

## Obesity and recent mammography use among black and white women in the Southern Community Cohort Study (United States)

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### Abstract

**Objective** To examine the relationship between obesity and mammography use in a large population of black and white women.

**Methods** Baseline data from 18,756 black and 6,304 white women enrolled in the Southern Community Cohort Study were used to examine the association between body mass index categories (healthy weight: 18.5–24.9 kg/m<sup>2</sup>, overweight: 25–29.9 kg/m<sup>2</sup>, and obesity classes I: 30–34.9 kg/m<sup>2</sup>, II: 35–39.9 kg/m<sup>2</sup>, and III: 40+ kg/m<sup>2</sup>) and mammogram use in the past two years. Cross-sectional analyses were conducted using logistic regression controlling for socioeconomic measures, medical conditions, insurance coverage, and lifestyle factors.

**Results** Among white women, obesity class III was associated with a reduced likelihood of recent mammography compared to healthy weight women (OR = 0.70, 95% CI 0.56–0.87) that appeared unrelated to income and insurance coverage. A deterring effect of obesity was not evident among black women; instead, overweight and

obesity were associated with small elevations in mammography use compared to healthy weight.

**Conclusions** In light of rising obesity rates and known associations between obesity and breast cancer risk and prognosis, a deterring effect of extreme obesity on mammography screening for white women is a concern that should be addressed by screening programs and by further directed research into the factors underlying this association.

**Keywords** Mammogram · Obesity · Body mass index · Race · Epidemiology

### Introduction

Breast cancer accounts for nearly one in three female cancer diagnoses in the United States, and approximately 213,000 new cases of invasive breast cancer are expected in 2006 [1]. Screening mammography has been shown to be effective in reducing breast cancer mortality [2] and, despite recent controversy [3], the United States Preventive Services Task Force and other health organizations currently recommend screening at intervals of 1–2 years for all women over the age of 40 who are at average risk for breast cancer [4].

Obese women are reported to be less likely than non-obese women to receive screening mammography [5–8]. The reasons for this discrepancy are not well-understood, but factors such as physician bias, negative self-perception and poor body image, and higher illness burden among obese women have all been suggested [6, 7]. There is strong variation in the prevalence of obesity by race in the United States. According to the 1999–2002 National Health and Nutrition Examination Survey (NHANES), 30% of white women versus 50% of black women were classified as

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obese [9]. Further, recent results from the National Health Interview Survey (NHIS) suggest that obese white women are less likely to receive screening mammography but that this pattern does not hold for black women; however, these analyses included relatively small numbers of black women compared to white women [6, 7]. Therefore, in order to improve screening behavior rates among obese women, we must first understand the interaction between race and obesity in relation to mammography use.

The goal of the current analysis was to examine the association between body size and mammography use, and to evaluate the potentially modifying effect of race on this relationship, among women enrolled in the Southern Community Cohort Study which includes a large sample of both black and white women of generally similar socioeconomic status in the age range appropriate for mammography screening.

## Materials and methods

### Study population

The SCCS is a prospective epidemiologic cohort study with ongoing participant enrollment across the southeastern U.S., the aim of which is to investigate racial disparities in cancer occurrence [10]. The study was approved by the institutional review boards at Vanderbilt University and Meharry Medical College. To date, participants have been enrolled in-person at 48 community health centers (CHCs) in urban and rural areas across the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. CHCs are government-funded health care facilities that provide basic health services primarily to low-income individuals [11]. They typically do not provide mammography services. Participants were enrolled by randomly approaching people entering the CHCs (patients, persons accompanying patients, etc.) who appeared to be age 40–79 and screening them for eligibility and interest in study participation. In addition to the age criteria, participants were required to be English-speaking and not to have undergone treatment for cancer within the past year. For the present cross-sectional analysis of baseline data, we identified all female cohort members enrolled since the beginning of the study (March 2002) through June 2006 ( $n = 30,760$ ).

### Data collection

Trained interviewers conducted comprehensive, in-person, baseline interviews with all participants that covered various aspects of health and behavior, including body size,

personal and family medical history, reproductive history, diet, physical activity, tobacco use, health care utilization, and demographic characteristics. This interview was conducted at the CHC at the time of study enrollment. During the interview, participants were asked: “Have you ever had a mammogram?” Participants responding “yes” were also asked “When was your last mammogram?” A standard definition of the term mammogram was provided when necessary. From these data we determined whether women had a mammogram within the past two years (i.e.,  $\leq 2$  years ago), in line with standard screening mammography recommendations [4] and consistent with the metric used by previous studies examining obesity and recent mammogram use [5–8].

Current weight and height were self-reported by participants. We calculated current body mass index (BMI) as weight in kilograms divided by the square of height in meters. We categorized BMI using nationally defined cutpoints [12]. Women with a BMI between 18.5 and 24.9 kg/m<sup>2</sup> (considered healthy weight) were used as the referent group in our analyses. Overweight and obesity were defined as overweight (BMI 25.0–29.9 kg/m<sup>2</sup>), obesity class I (BMI 30.0–34.9 kg/m<sup>2</sup>), obesity class II (BMI 35.0–39.9 kg/m<sup>2</sup>) and obesity class III or extreme obesity (BMI  $\geq 40$  kg/m<sup>2</sup>) [12].

### Statistical analysis

We excluded from the study population 1,278 (4.2%) women who identified their racial/ethnic background as something other than only Black/African-American or only Caucasian/White, 515 (1.7%) women who reported a prior diagnosis of breast cancer, 3,100 (10.1%) women who were less than 42 years of age because our metric of having a mammogram within the past two years would put them outside of the bottom age range (40 years) for mammography screening recommendations [4], 329 (1.1%) women whose BMI was less than 18.5 kg/m<sup>2</sup>, and 478 (1.6%) women who were missing information about mammography use, height or weight, leaving a total of 25,060 participants (18,756 black, 6,304 white) to serve as our study population.

Logistic regression was used to measure the association (presented as odds ratios (OR) with 95% confidence intervals (95% CI)) between the categories of BMI and mammography use within the past two years (yes/no) [13]. Race was considered to be a potential effect modifier. The likelihood ratio test (LRT) was used to compare models with all women (black and white) with and without an interaction term between race and BMI category. Based on the LRT  $p$ -value (with a cut-off set a priori as  $<0.10$ ), the data for black and white women were analyzed separately.

Several factors reported in the baseline interview were considered a priori to be possible confounders of the relation between BMI and mammography use, including age, measures of socioeconomic status and access to health care (i.e., income, education, health insurance coverage), parity, cigarette smoking status, a history of obesity-related conditions that could lead to more frequent contact with the health care system (i.e., diabetes, hypertension, high cholesterol, heartburn/acid reflux, heart disease, and arthritis), time since last physician visit (as a proxy of the frequency of contact with health care providers), and family history of breast cancer. These formed the core group of adjustment factors and were included in the regression models using the categories shown in Table 1. Other variables evaluated as potential confounders (using a >10% change-in-estimate criterion) but found not to make an appreciable change in the results were marital status, the number of breast self-examinations performed within the past year, geographic population density (determined from the 2000 U.S. Census for the census tract of the CHC where the participant was enrolled) as a possible surrogate for access or proximity to facilities offering mammography, and depressive symptom score (based on the short version of the Center for Epidemiologic Studies Depression Scale) [14]. None of these variables were included in the models presented here.

## Results

White women were slightly more likely than black women to have reported ever having had a mammogram (87.4 vs. 85.0%), whereas black women were slightly more likely than white women to report having had a mammogram within the past two years (73.0 vs. 68.7%). Despite the slightly older age distribution of the white women (Table 1), both of these racial differences in mammography use remained statistically significant after age adjustment (data not shown). Due to the study design involving participant enrollment at CHCs, the majority (61%) of the study population had a total household income of less than \$15,000 per year, a substantial proportion (40%) reported having no health insurance, and 32% had less than a high school education. The distributions of these sociodemographic indicators were similar by race. Obesity (BMI  $\geq 30$  kg/m<sup>2</sup>) was more prevalent among the black women (58%) than the white women (49%).

Table 1 also shows the percentage of women receiving a mammogram in the past two years for each stratum of the a priori set of confounders. As expected, the percentage of women who underwent mammography within the past two years generally increased with increasing age and household income, and was positively related to having a college education. Women without any health insurance were less

likely to have had a recent mammogram compared to women with some form of coverage (62 vs. 78%), and current smokers were less likely to report a recent mammogram (62%) than former and never smokers (77%). Black and white women with a history of chronic medical conditions (i.e., diabetes, hypertension, high cholesterol, heartburn/acid reflux, heart disease, and arthritis) were, overall, more likely to report having a recent mammogram than women without these conditions.

For both black and white women, the crude percentage of women reporting a mammogram within the past two years increased with increasing BMI up to 35 kg/m<sup>2</sup> and then leveled off and decreased (Table 1), but the relationship between BMI and mammography use significantly differed by race (LRT  $p < 0.0001$ ). In particular, the increase in mammography use associated with rising BMI was more pronounced among black women, and for white women the drop off in mammography use associated with a BMI  $\geq 40$  kg/m<sup>2</sup> was more pronounced. After multivariate adjustment, black women at every level of overweight and obesity were more likely to have had a mammogram in the past two years than black women of healthy weight (Table 2 and Fig. 1a). Among white women, multivariate adjustment eliminated the crude positive association between BMI and mammography use, and there was a marked decrease in the likelihood of having had a mammogram within the past two years among women with a BMI  $\geq 40$  kg/m<sup>2</sup> [OR = 0.70, 95% CI 0.56–0.87] (Table 2 and Fig. 1b). The changes in the BMI estimates in Table 2 between the crude and adjusted-ORs were driven largely by personal health and health-care related confounders including smoking status, time since last physician visit, co-morbidities, and type of health insurance. For comparison purposes, in Fig. 1a and b, adjusted ORs from the present analysis are plotted alongside those from previous studies that examined the relationship between BMI and mammography use in the past two years separately for black and white women [6, 7, 15]. Since the relationship between obesity and breast cancer differs between pre and post-menopausal women, we repeated the analyses in Table 2 separately for pre- and post-menopausal women with similar results in both groups (data not shown).

We noted an inverse relationship between socioeconomic status and obesity among white women in this study population, where the proportion who were obese in each income level was as follows: <\$15,000: 51%, \$15,000–24,999: 54%, \$25,000–49,999: 46%,  $\geq$ \$50,000: 36%. There was substantially less association between obesity and income among the black women (<\$15,000: 58%, \$15,000–24,999: 60%, \$25,000–49,999: 59%,  $\geq$ \$50,000: 53%). To evaluate whether the reduced likelihood of mammography use among extremely obese white women was a result of residual confounding by income, we ran income-specific regression

**Table 1** Use of mammography within the past two years in relation to body mass index (BMI) and to potential confounders of the relationship between BMI and mammography use

	Black ( <i>n</i> = 18,756)		White ( <i>n</i> = 6,304)	
	<i>n</i>	% reporting a mammogram within the past two years	<i>n</i>	% reporting a mammogram within the past two years
<b>BMI (kg/m<sup>2</sup>)</b>				
18.5–24.9	2,956	64.5	1,489	67.0
25–29.9	4,843	72.1	1,704	68.5
30–34.9	4,790	76.3	1,422	71.5
35–39.9	3,152	76.2	866	70.7
40+	3,015	74.4	823	65.4
<b>Age at interview (years)</b>				
42–44	3,142	59.3	837	55.4
45–49	5,007	67.3	1,471	61.7
50–54	4,099	74.6	1,245	70.0
55–59	2,661	81.3	1,092	71.9
60–65	1,756	84.3	823	78.4
65–69	1,061	85.5	438	82.4
70+	1,030	83.3	398	74.9
<b>Education</b>				
<9 years	1,558	73.9	610	68.0
9–11 years	4,539	70.2	1,280	64.5
High school <sup>a</sup>	7,327	72.6	2,547	68.8
Some college or junior college	3,628	74.0	1,201	68.1
College graduate and beyond	1,698	79.5	664	78.2
Missing	6		2	
<b>Household income</b>				
<\$15,000	11,470	70.0	3,676	64.6
\$15,000–24,999	4,379	75.3	1,258	69.0
\$25,000–49,999	2,070	81.0	791	75.9
\$50,000+	614	85.8	507	85.8
Missing	223		72	
<b>Health insurance</b>				
No health insurance	7,267	64.1	2,666	56.9
Medicaid only	3,156	71.7	744	68.6
Medicare only	1,903	82.1	709	75.6
Any private	4,324	80.4	1,489	81.9
Other (includes military)	2,082	82.4	689	79.1
Missing	24		7	
<b>Number of live births</b>				
0	1,687	72.7	704	71.9
1	2,505	73.4	983	71.3
2	4,039	73.4	1,876	68.8
3	3,920	72.5	1,359	66.7
4	2,666	72.9	717	67.0
5+	3,936	73.1	664	67.6
Missing	3		1	

**Table 1** continued

	Black ( <i>n</i> = 18,756)		White ( <i>n</i> = 6,304)	
	<i>n</i>	% reporting a mammogram within the past two years	<i>n</i>	% reporting a mammogram within the past two years
Smoking status				
Current smoker	6,057	63.2	2,371	58.8
Former smoker	3,822	78.7	1,624	74.5
Never smoked	8,859	77.2	2,303	75.0
Missing	18		6	
Diabetes <sup>b</sup>				
Yes	4,940	78.4	1,377	71.6
No	13,811	71.1	4,924	67.9
Missing	5		3	
Hypertension <sup>b</sup>				
Yes	12,413	76.6	3,393	71.6
No	6,337	66.1	2,908	65.3
Missing	6		3	
High Cholesterol <sup>b</sup>				
Yes	6,293	82.1	2,731	75.8
No	12,422	68.5	3,559	63.3
Missing	41		14	
Heartburn or acid reflux <sup>b</sup>				
Yes	5,474	78.8	2,544	73.1
No	13,264	70.6	3,758	65.8
Missing	18		2	
Heart attack or coronary artery bypass surgery <sup>b</sup>				
Yes	1,040	77.5	505	68.7
No	17,702	72.8	5,796	68.7
Missing	14		3	
Arthritis <sup>b</sup>				
Yes	7,974	78.4	3,165	71.7
No	10,766	69.1	3,135	65.7
Missing	16		4	
Months since last physician visit <sup>c</sup>				
<1	5,498	75.9	1,972	70.2
1–3	8,711	77.5	2,882	72.9
4–6	1,663	73.7	585	69.9
7–12	1,848	62.9	518	58.9
13–24	463	48.4	157	56.1
>24	460	25.7	170	22.4
Missing	113		20	
Family history of breast cancer <sup>d</sup>				
Yes	1,699	77.9	722	74.5
No	17,057	66.0	5,582	68.0

<sup>a</sup> Includes those with a GED and those who attended vocational school

<sup>b</sup> “Has a doctor ever told you that you have had...”

<sup>c</sup> Visit to a doctor or other medical person

<sup>d</sup> Family history includes birth mother and any full sisters

**Table 2** Crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) describing the association between body mass index (BMI) and mammography use within past two years among female Southern Community Cohort Study participants

	Black				White			
	Crude		Adjusted <sup>a</sup>		Crude		Adjusted <sup>a</sup>	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
BMI (kg/m <sup>2</sup> )								
18.5–24.9	Ref				Ref			
25–29.9	1.44	1.30–1.59	1.12	1.00–1.25	1.07	0.92–1.24	0.89	0.76–1.05
30–34.9	1.77	1.60–1.96	1.25	1.12–1.40	1.22	1.04–1.43	0.99	0.83–1.18
35–39.9	1.78	1.59–1.99	1.22	1.07–1.38	1.20	1.00–1.44	0.96	0.78–1.18
40+	1.60	1.43–1.80	1.06	0.93–1.21	0.92	0.77–1.10	0.70	0.56–0.87

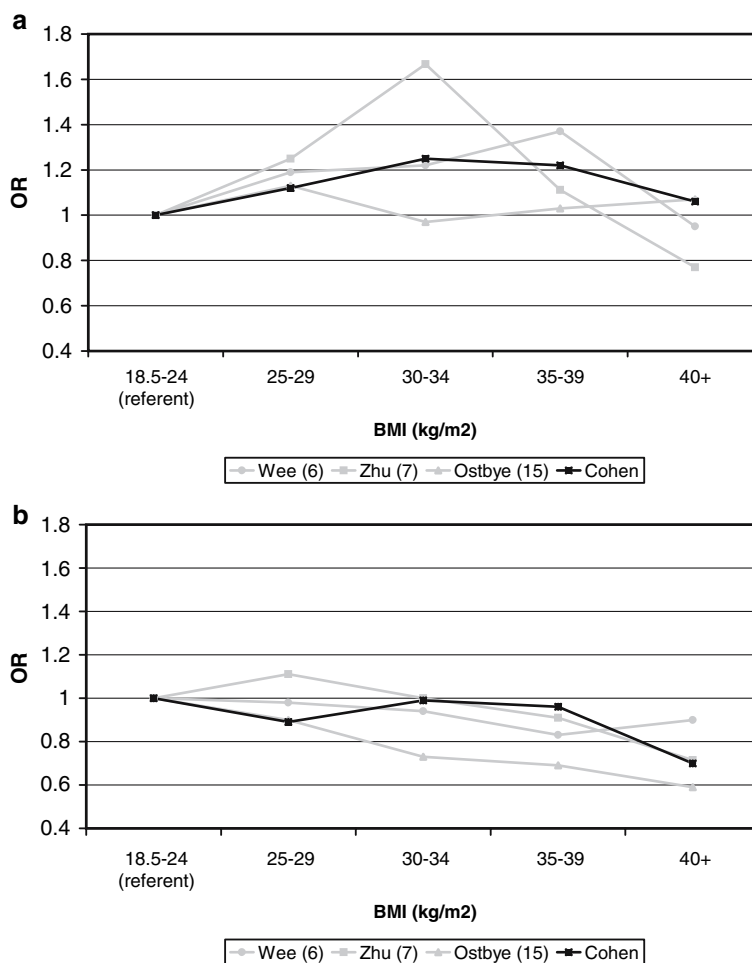
<sup>a</sup> Adjusted for education, income, age, type of health insurance, number of live births, smoking status, family history of breast cancer (Y/N), diabetes (Y/N), hypertension (Y/N), high cholesterol (Y/N), heartburn/acid reflux (Y/N), heart attack or coronary artery bypass surgery (Y/N), arthritis (Y/N), and time since last physician visit using the categories shown in Table 1

models for white women, and the decrease in mammography use was apparent for women with a BMI  $\geq 40$  kg/m<sup>2</sup> at each of the four income levels [For income <\$15,000: OR = 0.78, 95% CI 0.60–1.03; Income \$15,000–24,999: OR = 0.76, 95% CI 0.47–1.22; Income \$25,000–49,999: OR = 0.41, 95% CI 0.21–0.79; and Income  $\geq$ \$50,000: OR = 0.48, 95% CI 0.14–1.69]. Similarly, we observed decreased mam-

mography use among extremely obese white women in a regression model restricted to women with no health insurance coverage [OR = 0.74, 95% CI 0.55–1.00] as well as in a model restricted to women with private health insurance [OR = 0.38, 95% CI 0.22–0.65].

We conducted additional analyses to examine whether co-morbid conditions influenced the association between

**Fig. 1 a and b.** Adjusted odds ratios for the current analysis and recent publications [6, 7, 15] that examined the relationship between body mass index (BMI) and recent mammography use within the past two years separately for black (Fig. 1a) and white (Fig. 1b) women. Odds ratios calculated by the authors from data provided by Zhu et al. [7]





mammography use and obesity. In an analysis restricted to black women who reported never being diagnosed with any of the six obesity-related conditions we included in our analysis (diabetes, high blood pressure, high cholesterol, heartburn/acid reflux, heart disease, and arthritis), we found that above-healthy weight (BMI  $\geq 25$  kg/m<sup>2</sup>) black women were slightly more likely to have had a mammogram within the past two years [OR = 1.14, 95% CI 0.96–1.37] compared to healthy weight black women. Among white women without any of these six conditions, being above-healthy weight was associated with decreased recent mammography use (OR = 0.62, 95% CI 0.46–0.84).

## Discussion

In this large study population of black and white women of screening age, the most extreme level of obesity (BMI  $\geq 40$  kg/m<sup>2</sup>) was found to be inversely related to recent mammography use among white women, while black women at nearly all levels of overweight and obesity were more likely to have had a recent mammogram than black women of healthy weight. The associations remained even after adjustment for socioeconomic factors, health insurance coverage, and co-morbidities that could affect health care utilization.

These results generally correspond with the few previous examinations of obesity and mammography use that have been conducted separately for black and white women [6, 7, 15]. The previous studies found that extremely obese white women were 10–40% less likely than healthy weight white women to have had a mammogram in the past two years [6, 7, 15], but unlike our study, some also found a deficit in mammography screening at obesity levels less than 40 kg/m<sup>2</sup> [6, 15]. Among black women, the findings have been less consistent. Ostbye et al. [15] did not find any association between body mass index and recent mammography use among black women, while Wee et al. [6] and Zhu et al. [7] both found recent mammography use somewhat more likely among women in the overweight through moderate obesity categories and slightly less likely at the most extreme level of obesity. Previous findings for black women suffered from a lack of precision due to the relatively small number of black women included in these analyses.

If causal, a deterring effect of extreme obesity on mammography screening for white women is of concern because of the overall rising prevalence of obesity in the U.S. [9] and the link between obesity and breast cancer. Studies of primarily white women have shown that obesity is associated with an increase in post-menopausal breast cancer risk (with relative risks ranging from 1.1 to 2.7) and with poorer prognosis in both pre and post-menopausal

women [16–20]. Thus, if obesity is associated with decreased screening among obese white women, breast cancer mortality could feasibly increase in the future as obesity rates continue to rise.

Physician bias has been postulated as one explanation for lower rates of screening observed among obese women [5–8, 15]. However, in our study, participants who had gone five years without a mammogram or who had never had one were asked to choose among several reasons why they had not received a mammogram recently, and the proportion who answered ‘Not recommended by my doctor’ was similar among obese and non-obese black (25 and 26%, respectively) and white women (20 and 21%, respectively).

Negative body self-perception among extremely obese women is another possible explanation for decreased mammography screening in this group. The seemingly different trend for black women where extreme obesity does not translate into less frequent mammogram use compared to healthy weight black women is consistent with research that suggests that black women report having less body dissatisfaction, preferring a larger body size, and defining a larger ideal body size [21, 22]. While not a direct assessment of body self-perception related to weight, in our study, the proportion of white women reporting ‘Embarrassment’ as a reason they hadn’t received a recent mammogram increased with increasing BMI. In the healthy weight category, 1.3% of white women reported ‘Embarrassment’ while the proportion increased with BMI (1.6% among overweight women, and 1.8, 3.3, and 4.8% in obesity classes I, II, and III, respectively). In contrast, the proportion of women reporting ‘Embarrassment’ was similar across BMI categories among the black women (0.5% among healthy weight women, 0.9% among overweight women, and 0.8, 0.8, and 1.0% in obesity classes I, II, and III, respectively). However, these findings should be interpreted with caution because they are based on very small numbers. If in fact white women are more self-conscious about having a larger body size than black women, this may explain some of the differences seen in mammography screening behavior among extremely obese women. Our baseline interview did not elicit information specifically focused on self-perception related to weight, and thus we were unable to evaluate the role that markers of self-image may have on screening practices.

The reasons that overweight and obese black women might be more likely to have a mammogram than healthy weight black women are not clear. We had hypothesized that heavier women may have more contact with health care providers related to care for chronic obesity-related conditions. However, this same reasoning would be expected to hold for white women, yet we observed no increase in mammography use among overweight and obese white women. It is possible that the modest positive

association between BMI and mammography use is due to residual confounding by unmeasured or incompletely measured factors related to co-morbidities or health care utilization.

Despite the low-income status of the study population, the rate of mammogram use within the past two years (72% for our study population overall) is comparable to that seen in the general population. According to the 2004 Behavioral Risk Factor Surveillance System (BRFSS), the median percentage of women aged 40 and over nationwide reporting mammography within the past two years is 75% [23]. This may be an encouraging indication that screening guidelines are being met with moderate success in an underserved population [24]. However, it may be that CHC attendees who chose to participate in the SCCS were selectively more health conscious and therefore more likely to participate in cancer screening activities. In addition, CHCs tend to actively refer their patients to mammography services according to an internal survey done among CHC staff. Thus, as with most epidemiologic studies that rely on volunteers, issues related to study participant selection might limit our ability to generalize our findings regarding the prevalence of mammography utilization outside of this study. However, this would not affect the validity of our evaluation of the relationship between BMI and mammography use among black compared with white women within this study. Moreover, to the extent that our results did not differ by income level (and that we had approximately 4,000 women with a total household income above \$25,000 per year to evaluate), our findings may be applicable regardless of income.

Strengths of the study include the population of over 18,000 black women and over 6,000 white women systematically identified and interviewed in a standardized manner. Further strengthening our study are the large numbers of women available at all levels of overweight and obesity; 16% of the black women and 13% of the white women in the current analysis had a BMI  $\geq 40$  kg/m<sup>2</sup>, compared to 5–7% of black and 2–3% of white women in previous studies [6, 7].

Limitations should also be considered. BMI was calculated from self-reported participant height and weight. While the nature of the in-person interview should minimize gross under- or over-reporting of height and weight values, reports in the literature indicate that heavier women are more likely to under-report their weight and over-report their height, leading to underestimates of their true BMI [25]. If BMI was misclassified, the ORs reported may not accurately represent the true effect at various BMI cut-points, and, for example, the decline in mammography use among white women may in fact not be manifest until a BMI greater than the cutoff of 40 kg/m<sup>2</sup>. However, our general classification of BMI in categories of 5 kg/m<sup>2</sup>

should limit the effect of such misclassification, as even moderate misclassification in self-reported BMI could still place an individual within the same BMI category as their true measured BMI. Another potential limitation is that our baseline questionnaire did not ask about the reason for the woman's most recent mammogram. It is likely that a small proportion of the mammograms reported were for diagnostic purposes rather than screening purposes, but this should have a negligible effect on the observed associations because of the small number of mammograms expected to be involved.

In summary, our findings among low-income women are generally supportive of those from previous reports that extremely obese white women are less likely to receive mammograms, and they extend the current knowledge regarding mammography practices among black women with a large sample size across all levels of overweight and obesity. Due to the known associations between obesity and breast cancer and the rising rate of obesity in women of all races, future research directed toward understanding the role of socioeconomic, clinical, and psychological factors related to body size and mammography practice will be of increasing importance.

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