

SEDENTARY BEHAVIOR, BODY MASS INDEX, AND WEIGHT LOSS MAINTENANCE AMONG AFRICAN AMERICAN WOMEN

Objectives: Relationships among sedentary behavior, weight gain, and weight loss and regain are understudied particularly for African Americans, a high risk group for obesity. The hypotheses were: sedentary behavior is positively associated with current body mass and % of weight loss maintained after initial weight loss; these associations differ by physical activity status.

Design: Cross-sectional

Setting: National survey

Patients or Participants: 1,110 African American women

Interventions: Observational study

Main Outcome Measures: A cross-sectional survey was administered to African Americans who had intentionally lost 10% of their body weight. Those who lost weight and maintained at least a 10% weight loss for a year were classified as weight loss maintainers; all others were classified as weight loss re-gainers. Participants were classified into one of four categories based on low and high levels of sedentary behavior and physical activity. The high physical activity, low sedentary behavior category was the reference group. Sociodemographic characteristics and health conditions were covariates. Data were collected in 2009 and analyzed in 2013.

Results: Each additional daily hour of sedentary time was associated with an increase in BMI ($P < .001$) and poorer weight loss maintenance ($P < .01$). Regardless of sedentary behavior, low physically active participants had BMIs that were greater ($P < .001$) compared to the reference group. Sedentary behavior had

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an independent effect on BMI and % of weight loss maintained for high but not low physically active participants.

Conclusions: High levels of sedentary behavior were associated with poorer weight-loss maintenance among African American women even for those with high levels of physical activity. The implications of this study are that physical activity and sedentary behavior, independently and combined, are associated with BMI and weight-loss maintenance. (*Ethn Dis.* 2015;25[1]:38–45)

Key Words: Sedentary Behavior, Weight Loss, Body Mass Index, African Americans, Weight Regain

INTRODUCTION

One definition of sedentary behavior is sitting without being otherwise active.¹ Recent reviews of empirical studies^{2–7} provide clear and compelling evidence that prolonged sitting has adverse health consequences. Sedentary behavior has increased over the past five decades, particularly in work settings⁸; and US adults spend 56% of their time in sedentary behavior.⁹ In a study of 17,013 adults, greater time spent sitting was associated with increased cardiovascular disease mortality, independent of physical activity.¹⁰ In another study, mortality risk increased for each 1-hour increment in television viewing, irre-

spective of physical-activity levels and adiposity status.¹¹

In addition to increased sedentary behavior, obesity rates in the United States are a great public health concern; approximately two of every three adults is either overweight or obese.¹² Obesity is associated with major causes of death and disability and with development and maintenance of chronic diseases (eg, type 2 diabetes, hypertension, cancer).¹² The estimated annual cost of obesity-related illnesses is \$190.2 billion, almost 21% of annual medical spending in the United States.¹² Also disturbing is that prevalence rates for obesity are generally greater among racial/ethnic minorities, lower-socioeconomic-status groups, rural populations, and women.¹³

Among women, observational studies in Australia and the United States have investigated the associations between sedentary behavior and body mass index (BMI), obesity, and weight gain. Among studies in Australia, during a four year study, women who reported greater sitting time were less likely to maintain weight.¹⁴ In another study among Australian men and women, with a separate analysis of women, sitting and television viewing time were detrimentally associated with BMI, independent of leisure time physical activity.¹⁵ In an analysis of The Australian Longitudinal Study of Women's Health study, gaining >5 kg of weight over 5 years was independently associated with more time spent sitting.¹⁶

Among studies in the United States with predominately non-Hispanic White women (ie, ranging from 83% to 95% or racial/ethnic identity of sample not specified), a significant positive association was found between television viewing and obesity.¹⁷ In

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another study, both baseline television viewing and increases in television viewing were significant predictors of one year weight regain, independent of physical activity.¹⁸ During six years of follow-up, sedentary behavior (ie, driving, sitting at work, time spent watching television) was positively associated with risk of obesity.¹⁹ During a seven year follow-up, non-occupational sedentary behavior independently predicted risk of ≥ 10 pound weight gain among postmenopausal women who were not overweight at baseline.²⁰

One study included a predominately African American sample of men and women (94%) and found a significant positive association between sitting time, computer use, and transit time and BMI.²¹ In this study, a sex specific analysis of African American women was not reported. In the only study with an analysis of African American women, the authors reported that time spent sitting was directly related to BMI with stronger associations for non-Hispanic White than Black women.²²

There is evidence that sedentary behavior is related to BMI, obesity, and weight gain, however, the existing literature is very limited because racially and ethnically diverse populations of women have not been studied. Also, there are no known studies of African American women and analysis of sedentary behavior, weight loss, weight loss maintenance, and weight regain.

Because of the absence of data, we chose a high-priority group, African American women who have high rates of obesity and physical inactivity.^{23–25} From 1999–2010, the overall prevalence of obesity among women was greater for non-Hispanic Blacks (51%) than other racial/ethnic groups including Mexican Americans (41%) and non-Hispanic Whites (31%).²³ From 2011–2012, the prevalence of obesity was higher among non-Hispanic Black women (56.6%) than among Hispanic (44.4%), non-Hispanic White (32.8%), non-Hispanic Asian (11.4%) women

as well as non-Hispanic Black men (37.1%).²⁴ In another study, non-Hispanic Black and Hispanic women compared to non-Hispanic White women had a greater prevalence of physical inactivity during leisure time.²⁵ Disparities persist in the prevalence of obesity and physical inactivity.

Previous studies controlled for physical activity because it is important to establish the independent effects of sedentary behavior apart from physical activity.^{15–19,21} Consistent with this approach, after controlling for physical activity, we investigated the associations among sedentary behavior, body mass index (BMI), and weight-loss maintenance in African American women. Our hypotheses were: 1) sedentary behavior is positively associated with current BMI; 2) sedentary behavior is positively associated with % of weight loss maintained after initial weight loss; and 3) relationships among sedentary behavior, current BMI, and % of weight loss maintained differ by physical-activity status.

METHODS

Study Participants

A cross-sectional survey of African American adults who had lost weight was conducted between October 2006 and April 2009. Individuals were eligible if they self-identified as non-Hispanic Black or African American, were aged ≥ 18 years, and had intentionally

We investigated the associations among sedentary behavior, body mass index (BMI), and weight-loss maintenance in African American women.

lost at least 10% of their body weight. Those who had lost weight and maintained $\geq 10\%$ weight loss for ≥ 1 year were classified as weight-loss maintainers. Those who had lost weight but had not maintained a 10% weight loss were classified as weight-loss re-gainers. Women who had become pregnant within a year of taking the survey or who had not maintained a 10% weight loss for ≥ 1 year were ineligible.

Potential participants responded to online or mailed surveys regarding their experiences with weight loss, weight-loss maintenance, and weight regain; 1,280 responded, and 90% were women. Details of the surveys and responses have been published previously.²⁶ For this study, we excluded men because of low response rate and individuals who had achieved weight loss through bariatric surgery because our focus was on health behaviors associated with weight loss. The final sample for this analysis was 1,110 African American women. Analyses were conducted in 2013. All procedures were approved by institutional IRB committees.

Assessment of Weight and Maintenance Status

Weight-related eligibility was determined from respondents' maximum body weight, weight after greatest weight loss, weight at time of survey, and number of months/years between greatest weight loss and weight at time of survey. Body mass index (kg/m²), calculated from height and weight, was determined before and after weight loss; current BMIs were calculated. In addition, we calculated percent of initial weight loss maintained by the time of the survey, calculated as $([\text{starting weight} - \text{lowest weight}] - [\text{starting weight} - \text{current weight}]) / [\text{starting weight} - \text{lowest weight}] \times 100$. Participant weights were self-reported. Although less accurate than objectively measured height and weight, self-reported values are considered acceptable.^{27–31}

Assessment of Physical Activity and Sedentary Behaviors

Survey respondents were asked questions related to physical activity, including those from the Short International Physical Activity Questionnaire (IPAQ).³²⁻³⁴ Responses to the IPAQ were converted into three physical-activity categories; Low, Moderate, and High Physical Activity, based on individual metabolic equivalent (MET) scores and IPAQ guidelines.³⁵ Sedentary behavior was measured with the final question of the Short IPAQ: "During the last 7 days, how much time did you spend sitting on a week day?" Sitting included time spent "sitting at a desk, visiting friends, reading, or sitting or lying down to watch television." Two measures of sedentary behavior representing hours and quartiles of sedentary time were calculated. For an overall assessment of sedentary behavior, the sitting question was converted from minutes and hours to total number of hours of sedentary time on a week day. Hours of sedentary time were also converted into quartiles. Finally, physical activity and sedentary behavior were combined into four categories: high physical activity, low sedentary behavior (reference group); high physical activity, high sedentary behavior; low physical activity, high sedentary behavior; and low physical activity, low sedentary behavior. Respondents in the highest tertile (ie, highest third) for sedentary behavior were classified as high sedentary, and those in the high-physical-activity category on the IPAQ were classified as having high physical activity. Low sedentary behavior resulted in categorization as being in one of the lower two tertiles of sedentary time, and low physical activity included those in the moderate- and low-physical-activity categories. This analytic strategy is similar to previous research that categorized women into tertiles based on sitting time.¹⁴

Covariates

Several covariates were included in our analysis: education (<high school,

high-school degree, and \geq college), marital status, age, number of children, employment status, typical means of travel (walking, biking, or taking public transit vs driving), and a health-conditions index that was a sum of seven possible diagnosed health conditions (arthritis, depression, high blood pressure, high cholesterol, heart disease, diabetes, and stroke).

Statistical Analysis

Ordinary least-squares (OLS) regression models were used to predict current BMI and % of weight maintained after initial loss, to test hypotheses 1 and 2. The models predicting current BMI controlled for BMI at the start of the weight-loss period; sets of covariates were introduced sequentially, to assess whether any observed influence of sedentary behavior on our outcomes was explained by sociodemographic characteristics or levels of physical activity. For the current BMI analysis, Model 1a controlled only for BMI at the start of the weight-loss period and hours of sedentary time. Model 2a added socio-demographic measures, typical means of travel, the health-conditions index, and physical-activity categories based on the IPAQ (low, moderate, and high physical activity). To assess hypothesis 2, we used the same OLS regression models to predict the % of weight loss maintained, except that BMI was not controlled at the start of weight loss. Model 1b included only hours of sedentary time, and Model 2b added the additional control measures and physical-activity measures. Models 3a and 3b tested hypothesis 3, which investigated whether physical activity and sedentary behavior worked together to influence both current BMI and % of weight maintained, by combining physical activity and sedentary behavior into categories, as previously described.

RESULTS

Descriptive Data

Table 1 presents descriptive statistics for the total sample, as well as the total

disaggregated into weight-status categories (healthy weight, overweight, and obese). Each mean value or proportion was tested for its significant difference from those in the healthy-weight category. Although some women were successful with weight-loss maintenance, on average, the sample gained back all weight lost plus about 2%. The average amount of sedentary time on weekdays was 8.03 hours. Overweight and obese respondents differed significantly from healthy weight respondents on several measures (they were older, had more biological children, and reported more chronic health conditions). Obese women reported significantly less physical activity and were sedentary nearly 1 additional hour per day compared with women who were not overweight or obese.

Table 2 presents the results of OLS regressions predicting current BMI (Models 1a-3a) and % of weight loss maintained at the time of the survey (Models 1b-3b). In support of Hypothesis 1, Model 1a showed that each additional daily hour of sedentary time was associated with a .19 ($P<.001$) increase in expected current BMI. After accounting for covariates and physical activity in Model 2a, the association was reduced to .10, but remained significant ($P=.03$) such that each additional daily hour of sedentary time was associated with an increase in expected current BMI. In support of hypothesis 2, Model 1b showed that each additional hour of sedentary time was associated with poorer weight-loss maintenance; although, this result was reduced to marginal significance ($P=.08$) after controlling for physical activity.

To test hypothesis 3, Models 3a and 3b combined physical activity and sedentary time into four categories and tested how both classifications combined (2×2 design) influenced current BMI (3a) and % of weight loss maintained (3b). Starting with current BMI, we found those in the high-physical activity/high sedentary category had a current

Table 1. African American weight control registry female sample characteristics

	Current Weight Status					
	Total Sample	Normal Weight	Overweight	<i>P</i> ^a	Obese	<i>P</i> ^b
	Mean (SD)	Mean (SD)	Mean (SD)		Mean (SD)	
BMI before initial weight loss	33.63 (7.44)	26.71 (5.22)	30.02 (4.71)	<.001	36.63 (7.06)	<.001
Current BMI	33.12 (7.80)	23.04 (1.61)	27.44 (1.38)	<.001	37.66 (6.40)	<.001
% of weight loss maintained	-1.70 (95.99)	52.13 (80.42)	33.23 (73.32)	.01	-29.31 (97.31)	<.001
Sedentary time, hours/weekday	8.03 (4.13)	7.55 (3.91)	7.09 (3.45)	.24	8.53 (4.35)	.01
Education						
≥High school	.07	.05	.07	.36	.08	.14
College graduate	.69	.64	.65	.88	.72	.05
Graduate degree	.24	.31	.29	.53	.21	.002
Marital status						
Married	.36	.37	.40	.61	.34	.50
Single	.43	.48	.41	.14	.42	.17
Divorced/widowed	.21	.15	.19	.20	.23	.01
Age, in years	41.17 (10.81)	38.04 (10.83)	41.14 (11.21)	.004	41.98 (10.50)	<.001
N of biological children	1.11 (.96)	.90 (.96)	1.11 (.93)	.02	1.17 (.96)	.001
Employed	.79	.77	.78	.79	.81	.25
Walks, bikes, or rides public transportation	.17	.22	.15	.06	.16	.06
N of chronic health conditions	.75 (1.07)	.36 (.85)	.60 (.93)	.01	.90 (1.14)	<.001
MET score categories						
Low physical activity	.40	.33	.29	.35	.47	.001
Moderate physical activity	.22	.15	.24	.01	.22	.03
High physical activity	.38	.52	.47	.24	.31	<.001
Physical activity/sedentary categories						
High PA, high sedentary	.08	.12	.10	.55	.07	.02
High PA, low sedentary	.31	.42	.40	.75	.25	<.001
Low PA, high sedentary	.26	.19	.17	.49	.32	.002
Low PA, low sedentary	.34	.26	.33	.19	.36	.03
<i>n</i>	1110	172	266		672	

BMI, body mass index; MET, metabolic equivalent; PA, physical activity.

^a χ^2 *P* (or *t* test values for continuous measures) showing significant differences between normal weight and overweight respondents.

^b χ^2 *P* (or *t* test values for continuous measures) showing significant differences between normal weight and obese respondents.

BMI 1.65 units greater ($P=.02$) than those with high physical activity/low sedentary behavior. Those in the low-physical activity categories, regardless of sedentary behavior, had BMIs approximately 2.90 units ($P<.001$) greater than the high-physical activity/low-sedentary behavior respondents. Additional tests (not shown) revealed that the two low-physical activity categories were not significantly different from one another indicating that sedentary behavior levels were not differentially associated with BMI for women with low levels of physical activity. Our third hypothesis that the impact of sedentary behavior on current BMI would vary by physical-activity level, was confirmed. Sedentary behavior had an independent effect on

BMI for those with high levels, but not for those with low levels, of physical activity.

In Model 3b, sedentary behavior and physical activity interact to influence % of weight loss maintained. Compared with the most-active, least-sedentary respondents, those with high physical activity and high sedentary time had a weight-loss maintenance 33% ($P=.006$) lower (ie, they regained more weight) than the comparison group. Those with low physical activity and high sedentary time and those with low physical activity and low sedentary time had a weight-loss maintenance that was, respectively, 42% and 39% lower (ie, they regained more weight) than the most-active respondents ($P<.001$). Ad-

ditional tests (not shown) revealed that the two low-physical activity categories were not significantly different from one another in terms of their weight-loss maintenance, indicating that sedentary behavior levels were not differentially associated with BMI for women with low levels of physical activity. Our third hypothesis was confirmed again. Sedentary behavior had an independent effect on % of weight-loss maintained for those with high levels, but not for those with low levels, of physical activity.

DISCUSSION

The three hypotheses of this study were supported by the data. Among

Table 2. Results of OLS regressions for current BMI and percent of weight loss maintained

	Current BMI																	
	Model 1a			Model 2a			Model 3a			Model 1b			Model 2b			Model 3b		
	b (SE)	P		b (SE)	P		b (SE)	P		b (SE)	P		b (SE)	P		b (SE)	P	
BMI before initial weight loss	.72 (.02)	<.001		.69 (.02)	<.001		.70 (.02)	<.001		-2.53 (.74)	.001		-1.47 (.83)	.08				
Sedentary time, hours/weekday	.19 (.04)	<.001		.10 (.05)	.03													
College degree, ref																		
≥High school				-1.24 (.76)	.10		-1.22 (.76)	.11					3.77 (13.35)	.78		2.98 (13.32)	.82	
Graduate degree				-.67 (.43)	.12		-.76 (.43)	.08					8.43 (7.58)	.27		9.53 (7.56)	.21	
Married, ref																		
Single				.18 (.46)	.70		.29 (.46)	.53								-8.18 (8.08)	.31	
Divorced/widowed				-.49 (.51)	.34		-.47 (.51)	.36								5.34 (8.97)	.55	
Age, in years				.00 (.02)	.98		.00 (.02)	.95								-.25 (.38)	.45	
N of children				-.08 (.23)	.72		-.10 (.23)	.65								1.97 (4.01)	.62	
Employed				-.42 (.49)	.39		-.38 (.49)	.43								6.87 (8.58)	.42	
Walks/bikes/uses public transit				-.57 (.50)	.25		-.58 (.49)	.24								14.36 (8.83)	.10	
Chronic conditions				.83 (.19)	<.001		.83 (.19)	<.001								-7.46 (3.37)	.03	
Low physical activity, ref																		
Moderate physical activity				-.48 (.49)	.32											5.39 (8.67)	.53	
High physical activity				-2.51 (.43)	<.001											32.28 (7.63)	<.001	
High PA, low sedentary, ref																		
High PA, high sedentary																1.65 (.70)	.02	
Low PA, high sedentary																2.91 (.48)	<.001	
Low PA, low sedentary																2.87 (.45)	<.001	
Constant	7.43 (.87)	<.001		10.26 (1.39)	<.001		7.86 (1.30)	<.001		18.08 (6.70)	.01		-.06 (20.53)	.99		31.23 (18.31)	.09	

OLS, Ordinary least squares; SE, Standard error; BMI, body mass index; ref, reference; PA, physical activity.

Among African American women who had achieved clinically significant weight loss, sedentary behavior was positively associated with current BMI and negatively associated with weight-loss maintenance...

African American women who had achieved clinically significant weight loss, sedentary behavior was positively associated with current BMI and negatively associated with weight-loss maintenance; however, this effect was greatest among individuals with low levels of physical activity, irrespective of sedentary behavior patterns, and among those who were physically active with high levels of sedentary behavior.

Our study contributes to the literature by investigating sedentary behaviors in a sample of African American women. Most studies focusing on sedentary behavior, BMI, weight loss, maintenance of weight loss, and weight regain had minimal or no inclusion of African American women.¹⁴⁻²⁰ Only one study had an analysis of African American women.²² The sample in the study by Buchowski et al²² included Black and White women with little-education, and >50% had annual household incomes <\$15,000. Both studies found that time spent in sedentary behavior was positively associated with obesity even among women with the highest levels of physical activity. Our study was unique in that we also analyzed weight loss maintenance and regain. The Buchowski et al²² study was unique in that Black and White women were compared; associations between sedentary behavior and BMI were greater for White than Black women.

Possible explanations for this finding included differential reporting of sedentary behaviors and racial differences in BMI as a marker of body composition and body-fat distribution.²² This finding further confirms the importance of including women of diverse socio-demographic and racial/ethnic characteristics in research.

In a cross-sectional study²¹ among members of a low-income, predominantly African American community with men and women, time spent sitting was independently and significantly associated with BMI. Even though their results²¹ are similar to our study's findings, the two studies had different methodological approaches and population characteristics. Our study included only women, who were highly educated, in contrast to the study by Shuval et al,²¹ which included men and women from predominantly low-income communities. Also, in our study, sedentary time was limited to time spent sitting on a week day, in contrast to the study by Shuval et al,²¹ which included sitting time, computer time, and transit time. Even with these differences, both studies found similar associations between sedentary time and BMI for African Americans. There was no sex specific analysis in the previous study²¹ to compare results of African American women with our findings.

Our study demonstrated the detrimental influence of sedentary behavior on weight-loss maintenance among African American women. Sedentary behavior independently predicted degree of weight-loss maintenance among the physically active but not among those with low physical activity. Perhaps those with low physical activity levels are in a condition such that other factors have marginal and minimal effects. In contrast, those who are physically active have a healthier state and other factors can positively and negatively influence their condition and health.

Several studies have shown that physical activity is important for

weight-loss maintenance and prevention of weight regain^{29,36-37} in addition, we found that sedentary behavior may be an important contributing factor to poorer weight-loss maintenance, independent of physical activity. Our findings suggest that high levels of sedentary behavior may contribute to poorer weight-loss maintenance.

Our study has limitations. Participants were volunteers, so there is a self-selection bias. Further research needs to assess the extent to which our results are generalizable to men and other populations. Analyses were cross sectional, therefore, prospective, longitudinal, and intervention studies are needed to assess the direction of causality. From our study, we cannot determine whether sedentary behavior precedes weight gain and greater BMI or vice versa. The psychometric properties of the IPAQ have been documented,³²⁻³⁴ however, the reliability and validity of IPAQ questions related to sitting time have not been consistently documented among African Americans.³⁸ An alternative approach to assess sedentary time is electronic devices, such as accelerometers. Objective measures are considered less subject to bias, with reduced potential for measurement error. Also, we do not know the effects of sedentary behavior on the weekend. Our study assessed sedentary behavior during the week day only.

Self report data are subject to recall and social desirability biases. Body weight tends to be under-reported whereas height is over-reported.³⁹⁻⁴¹ A study investigating the prevalence of weight maintenance/gain is different from a study with a one-time assessment of overweight and obesity. As noted in an earlier study,¹⁴ a reasonable expectation is that any self-report bias of body weight should be consistent over different time periods. Given this consistency, the accuracy of categorizing weight maintainers/gainers should not be seriously compromised.

Our study has several strengths. As noted by previous authors, there is a

compelling case to expand research to include a diversity of sociodemographic characteristics to strengthen claims of external validity.^{22,42} Participants in our study were highly educated African American women; no published study was identified with a sample of similar sociodemographic characteristics. Another strength is that potential confounders (ie, covariates) were adjusted for in the statistical models. Furthermore, previous studies analyzed associations between BMI or obesity and sedentary behavior,^{15,17,21,22} not weight-loss maintenance. In addition to the association between BMI and sedentary behavior, we analyzed the relationship between sedentary behavior and weight-loss maintenance, a unique contribution to the literature.

Several studies have concluded that physical activity and sedentary behavior are separate components of lifestyle and to prevent weight gain reducing sedentary behavior and increasing physical activity are needed. Previous studies found that sedentary behavior is detrimentally associated with weight regain.^{14,16,18,20} Our findings are unique by showing that the effects of sedentary behavior may differ by physical activity status. For those with both high levels of physical activity and sedentary behavior had poorer weight-loss maintenance compared to those with high levels of physical activity and low levels of sedentary behavior. Those with low levels of physical activity had poor weight-loss maintenance irrespective of low- or high-levels of sedentary behavior.

The average amount of sedentary time in our study was 8.03 hours per day which is similar to the 7.5–8.0 hours per day for middle-aged women reported in a national study.⁹ Nevertheless, even the high-physical activity/low-sedentary behavior group (ie, five mean hours of daily sedentary time) could benefit from reducing sedentary behavior. These findings have clinical implications and are consistent with the recommendations from a recent epidemiological

review that clinical practice guidelines include advice for patients to reduce sedentary behavior.⁷

ACKNOWLEDGMENTS

Implementation of this study was funded by an NIDDK Career Development award to A. S. Barnes (K08 DK064898). Data analysis was supported by the Health Economics Program at the James A. Baker III Institute for Public Policy at Rice University. The study sponsor had no role in study design; collection, analysis, and interpretation of data; writing the report; and the decision to submit the report for publication.

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