] and obesity.[14–16]

Sedentary behavior is not the same as a lack of moderate to vigorous intensity physical activity and there is evidence showing that regular moderate to vigorous intensity physical activity does not undo the deleterious effects of sedentary behavior.[17,18] This distinction has important implications from a public health standpoint in that in addition to promoting physical activity of sufficient intensity, frequency, and duration to positively affect health, public health efforts directed at decreasing the amount of time spent engaged in sedentary activities may also be warranted. Researchers have advocated for the creation of recommendations regarding the reduction of sedentary behavior that would coexist with the current physical activity recommendations for adults.[17,19]

Sedentary time is prevalent among US adults; most recent objectively measured surveillance data on sedentary behavior from the 2003–2006 National Health and Nutrition Examination Survey (NHANES) found that United States adults (aged ≥20 years) spent well over half (8.4 hours/day) of all waking hours in sedentary behaviors.[20] Further, results showed that women are more sedentary than men, and Whites are more sedentary than African Americans or Mexican Americans.[20]

Not only does total time spent in sedentary behavior have a negative effect on health,[20–23] there is growing evidence that the manner in which sedentary behavior is accumulated may also be important. Particular metabolic factors have been shown to be more favorable in individuals who accumulate sedentary behavior in shorter bouts (ie, more breaks or interruptions in sedentary behavior, where activity levels reach at least light intensity) compared to individuals who accumulate sedentary behavior in more prolonged bouts.[20,21,24] Data from the 2003–2006 NHANES found that on average, adults had 92.5 breaks (ie, interruptions) in sedentary behavior per day, and the mean break lasted 4.1 minutes.[20] A higher number of breaks from time spent sedentary, which could be as short as one minute in length, was associated with a more favorable waist circumference and C-reactive protein.[20]

A majority of the studies in the existent sedentary literature have relied on self-report measures to quantify sedentary behavior. Although self-report measures can be useful for assessing various domains and specific behaviors (eg, sitting, television watching, computer use), objective measures are preferred because they measure total sedentary time and the manner in which it is accumulated.[25] Objective measures, such as the Actigraph accelerometer,

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provide researchers with additional information such as the length and intensity of bouts of sedentary behavior and the frequency of breaks from sedentary behavior. Furthermore, the time stamp feature provides an opportunity to look at sedentary patterns during particular time periods (eg, mornings, afternoons, evenings) or on certain days (eg, weekend, weekday).[25]

Unfortunately, there is a large gap in the current literature regarding the quantification of sedentary behavior in subgroups of the population, particularly in low socioeconomic and minority subgroups in which chronic disease health disparities currently exist.[26] Although there are published data from NHANES quantifying sedentary behavior by sex, race/ethnic, and age groups,[20,27] no studies have quantified sedentary behavior in the context of multiple potential risk statuses simultaneously (eg, low-income, African American, women). A better understanding of the volume and patterns of sedentary behavior among high risk subgroups may be necessary to develop effective interventions to reduce sedentary behavior. The purpose of this study was to objectively quantify the volume (including patterns)

of sedentary behavior and breaks from sedentary behavior in a sample of overweight and obese, primarily African American women recruited from low-income neighborhoods in a Southeastern US urban setting. The findings from this study can be used to better understand sedentary behavior in a high risk population and inform future behavioral interventions.

METHODS

Sisters Taking Action for Real Success (STARS) is a randomized controlled weight loss trial in overweight and obese women recruited from economically disadvantaged neighborhoods. Women enrolled in the study were randomly assigned to a 16-week behavioral and social support group-based intervention or a minimal intervention control group. Primary outcomes of the study were weight, body mass index (BMI), and waist circumference, and secondary outcomes included physical activity and dietary intake. A detailed description of the study methods, including inclusion and exclusion criteria, is provided elsewhere.[28] The study protocol was approved by the University's Institutional Review Board.

Participants and Recruitment

Women aged 25–50 years with a BMI $\geq$25 kg/m^2 and a waist circumference $\geq$88 cm were recruited from 18 census tracts in Columbia, South Carolina with higher than state and national poverty levels. A community advisory board, consisting of women who lived and/or worked within the targeted neighborhoods, helped identify recruitment strategies, contact persons and recruitment venues, while promoting trust, cultural relevance, and research acceptability within the community.

Procedures

Women were initially screened for inclusion/exclusion criteria over the

phone. Those who remained eligible after the phone screen were scheduled for an in-person visit to provide informed consent, confirm eligibility, and conduct baseline measurements. Staff persons took anthropometric measures and conducted an interview to collect sociodemographic, health status and behavior, and psychosocial data. Participants were oriented to wearing the Actigraph accelerometer. They received cash incentives for completing the measurement session and returning the Actigraph. Baseline data collected prior to randomization were analyzed for this study.

Measures

Sociodemographics

Participants self-reported their age, race, marital status, employment status, and highest grade or year of school completed.

Body Mass Index

Height to the nearest quarter inch and weight to the nearest tenth of a kilogram were obtained by trained staff. BMI was calculated as kg/m^2 using standard procedures.

Waist Circumference

Using the iliac crests as landmarks, waist circumference to the nearest tenth of a centimeter was measured by trained staff.[29]

ActiGraph Accelerometer

The ActiGraph accelerometer (GT1M model, ActiGraph, LLC, Fort Walton Beach, FL) was used to objectively measure the intensity of ambulatory movement. A detailed description of the accelerometer orientation and wear protocol has been published elsewhere.[30] Participants were instructed to wear the monitor on the right hip during all waking hours (except during activities involving water) for seven consecutive days. Participants were required to wear the monitor for a

minimum of ten hours per day, on four days.

After seven days, participants returned the accelerometer to the research office where staff downloaded the data (ActiLife Lifestyle Monitoring System software, version 3.2.11) and reviewed displays of the data to determine if participants met the minimum wear criteria described above. If they did not, staff requested that the participants wear the accelerometer for an additional seven days. Days from the second week (matching weekdays for weekdays and weekend for weekend) were substituted for missing days due to insufficient wear time during the first week. This substitution was necessary for 11 women. Any day the monitor was worn for <10 hours was excluded from the analysis, and if a participant did not meet the four-day, ten hours per day minimum wear time requirement after the second week, they were not included in analyses.

A 60-second epoch length was used for data collection. The data reduction process (using SAS version 9.2) began by identifying non-wear time, which was defined as ≥60 consecutive minutes of counts equaling zero;[31,32] we assumed participants were not wearing the monitor during this time and thus the data were not included in the computation of sedentary time. To facilitate comparisons with other population groups,[20,21,27,33] any count <100 counts per minute was considered a minute of sedentary time.[27] Any continuous period of counts <100 was defined as a bout of sedentary behavior. Any single count ≥100 ended the bout, and the period of continuous counts ≥100 was defined as a break from sedentary behavior. Both bouts and breaks were purely continuous periods with no exceptions or interruptions allowed in the definition. Note that intervals identified as non-wear were not considered part of any sedentary bout; therefore each minute of Actigraph data is exclusively assigned to one of the three categories (non-wear, sedentary bout, break from sedentary behavior) with no overlap.

STATISTICAL ANALYSIS

Descriptive statistics included means and standard deviations or frequencies and percentages of key sociodemographic and health-related variables. Estimated daily averages of volume of sedentary behavior were computed as: 1) % of day spent in sedentary behavior; 2) total minutes of sedentary behavior; 3) number of bouts of sedentary behavior per hour of sedentary time; 4) length of bouts of sedentary behavior; 5) the number of ≥10, ≥30, and ≥60 minute bouts of sedentary behavior per hour of sedentary time; 6) length of ≥10, ≥30, and ≥60 minute bouts of sedentary behavior; 7) % of morning, afternoon, and evening time spent in sedentary behavior; 8) total minutes of sedentary behavior during the morning, afternoon, and evening; 9) number of bouts of sedentary behavior during the morning (6 am–noon), afternoon (noon–6 pm), and evening (6 pm–midnight) per hour of sedentary time; 10) % of weekday and weekend days spent in sedentary behavior; 11) total minutes of sedentary behavior on weekdays and weekend days; 12) number of bouts of sedentary behavior on weekend days (Saturday-Sunday) and week days (Monday-Friday) per hour of sedentary time. Estimated daily averages of breaks from sedentary behavior were computed as: 1) total number of breaks, 2) mean length of the breaks, and 3) the mean intensity (count) of the breaks. Statistical analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA).

RESULTS

Informed consent was obtained from 230 women, and 26 were excluded because of contraindications. Of the remaining 204 women, seven did not have complete Actigraph accelerometer data, yielding 197 for these analyses. As shown in Table 1, the mean age of participants was 38.3 years, the mean BMI was 40.6 kg/m^2, and the mean waist circumference was 116.8 cm. A majority of participants were African American (86.8%), not married (70.1%), employed (77.7%), and had at least some college education (79.7%).

The mean, standard error, median, and range of the total volume and % of time spent in sedentary behavior, as well as the number of bouts of sedentary behavior per hour of sedentary time are shown in Table 2. Participants spent an average of 544.1 minutes per day sedentary (64.1% of the day). On average, participants engaged in 10.5 bouts of sedentary behavior per hour of sedentary time each day; each bout averaged 6.4 minutes. Women engaged in 1.6 bouts of sedentary behavior lasting ≥10 minutes per hour of sedentary time (mean duration=21.4 minutes), .3 bouts lasting ≥30 minutes per hour of sedentary time (mean duration=46.3 minutes) and .1 bouts lasting ≥60 minutes per hour of sedentary time (mean duration= 79.9 minutes).

The mean, standard error, median, and range of the number, length, and intensity of breaks from sedentary behavior are also shown in Table 2. On average, participants had 90.9 breaks from sedentary behavior, and each break lasted 3.3 minutes. The mean intensity of the break was 484.3 counts, which is classified as light intensity.[34,35]

The mean, standard error, median, and range of the total volume and % of time spent in sedentary behavior, as well as the number of bouts of sedentary behavior per hour of sedentary time according to the time and the type of day are shown in Table 3. On average, women spent 61.8% (150.7 minutes) of the morning sedentary, engaging in 11.5 bouts of sedentary behavior per hour of sedentary time, 63.9% (224.7

Table 1. Sociodemographic and activity characteristics of participants (*n*=197)

			n	%
Race				
African American			171	86.8
White			16	8.1
Other			9	4.6
Missing			1	0.5
Education				
Less than high school graduate			9	4.6
High school graduate or GED			31	15.7
Some college			97	49.2
College graduate			60	30.5
Employment Status				
Employed			153	77.7
Not employed			44	22.3
Marital Status				
Married/Cohabitating			59	30.0
Not married			138	70.1
	n	Mean (SD)	Min	Max
Age, years	197	38.3 (7.6)	25.0	51.0
Body mass index, m/kg^2	197	40.6 (8.8)	26.9	69.4
Waist circumference, cm	197	116.8 (17.3)	88.0	172.0
Monitor wear time, minutes/day	197	845.0 (100.4)	616.3	1312.9

minutes) of the afternoon sedentary, engaging in 10.9 bouts of sedentary behavior per hour of sedentary time, and 65.8% (152.1 minutes) of the evening sedentary, engaging in 10.2 bouts of sedentary behavior per hour of sedentary time. On weekdays, participants were sedentary 64.6% of the time (556.2 minutes), engaging in 10.5 bouts of sedentary behavior per hour of sedentary time, whereas on weekends they were sedentary 63.0% of the time

(509.8 minutes), engaging in 10.7 bouts of sedentary behavior per hour of sedentary time.

DISCUSSION

Advances in technology over the past decades have led to a lifestyle that is highly sedentary. Sedentary behavior has been shown to have detrimental effects on health. Few studies have objectively quantified sedentary behavior and even fewer have examined patterns of sedentary behavior. In order to effectively address a public health concern such as high rates of sedentary behavior, we must first understand the behavior. Our study takes the first step in addressing this major public health problem by providing insight into sedentary behavior and patterns of sedentary behavior in a high-risk population.

Women spent a majority of their waking hours (9.1 hours or 64%) sedentary, a greater proportion than that found in other studies.[20–22,24,27,33,36,37] According to NHANES data, US adults are sedentary approximately 57–58% of the day,[20,33] women are sedentary 59%

Table 2. Daily volume, bouts, and breaks from time spent in sedentary behavior among overweight and obese women[a]

	n	Mean (SD)	Median	Minimum[b]	Maximum[b]
% of day spent sedentary[c]	197	64.1 (8.7)	64.8	35.1	81.7
Total minutes in bouts of sedentary behavior	197	544.1 (107.4)	535.3	248.7	924.0
Number of bouts of sedentary behavior, per hour of sedentary time	197	10.5 (2.8)	10.0	5.0	22.0
Length of bouts of sedentary behavior, minutes	197	6.4 (1.7)	6.2	2.7	13.7
Number of ≥10 minute bouts of sedentary behavior, per hour of sedentary time	197	1.6 (0.2)	1.7	.8	2.1
Length of ≥10 minute bouts of sedentary behavior, minutes	197	21.4 (3.5)	20.8	14.3	34.8
Number of ≥30 minute bouts of sedentary behavior, per hour of sedentary time	197	0.3 (0.1)	0.3	0.02	0.6
Length of ≥30 minute bouts of sedentary behavior, minutes	197	46.3 (7.1)	45.6	32.3	82.0
Number of ≥60 minute bouts of sedentary behavior, per hour of sedentary time	197	.1 (.04)	.05	0	.2
Length of ≥60 minute bouts of sedentary behavior, minutes	163[d]	79.9 (17.9)	74.3	60.0	222.0
Number of breaks from sedentary behavior[e]	197	90.9 (16.0)	91.7	51.1	134.0
Length of breaks from sedentary behavior, minutes[f]	197	3.3 (.8)	3.2	2.1	7.6
Intensity of breaks from sedentary behavior, as Actigraph counts	197	484.3 (75.2)[g]	475.2	348.7	860.8

[a] A bout of sedentary behavior is an uninterrupted period of time spent sedentary as defined by accelerometer counts less than 100.
[b] The minimum and maximum bouts are the average across the sample of individuals.
[c] A day is defined as the period of time wearing the accelerometer.
[d] 34 participants did not have a ≥60 minute bout of sedentary behavior.
[e] A break from sedentary behavior is any single count ≥100.
[f] The period of continuous counts ≥100 was defined as the length of the break from sedentary behavior.
[g] Classified as light intensity physical activity.

Table 3.   Daily time spent in sedentary behavior by time of day and type of day among overweight and obese women[a]

	n	Mean (SD)	Median	Minimum[b]	Maximum[b]
Time of Day[c]					
% of morning time spent sedentary	197	61.8 (10.7)	63.3	23.8	83.8
Total morning time in bouts of sedentary behavior, minutes	197	150.7 (44.5)	151.5	45.5	242.9
Number of morning bouts of sedentary behavior, per hour of morning sedentary time[a]	197	11.5 (3.8)	10.6	5.2	29.8
% of afternoon time spent sedentary	197	63.9 (9.5)	64.7	31.8	84.8
Total afternoon time in bouts of sedentary behavior, minutes	197	224.7 (35.4)	230.0	103.7	291.8
Number of afternoon bouts of sedentary behavior, per hour of afternoon sedentary time	197	10.9 (3.1)	10.7	4.3	21.6
% of evening time spent sedentary	197	65.8 (10.0)	66.9	32.2	88.1
Total evening time in bouts of sedentary behavior, minutes	197	152.1 (56.9)	156.4	2.0	278.6
Number of evening bouts of sedentary behavior, per hour of evening sedentary time	197	10.2 (3.4)	9.8	4.0	30.0
Type of Day					
% of weekday time spent sedentary	197	64.6 (8.9)	65.3	35.8	81.4
Total weekday time in bouts of sedentary behavior, minutes	197	556.2 (111.1)	550.8	255.0	876.4
Number of weekday bouts of sedentary behavior, per hour of weekday sedentary time	197	10.5 (3.0)	10.1	5.2	22.6
% of weekend time spent sedentary	186[d]	63.0 (11.3)	64.1	28.0	87.2
Total weekend time in bouts of sedentary behavior, minutes	186[d]	509.8 (139.1)	500.3	227.0	1093.5
Number of weekend bouts of sedentary behavior, per hour of weekend sedentary time	186[d]	10.7 (3.4)	10.1	3.8	21.0

[a] A bout of sedentary behavior is an uninterrupted period of time spent sedentary as defined by accelerometer counts <100.
[b] The minimum and maximum bouts are the average across the sample of individuals.
[c] Morning defined as 6 am–noon; afternoon as Noon–6 pm; and evening as 6 pm–midnight.
[d] 11 participants did not wear the accelerometer on a weekend day.

of the day,[20] overweight women about 57%, and obese women about 58%.[33] The mean length of sedentary bouts was also higher in our sample (6.4 minutes) than women in the NHANES sample (5.5 minutes).[20]

A unique aspect of our study was the exploration into the frequency of prolonged bouts of sedentary behavior. Although bouts of sedentary behavior were only 6.4 minutes on average, participants spent longer periods of time sedentary throughout the day. All participants engaged in multiple bouts of sedentary behavior lasting ≥10 and ≥30 minutes, and a large percentage (83%) of participants were sedentary for ≥60 minutes at one time. These prolonged periods of sedentary behavior may be an ideal focal point for future interventions and the development of optimal sedentary guidelines.

The average number and length of breaks from sedentary behavior was comparable to what has been found in the NHANES data set.[20,33] Participants in this study took 91 breaks from sedentary behavior each day, whereas women taking part in NHANES took 95 breaks.[20] The number of breaks in our study was also comparable to the number of breaks reported by overweight and obese women taking part in NHANES; overweight women took nearly 92 breaks and obese women took 90 breaks per day. The average break from sedentary behavior in our sample lasted a little over 3 minutes, similar to the nearly 4 minutes reported in NHANES.[20]

Overall, women spent a greater percentage of the day engaged in sedentary behavior compared to national data from NHANES, but took a comparable number of breaks lasting a similar period of time. Although additional research is needed to establish the amount of sedentary time that increases the risk for chronic diseases and the frequency and duration of breaks from sedentary behavior needed to realize protective effects, lowering total time spent sedentary and increasing the number of breaks from sedentary behavior should be a public health target, as evidence suggests it may provide an opportunity to improve population health.

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To the best of our knowledge, no studies have used an accelerometer to examine patterns of sedentary behavior according to time and type of day among similar samples of women. Examining patterns can be useful for intervention development, as researchers may know which days of the week or times of the day may need additional attention and/or more intense efforts. Scheers et al[38] used the SenseWear armband to examine differences in sedentary behavior on week days compared to weekend days (Saturday and Sunday separately). They found that the time overweight and obese women spent sedentary was similar on weekdays and Saturday, but increased on Sundays.[38] Participants in our study tended to be slightly more sedentary on week days (65% of day) compared to weekend days (63% of day) and in the evening (66% of time) compared to the morning (62% of time) and afternoon (64% of time).

The very high level of sedentary behavior (64% of day) substantiates the need for addressing sedentary behavior in overweight and obese African American women from low-income neighborhoods. In addition to health messages promoting sufficient levels of moderate-to-vigorous intensity physical activity, messages encouraging women to take more active breaks throughout the day (ie, increase light intensity activity), may provide a feasible starting point for sedentary women. An increase in breaks, and thus decrease in volume of sedentary behavior, may produce meaningful risk reductions.

Findings from this study should be interpreted with study limitations in mind. Compared to national data, the sample size was significantly smaller. Although comparisons with NHANES data were made, we recognize that our sample may be different in that they were all overweight or obese and enrolled in a weight loss trial. There are also limitations in using accelerometers to measure sedentary behavior,

including the possibility of misclassifying sedentary time as non-wear time, and vice versa. Additionally, because accelerometers may not adequately capture time spent in activities of all intensities that do not involve ambulation, there is likely some unknown degree of misclassification.

In conclusion, the findings from this study reveal that overweight and obese, primarily African American, women recruited from low-income neighborhoods in South Carolina live a highly sedentary lifestyle. Although the number and length of breaks from sedentary behavior in this study were similar to national data, the total volume of sedentary behavior in our sample was higher than what NHANES data have shown. High levels of sedentary behavior may increase the risk for adverse health outcomes, and thus warrant public health efforts aimed at reducing such detrimental behaviors.

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