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Race moderates the relationship between obesity and colorectal cancer screening in women

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Abstract

Objective—To determine if the relationship between obesity and usage of colorectal cancer (CRC) screening in women varies when stratifying by race.

Methods—Using nationally representative data from the 2005 National Health Interview Survey, we examined the relationship between obesity and CRC screening for white and African-American women aged 50 and older. Screening usage variables indicated if a woman was up-to-date for any CRC screening test, colonoscopy, or FOBT. We used multivariable logistic regression models that included interaction terms to determine if race moderates the obesity-screening relationship. We also calculated adjusted up-to-date colonoscopy rates using direct standardization to model covariates.

Results—The relationship between obesity and screening differed by race for any CRC screening test ($P = 0.04$ for interaction) and for colonoscopy ($P = 0.01$ for interaction), but not for FOBT. Obese white women had a lower adjusted colonoscopy rate (30.2%, 95% CI 25.9–34.8) than non-obese white women (39.1%, 95% CI 36.1–42.2). Obese African-American women, on the other hand, had

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a higher adjusted colonoscopy rate (41.2%, 95% CI 31.6–51.4) than their non-obese counterparts (35.6%, 95% CI 28.3–43.6). Overall, adjusted colonoscopy rates were lowest among obese white women.

Conclusions—Obesity is associated with lower CRC screening rates in white, but not African-American women.

Keywords

Colorectal neoplasms; Early detection of cancer; Obesity; Women's health; Minority health

Introduction

Among women in the Unites States, colorectal cancer (CRC) accounts for approximately 10% of all cancers diagnosed annually and was responsible for an estimated 25,700 deaths in 2008, making it the third leading cause of cancer mortality [1]. Regular screening for CRC and adenomatous polyps starting at age 50 has the potential to significantly reduce CRC incidence and mortality [2,3]. Despite their proven effectiveness, utilization of CRC screening tests remains sub-optimal, especially when compared with screening for other cancers, like breast or cervical cancer [4-6]. Among women under age 65, over 85% are up-to-date with cervical cancer screening recommendations and over 58% with breast cancer screening [7], but only 47.4% are meeting CRC screening recommendations [8]. Many barriers to CRC screening have been identified, including lack of physician recommendation for screening [9], lack of knowledge about testing options and intervals [10], and embarrassment about the testing procedure [11].

In addition, some research indicates that obesity may be a barrier to CRC screening in women [12-15]. Obesity is a prevalent condition in the United States, particularly among older women; it is estimated that more than 31% of women in the United States over age 60 are obese [16]. There is a wide body of research showing a positive relationship between body mass index (BMI) and both colon cancer incidence and mortality. One study found that morbidly obese women (BMI $\geq$ 40) were 49% more likely to get colon cancer than normal weight women [17]. It is also estimated that obese women (BMI $\geq$ 30) have a 40–85% greater chance of dying from colon cancer than normal weight individuals (BMI<25) [18]. Because obese women are at high risk for colon cancer, failure to screen for CRC in this population could result in substantial morbidity and mortality.

In order to decrease CRC risk among obese women, it is important to understand if their weight is a barrier to receiving a screening that could potentially prevent them from ever getting CRC. Several studies have investigated the relationship between CRC screening and bodyweight, but the results have been mixed [19]. Two studies that used data from the Behavioral Risk Factor Surveillance Survey (BRFSS) showed that as weight increased the likelihood that an individual was adherent to CRC screening recommendations decreased for women, but not for men [12,14]. A medical record review of 22 medical practices found that both obese men and women had significantly lower rates of screening than their non-obese counterparts [15]. Research on the Cancer Prevention II Nutrition Cohort, a predominately white (97%) study population, found that, compared to normal weight women, overweight, obese, and morbidly obese women were all significantly less likely to have had a flexible sigmoidoscopy or colonoscopy [20,21]. However, three other studies have concluded that there was no statistically significant relationship between screening and weight [22-24]. With the exception of Nutrition Cohort Study, the afore-mentioned studies included a similar proportion of African-Americans as is found in the U.S. population (range 9–21%). Despite this none of them stratified by race and gender, which could explain the mixed results. Studies on screening

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usage for other cancer types suggest that stratifying by race and gender may be important. For example, there is reasonable evidence to suggest that obesity is associated with lower breast and cervical cancer screening rates in white women, but not for other races/ethnic groups [25-27]. A similar pattern may also exist for women with regard to CRC screening.

The goal of this study is to determine whether or not race moderates the relationship between CRC screening and obesity in women. We hypothesize that, as was shown for breast and cervical cancer screening, there may be a previously unrecognized interaction between obesity and race that affects CRC screening rates. If this interaction exists, it could explain why previous research examining the relationship between CRC screening and obesity in women has been inconsistent.

Methods

Study sample

This analysis uses nationally representative data from the 2005 National Health Interview Survey (NHIS), which has one of the most comprehensive screening questionnaires of any national survey [28]. NHIS is a multi-purpose health survey conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics and is the principal source of information on the health of the civilian, non-institutionalized, household population of the United States. The survey collects a variety of health-related information including socio-demographic characteristics, basic indicators of health status, health insurance coverage, access to and utilization of health care services, medical conditions and history, and health behaviors.

Detailed information on survey and sampling methods for NHIS can be found elsewhere [28]. Briefly, NHIS uses a multistage sample design and one adult per family is randomly selected for an in-person interview by Census interviewers. In 2005, the interviewed sample included 31,428 persons 18 years of age and older. The final response rate for adults was 69.0% [29], which is comparable to other national surveys. For this analysis, individuals were excluded if they were under age 50, reported a race other than white/Caucasian or black/African-American, or if they had missing information on weight, CRC screening, or any relevant covariates.

Measures

Colorectal cancer screening—The primary dependent variable for this analysis was a dichotomous variable *Any CRC Screening* indicating whether or not a respondent reported being up-to-date with CRC screening. We classified an individual as being up-to-date with CRC screening if he or she reported having a fecal occult blood test (FOBT) within the year prior to the interview, flexible sigmoidoscopy (flex sig) within the past 5 years, or colonoscopy within the past 10 years. In addition to the primary screening variable, we looked separately at whether a respondent reported being up-to-date for each of the following individual screening modalities: colonoscopy, any endoscopy (flex sig or colonoscopy) and FOBT. For example, for the colonoscopy outcome, we only looked at whether or not an individual reported having a colonoscopy in the past 10 years and did not include any other screening modalities.

The screening variables were created based upon responses to the following survey questions about CRC screening test completion (1) "The following questions are about the blood stool or occult blood test, a test to determine whether you have blood in your stool or bowel movement. The blood stool test can be done at home using a kit. You smear a small amount of stool on cards at home and send the cards back to the doctor or lab. Have you EVER HAD a blood stool test, using a HOME test kit?" (2) "Have you EVER HAD a sigmoidoscopy, colonoscopy, or proctoscopy? These are exams in which a health care professional inserts a tube into the rectum to look for signs of cancer or other problems." For participants who answered yes to one or both of these questions, follow-up questions ascertained exactly which test the respondent had and the approximate date of their last test. Data on a particular test was coded as missing if the individual answered "don't know" or refused the question. If data on either endoscopy or FOBT was missing for a respondent, then the data was coded as missing for primary CRC screening variable. Screening data were available for 86% of female respondents aged 50 and older.

Data were only collected for the respondent's most recent endoscopic test (colonoscopy or flexible sigmoidoscopy) and her most recent FOBT. For these tests, respondents were asked if the test was "*part of a routine exam*," "*because of a problem*," or for an "*other reason*." We completed analyses both including and excluding tests that were not reported to be part of a routine examine (i.e., diagnostic vs. screening). Although screening rates across the board were slightly higher when diagnostic tests were included, the trends remained the same. For the results presented in this paper, diagnostic tests are included in the screening rate estimates, since a test administered for diagnostic purposes still "counts" toward whether or not an individual is considered up-to-date with CRC screening guidelines.

Obesity—The primary independent variable for this analysis was the dichotomous variable obesity status (i.e., obese vs. non-obese). We calculated each respondent's BMI as weight in kilograms divided by height in meters squared based on responses to self-reported questions on height and weight. For the dichotomous obesity status variable, we classified individuals as either obese (BMI ≥ 30) or non-obese (BMI 18.5–29.9). Because it was not clear whether the relationship between BMI and CRC screening would exhibit a threshold or graded pattern, we also examined results for trends using a BMI group variable. For the BMI group variable, individuals were classified as underweight (BMI<18.5), normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), obese I (BMI 30.0–34.9), obese II (BMI 35.0–59.9) or obese III (BMI ≥ 40).

Race/ethnicity—The original NHIS race variable included 6 possible categories: White only, Black/African-American, American Indian/Alaskan Native, Asian only, race group not releasable, and multiple races. We converted race to a dichotomous variable, using only the first two racial groups (White and African-American); all other categories were excluded from the analysis. These two racial sub-groups were examined because they have the highest CRC incidence rates of any racial sub-group [30]. We coded ethnicity as a dichotomous variable (Hispanic vs. Non-Hispanic) based on participants' responses to the question "*[Do you] consider [yourself] Hispanic/Latino?*" Since there were no differences in the proportions of Hispanics in each of the race and obesity categories, we did not stratify analyses by ethnicity. Additionally, separate analyses completed excluding Hispanics showed similar trends, thus we retained them in the final analyses.

Other covariates—Several potential demographic, behavioral, and healthcare-related confounders were included in the analyses because previous literature indicated that they might be associated with CRC screening. Sociodemographic variables examined included age, education, and marital status. Due to the high percentage of missing data for personal income (64%), NHIS created an imputed income variable using a variety of sociodemographic indicators [31]. The original imputed income variable had 11 categories, however, for this analysis we collapsed it into 4 categories ($0–$24,999, $25,000–$54,999, $55,000–$74,999, and $75,000 and up). Behavioral variables included smoking status (daily smoker, occasional smoker, former smoker or never a smoker), alcohol usage (never, former drinker, light drinker, or moderate/heavy drinker) and recreational physical activity. Physical activity was expressed as MET (metabolic equivalents) minutes per week. This figure was calculated as (3 METs × moderate/light minutes/week) + (7 METS × vigorous minutes/week). Recreational activity was then categorized as no activity/unable to exercise (0 METS), some activity (1–<675 MET minutes/week) or meets/exceeds the surgeon general's recommendation (≥675 MET minutes/week) [32]. We coded both reported physician recommendation for screening (either FOBT or any endoscopic test) and insurance coverage as dichotomous (yes/no) variables. Number of visits to a health care provider was ascertained using the question "During the past 12 months, how many times have you seen a doctor or other health care professional about your own health at a doctor's office, clinic or some other place? Do not include times that you were hospitalized overnight, visits to hospital emergency rooms, home visits, dental visits or telephone calls." A past-year visits variable was then created using the following categories: 0, 1, 2–3, 4–5, 6 or more. Participants were also asked about co-morbidities: "Have you EVER been told by a doctor or other health professional that you had [condition]?" We used a sum of all yes answers for the following conditions to determine the number of co-morbidities: hypertension, myocardial infarction, coronary heart disease, other heart disease, emphysema, stroke, asthma, any kind of cancer, ulcer, diabetes or arthritis. Number of co-morbidities was then categorized as 0, 1, 2–3, 4–5 and 6 or more.

Statistical analyses

All analyses were conducted using SAS v9.1.3 to account for the multistage sampling structure used by NHIS (Procedures: SURVEYFREQ, SURVEYMEAN, SURVEYLOGISTIC). We limited all analyses to women aged 50 and older, since this is the age at which screening is first recommended for normal risk individuals. Additionally, we used NHIS sampling weights for all analyses to create U.S. population estimates. We used Rao-Scott chi-square [33] to test for relationships between any CRC screening (up-to-date or not) and each of the covariates for both races and then separately for white and African-American women. Rao-Scott chi-square tests were also used to examine the relationship between obesity status (obese vs. non-obese) and all covariates.

All covariates found to be associated ($P<0.1$) with either screening or obesity status were entered into a multivariable logistic regression model with screening as the dependent variable. We created four separate regression models for each of the screening variables (Any CRC screening, colonoscopy, endoscopy and FOBT) to test the significance of the interaction term (obesity status × race) while controlling for possible confounders. A step-wise elimination procedure was used to create a logistic regression model of the relationship between each screening outcome variable and the interaction term while holding the race and obesity status variables constant in the model. We eliminated potential confounders if they had a P-value>0.1 and did not change the estimate of the interaction term by more than 10%. The regression model was also run using the BMI group variable and results were found to be similar, thus for simplicity further analyses were performed using the obesity variable.

We calculated adjusted odds ratios of the relationship between obesity and colonoscopy, stratified by race, using multivariable logistic regression to control for confounders. Both unadjusted and adjusted screening rates, including 95% confidence intervals, are reported for selected sub-groups. Adjusted colonoscopy rates for each weight and race group were calculated by direct standardization to the demographic characteristics of the study population using the coefficients from the multivariable model [34].

Results

Descriptive statistics

Since NHIS is designed to be nationally representative, demographic characteristics of this population should reflect those of White and African-American women aged 50 and older in the United States (Table 1). The average age of this population is 64.5 (95% CI 64.2–64.8), and the mean BMI is 32.0 (95% CI 31.5–32.5). Overall, 28.3% (95% CI 27.1–29.6) of women were obese, and 51.7% (95% CI 50.1–52.9) were up-to-date with any CRC screening. Obesity was more prevalent in African-American women than in white women (33.0% vs. 24.9%, $P<0.0001$). All measures capturing screening rates were significantly higher for white women (Table 1). Using combined data from all women, a statistically significant non-linear relationship was seen between the primary CRC screening variable and the following variables: age, marital status, alcohol usage, and smoking status (Table 2). Women aged 70–79, married women, light drinkers and former smokers had the highest screening rates in their respective categories. There was also significant positive association between screening and the following variables: reported physician recommendation for screening, past-year healthcare visits, number of co-morbidities and recreational physical activity. We did not find any difference in reported rate of physician recommendation for screening between obese and non-obese women overall or when stratifying by race (data not shown). Additionally, there were no statistically significant differences in CRC screening rates between insured and uninsured women (50.8% vs. 51.8%, $P = 0.6$).

Unadjusted screening rates

Unadjusted screening rates, stratified by obesity status and race, are shown in Table 3. When white and African-American women were combined, there was little overall difference in the proportion of women up-to-date with any CRC screening by obesity status. We did identify a difference in the percent of obese women who were up-to-date for colonoscopy ($P = 0.02$), compared with the percent of non-obese individuals who were up-to-date. Colonoscopy rates for obese women were 3.9 percentage points lower than those for non-obese women (95% CI 0.7, 7.2). In the unadjusted analysis, the relationship between obesity status and CRC screening differed according to race, but again only for the colonoscopy variable. Among whites, obese women were less likely to be up-to-date for colonoscopy compared with non-obese women (40.3% vs. 44.7%, $P = 0.01$). Conversely, among African-American women, there was no statistically significant relationship between obesity and colonoscopy usage (35.3% for non-obese women vs. 38.1% for obese women, $P = 0.51$).

Obesity-race interaction

Multivariable logistic regression models indicated that race moderates the relationship between up-to-date CRC screening and obesity for all screening tests except FOBT alone. There was a statistically significant association ($P = 0.04$) between the interaction term (obesity status × race) and the primary CRC screening variable (any up-to-date screening) when controlling for reported physician recommendation, past-year medical visits, number of co-morbidities, education, smoking status, physical activity, and age. The interaction term was also significant in the models which had up-to-date colonoscopy ($P = 0.01$) and up-to-date endoscopy ($P = 0.02$) as their dependent variables. When past-year FOBT was used as an outcome variable, neither race, obesity, nor the interaction term were found to be significantly related to screening, after controlling for potential confounders.

Race-stratified regression analyses

Multivariable logistic regression models were created to look at the relationship between colonoscopy usage and the selected covariates in white and African-American women, separately (Table 4). The models were similar for the three screening outcomes which were associated with the interaction term (any CRC screening, colonoscopy, and endoscopy); however, only race-stratified adjusted odds ratios for up-to-date colonoscopy are reported, since this is the screening test with usage most strongly associated with obesity status. Even after controlling for potential confounders, obesity was still significantly related to colonoscopy usage in white women ($P = 0.001$). Among white women, the odds of being up-to-date for colonoscopy was 33% lower for obese women compared to non-obese women (OR = 0.67, 95% CI 0.53–0.86). There was a non-significant trend among African-American women indicating that obesity actually increased the odds that a woman was up-to-date with a colonoscopy.

Physician recommendation for screening was the most significant predictor of colonoscopy for both races. White women who reported receiving a recommendation for screening from their physician had a much higher odds of having an up-to-date colonoscopy than those who did not receive a recommendation (OR = 59.72, 95% CI 47.10–75.72). The association was even greater for African-American women (OR = 145.58, 95% CI 75.69–283.86). Among whites, having an up-to-date colonoscopy was also significantly (P<0.05) associated with older age, a greater number of co-morbidities, and a greater number of medical visits. Among African-American women, colonoscopy was significantly associated with a higher number of past-year medical visits (P = 0.01).

Adjusted colonoscopy rates were created to examine differences between obese and non-obese white and African-American women after accounting for possible confounders included in the regression model for up-to-date colonoscopy (Fig. 1). Obese white women had an adjusted colonoscopy rate of 30.2% (95% CI 25.9–34.8), which was significantly lower than the 39.1% (95% CI 36.1–42.2) colonoscopy rate seen in non-obese white women (P = 0.001). Obese African-American women, on the other hand, had a higher adjusted colonoscopy rate (41.2%, 95% CI 31.6–51.4) than their non-obese counterparts (35.6%, 95% CI 28.3–43.6), but these differences were not statistically significant (P = 0.16). Overall, adjusted colonoscopy rates were lowest among obese white women.

Discussion

Our analysis found that race moderates the relationship between obesity and colon cancer screening usage. Among white women, being obese reduced the chances that a woman was up-to-date with CRC screening. The opposite, however, was true for African-American women, for whom obesity was associated with higher screening rates. This screening disparity appears to be driven by the lower rates of colonoscopy seen among obese white women, since the interaction between obesity and race affected whether or not a woman was up-to-date for any type of screening test and colonoscopy or flexible sigmoidoscopy, but was not related to past-year FOBT usage. Similar to past research on screening correlates, reported physician recommendation had the largest affect on reported screening rates; however, obesity was still related to screening even after controlling for physician recommendation and other factors. The relationship between CRC screening and health insurance has been inconsistent across studies [35]. In this analysis, whether or not a woman reported having health insurance was not related to being up-to-date with CRC screening.

Previous studies which have examined the relationship between screening and weight have shown mixed results. Three of these studies were limited to a specific geographic area and/or did not include high numbers of African-Americans [15,20,22]. Even studies that used more nationally representative data from BRFSS, were not able to differentiate between colonoscopy and flexible sigmoidoscopy, which have different screening timeframes and thus were not accurately able to classify women as up-to-date for colonoscopy or not [12,14,36]. One advantage of using data from NHIS is that it is sampled and weighted to be representative of the U.S. population. It also has one of the most comprehensive screening questionnaires of any nationally representative survey. Unlike BRFSS and other surveys, NHIS is able to differentiate between flexible sigmoidoscopy and colonoscopy. Additionally, NHIS is interviewer administered and allows respondents to answer in multiple formats to indicate when they had their last screening, which improves data accuracy. NHIS also included questions about many covariates including doctor recommendation for screening.

Only two previous studies have looked at the relationship between weight and screening using NHIS data, both of these used data from 2000. While both studies controlled for relevant confounders, they did not stratify their results by gender or race. Seeff et al. found no differences between normal, overweight or obese individuals for rates of past year-FOBT or endoscopy in the previous 10 years. A study by Wee et al. found a statistically significant relationship between screening and BMI, similar to our results, but this relationship was attenuated in the adjusted model. The present study improved upon previous research on CRC screening and weight by using a comprehensive nationally representative data set, examining each recommended screening modality within its recommended time frame, and stratifying results by race and gender. The literature on how weight affects breast and cervical cancer screening rates in women indicate that stratifying by race is appropriate and necessary. Similar to our findings with colonoscopy, previous research has shown that obese white women have lower rates of mammography and pap smears than non-obese white women, but there was no relationship between these screening tests and obesity in African-American women [25-27].

Despites its many advantages, using NHIS data did present a few limitations. First, because it is meant to be representative of the U.S. population, it has much smaller number of African-Americans and other minority groups compared to whites. Small numbers in the African-American group limit the power of the analysis when compared to that done with white women. Another limitation of NHIS is that it does not include questions on Barium Enema, a recommended screening test, so some women who have had this test may be improperly classified. We do not believe this will appreciably affect the data, since barium enema has steeply declined over the last decade and is now rarely used to screen for colon cancer; approximately 0.05% of the Medicare population received a barium enema in 2005 [37].

Future research is needed to better understand why obese white women are less likely to get screened than their non-obese counterparts. Findings from the breast and cervical cancer screening literature provide some insights. In one study investigating barriers to gynecological screening, more than half of morbidly obese women reported that they delayed seeking health care because of their weight and over 70% reported that their weight was a barrier to receiving appropriate health care [25,38]. In a recent qualitative study examining mammography usage, obese women reported additional barriers to screening, including previous bad experiences, discomfort, fear, poor treatment by providers, and low perceived susceptibility to cancer. They also stated that having a female doctor would increase their likelihood of having a screening. [1] It has been suggested that obese individuals may have lower screening rates because they have more co-morbidities or acute needs that may be prioritized over cancer screening tests [39,40]. Conversely, our data supports previous studies which have actually shown a positive relationship between screening and number of reported medical conditions [41]. Nevertheless, these theories do not fully explain why weight-related screening disparities may differ by race.

It is possible that racial differences in screening are related to differences in body image and body esteem. Previous research has indicated that obese women may delay preventive care because they are embarrassed or fear disrespectful treatment because of their weight [42]. Many obese women also are deterred from going to the doctor because they do not want to receive unsolicited weight loss advice, and they are made uncomfortable by small gowns and equipment that may not be appropriate for their size. These issues may be particularly salient for women who have poor body image or body esteem. This could explain why obese African-

[1] Personal communication with Jeanne Ferrante (New Jersey-Robert Wood Johnson Medical School) regarding unpublished focus group data.

American women, who tend to be more accepting of a larger body size than their white counterparts [43], do not have lower screening rates than non-obese African-American women.

Body image-related issues may also explain why obesity appeared to affect rates of endoscopic tests, particularly colonoscopy, but not of FOBTs. The invasive nature of the colonoscopy and the fact that it must be performed in a clinical setting (as opposed to at home which is the case with FOBT) may explain why screening rates are lower for obese women but not men. One focus group study found that men and women had similar views about FOBT testing, but noted gender differences in attitudes toward colonoscopy [11]. Women expressed more anxiety about being unclothed and exposed during endoscopic procedures. These feelings could be enhanced in higher weight women, especially if they have poor body image.

While the present study provides further evidence that obesity affects screening behavior in women, especially for more invasive tests like colonoscopy, it is still unclear why these disparities exist. Qualitative research is needed to better understand how weight affects a woman’s decision to get a cancer screening. Once the source of weight-related screening disparities are better understood, we can improve screening promotion and education to better meet the needs of women with the lowest screening rates.

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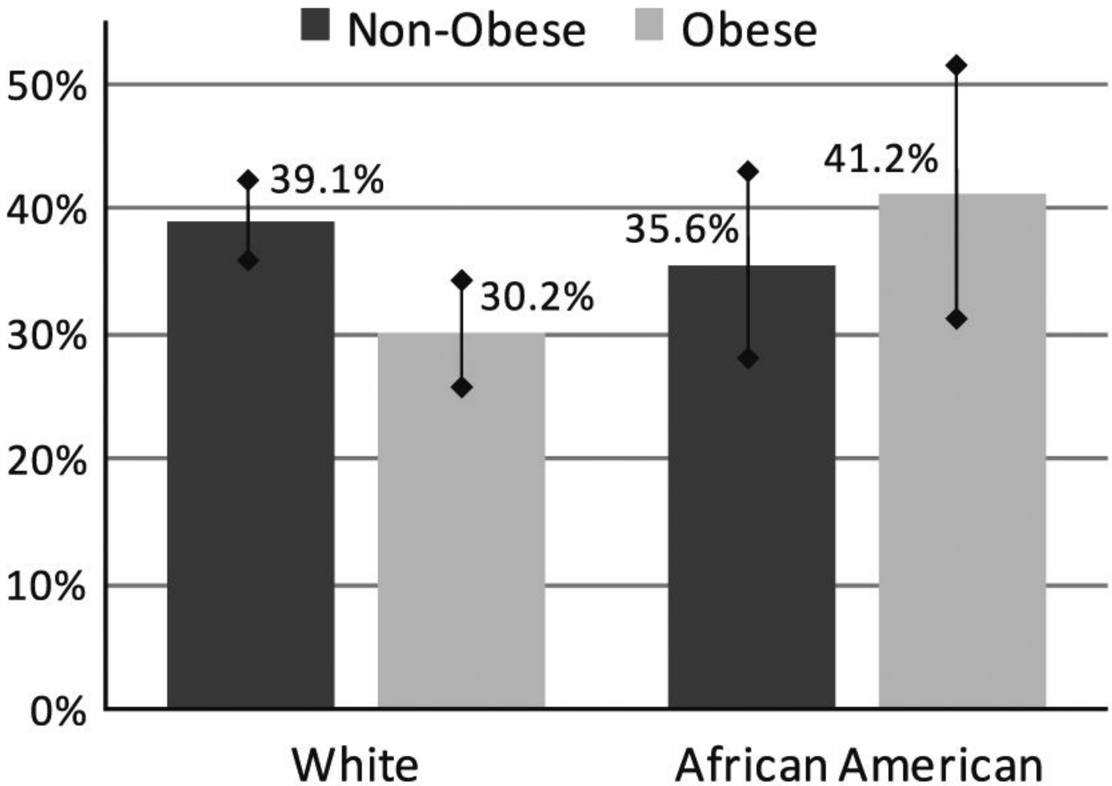

Fig. 1.
Race stratified adjusted colonoscopy rates for women aged 50 and older by obesity status. *Note* Adjusted colonoscopy rates for each weight and race group were calculated by direct standardization to the demographic characteristics of the study population using the coefficients from the multivariable model [34]

Table 1

Characteristics of White and African-American women aged 50 and older in the U.S

	White and African-American (*n* = 7,469) (%)	White only (*n* = 6,459) (%)	African-American only (*n* = 1,010) (%)	*P*-value*
Screening				
Up-to-date for Any CRC Screening	51.7	52.5	44.8	0.0004
Up-to-date Colonoscopy	42.3	43.0	36.1	0.002
Up-to-date Endoscopy	45.3	46.0	39.2	0.002
Up-to-date FOBT	15.4	15.7	12.7	0.046
Hispanic/Latino origin	23.9	23.8	25.4	0.34
Age				
50–59	40.9	40.3	46.4	0.001
60–69	26.9	26.9	26.9	
70–79	19.2	19.4	17.5	
80+	13.0	13.5	9.2	
BMI Group				
Underweight	2.1	2.3	1.1	<0.0001
Normal weight	37.3	39.1	21.7	
Overweight	32.8	32.3	37.4	
Obese I	16.6	16.1	21.0	
Obese II	6.7	6.3	10.1	
Obese III	4.4	3.9	8.6	
Marital status				
Married/living w/partner	56.4	59.0	34.0	<0.0001
Divorced/separated	15.3	13.9	26.8	
Never married	4.7	3.9	10.9	
Widowed	23.7	23.1	28.2	
Education				
Less than high school	37.4	36.9	38.5	0.46
High school/GED	22.2	22.5	20.1	
Some college/associates	22.2	22.1	22.8	

	White and African-American (n = 7,469) (%)	White only (n = 6,459) (%)	African-American only (n = 1,010) (%)	*P*-value*
College degree	12.8	12.7	13.9	
Graduate/professional	5.7	5.8	4.7	
Personal income				
$0–$24,999	46.5	46.7	44.4	0.26
$25,000–$54,999	33.9	33.5	37.3	
$55,000–$74,999	9.2	9.0	10.1	
$75,000 and up	10.4	10.7	8.1	
Health insurance coverage	83.7	83.6	84.5	0.52
Past year medical visits				
0	7.9	7.8	8.0	0.62
1	11.6	11.8	10.1	
2–3	24.8	24.7	25.2	
4–5	18.4	18.2	19.9	
6 or more	37.4	37.5	36.7	
Physician CRC screening recommendation	56.4	58.6	50.4	0.0002
Self-reported health status				
Excellent	33.9	33.9	33.7	0.93
Very good	29.3	29.4	28.7	
Good	26.3	26.3	26.6	
Fair	7.6	7.6	7.5	
Poor	2.9	2.8	3.4	
Co-morbidities				
0	21.9	22.4	17.4	0.002
1	27.3	27.6	24.7	
2–3	36.1	35.5	40.6	
4–5	11.6	11.4	13.8	
6 or more	3.1	3.0	3.6	
Alcohol usage				
Never	32.2	30.8	44.1	<0.0001
Former	20.0	19.2	26.5	

	White and African-American (*n* = 7,469) (%)	White only (*n* = 6,459) (%)	African-American only (*n* = 1,010) (%)	*P*-value*
Light	36.6	37.9	25.7	
Moderate/heavy	11.3	12.1	4.0	
Smoking status				
Daily	11.4	11.3	12.5	<0.0001
Occasional	2.2	2.1	3.8	
Former	26.5	27.1	21.8	
Never	59.8	59.5	61.9	
Recreational physical activity (MET minutes/week)				
None/unable to exercise	47.5	45.6	63.6	<0.0001
<675	30.0	30.7	24.8	
≥675	22.5	23.7	11.7	

* *P* value calculated using Rao-Scoot Chi-Square test of the relationship between race and the selected variable

Table 2

CRC screening rates for White and African-American women aged 50 and older: percent up-to-date for screening by selected demographic and health characteristics

	White and African-American (n = 6,412) (%)	White (n = 5,566) (%)	African-American (n = 846) (%)
Ethnicity			
Hispanic	52.4	52.9	44.7
Non-Hispanic	51.5	52.1	44.5
	$P = 0.58$	$P = 0.66$	$P = 0.96$
Age			
50–59	42.5	43.0	37.7
60–69	58.2	58.2	56.1
70–79	60.4	61.3	49.8
80+	55.7	56.6	39.7
	$P<0.0001$	$P<0.0001$	$P = 0.0009$
BMI Group			
Underweight	50.5	52.4	18.8
Normal weight	51.9	52.8	37.5
Overweight	54.0	54.8	48.0
Obese I	50.4	50.7	48.3
Obese II	52.5	53.6	45.9
Obese III	48.7	49.2	46.8
	$P = 0.52$	$P = 0.54$	$P = 0.27$
Marital status			
Married/living with partner	52.9	53.3	46.9
Divorced/separated	48.6	48.6	48.8
Never married	44.4	47.4	35.8
Widowed	52.4	53.9	42.1
	$P = 0.01$	$P = 0.04$	$P = 0.23$
Education			
Less than high school	51.7	52.6	44.3
High school/GED	49.1	50.0	40.1

	White and African-American (*n* = 6,412) (%)	White (*n* = 5,566) (%)	African-American (*n* = 846) (%)
Some college/associates	52.5	52.7	50.6
College degree	55.8	58.0	39.6
Graduate/professional	46.6	45.9	53.3
	$P = 0.06$	$P = 0.02$	$P = 0.37$
Personal income			
$0–$24,999	49.3	49.8	45.1
$25,000–$54,999	51.2	52.3	42.3
$55,000–$74,999	54.4	54.1	56.4
$75,000 and up	56.1	56.9	45.5
	$P = 0.20$	$P = 0.22$	$P = 0.61$
Health insurance			
Covered	50.8	51.7	43.0
Not covered	51.8	52.7	44.5
	$P = 0.60$	$P = 0.62$	$P = 0.78$
Past year medical visits			
0	18.0	18.1	17.5
1	39.3	40.5	27.2
2–3	49.7	51.1	37.2
4–5	58.0	59.6	46.7
6 or more	61.4	61.4	61.2
	$P<0.0001$	$P<0.0001$	$P<0.0001$
Physician CRC screening recommendation			
No	12.5	12.9	9.2
Yes	87.5	86.2	85.8
	$P<0.0001$	$P<0.0001$	$P<0.0001$
Self-reported health status			
Excellent	51.9	52.7	44.7
Very good	52.0	52.6	47.2
Good	51.0	51.9	42.9
Fair	49.8	51.2	38.1
Poor	59.2	59.3	58.7

	White and African-American (*n* = 6,412) (%)	White (*n* = 5,566) (%)	African-American (*n* = 846) (%)
	P = 0.42	*P = 0.63*	*P = 0.55*
Co-morbidities			
0	36.9	37.4	31.3
1	50.6	52.0	36.5
2–3	57.3	58.3	49.5
4–5	62.3	63.1	56.4
6 or more	58.1	59.1	50.4
	P<0.0001	*P<0.0001*	*P = 0.002*
Alcohol usage			
Never	44.9	46.5	35.4
Former	52.4	52.3	52.8
Light	56.1	56.4	52.2
Moderate/heavy	55.2	55.4	49.8
	P<0.0001	*P<0.0001*	*P = 0.0004*
Smoking status			
Daily	36.3	36.0	38.1
Occasional	43.7	49.1	18.7
Former	59.0	59.1	57.4
Never	51.8	52.8	43.2
	P<0.0001	*P<0.0001*	*P = 0.004*
Recreational physical activity (MET minutes/week)			
None/unable to exercise	44.3	45.3	38.4
<675	57.9	58.3	53.8
≥675	58.8	58.5	64.1
	P<0.0001	*P<0.0001*	*P<0.0001*

Table 3

Race stratified unadjusted CRC screening rates for women aged 50 and older by obesity status

	White and African-American Women		White Women		African-American Women	
	Non-obese	Obese	Non-obese	Obese	Non-obese	Obese
Up-to-date for Any CRC Screening, % (95% CI)	52.9 (51.1–54.6)	50.6 (47.9–53.3)	53.7 (51.8–55.5)	51.2 (48.1–54.2)	44.1 (38.6–49.5)	47.4 (41.1–53.7)
	P = 0.17		*P = 0.16*		*P = 0.44*	
Up-to-date Colonoscopy, % (95% CI)	43.9 (42.1–45.7)	40.0 (37.3–42.7)	44.7 (42.8–46.5)	40.3 (37.3–43.2)	35.3 (29.8–40.9)	38.1 (31.9–44.3)
	P = 0.02		*P = 0.01*		*P = 0.51*	
Up-to-date Endoscopy, % (95% CI)	46.7 (45.0–48.5)	43.6 (40.9–46.3)	47.5 (45.6–49.3)	44.0 (41.0–47.0)	38.8 (33.4–44.3)	41.0 (34.8–47.2)
	P = 0.06		*P = 0.06*		*P = 0.61*	
Up-to-date Fecal Occult Blood Test, % (95% CI)	15.2 (14.0–16.4)	15.9 (14.0–17.8)	15.4 (14.2–16.7)	16.5 (14.4–18.7)	12.5 (9.2–15.8)	12.4 (8.4–16.4)
	P = 0.53		*P = 0.39*		*P = 0.96*	

Note Non-obese = BMI 18.5–29.9, Obese = BMI 30+

Table 4

Adjusted odds ratios for up-to-date Colonoscopy

Predictor variable	White (n = 4,430)		African-American (n = 690)	
	Odds ratio (95% CI)	P-value*	Odds ratio (95% CI)	P-value*
Obesity				
Non-obese	1.00	0.001	1.00	0.16
Obese	0.66 (0.50–0.85)		1.30 (0.83–2.96)	
Age				
50–60	1.00	<0.0001	1.00	0.08
60–70	2.00 (1.51–2.65)		1.97 (0.90–4.30)	
70–80	2.84 (1.80–3.53)		2.52 (0.95–6.72)	
80+	2.52 (1.80–3.53)		2.39 (0.91–6.29)	
Physician CRC screening recommendation				
No	1.00	<0.0001	1.00	<0.001
Yes	59.72 (47.10–75.72)		145.58 (75.69–283.86)	
Past year medical visits				
0	1.00	0.001	1.00	0.01
1	1.01 (0.57–1.78)		1.60 (0.45–5.69)	
2–3	1.20 (0.71–2.04)		1.28 (0.11–3.97)	
4–5	1.82 (1.05–3.17)		4.73 (1.40–15.96)	
6 or more	1.92 (1.12–3.30)		4.37 (1.29–14.80)	
Co-morbidities				
0	1.00	0.03	1.00	0.50
1	1.00 (0.71–1.40)		0.51 (0.20–1.28)	
2–3	1.31 (0.91–1.88)		0.56 (0.22–1.41)	
4–5	1.29 (0.82–2.04)		0.52 (0.19–1.44)	
6 or more	2.26 (1.23–4.16)		0.89 (0.27–2.95)	
Education				
Less than high school	1.00	0.05	1.00	0.23
High school/GED	0.92 (0.70–1.21)		0.40 (0.16–0.95)	
Some college/associates	1.21 (0.90–1.63)		0.97 (0.40–2.30)	

Predictor variable	White (n = 4,430)		African-American (n = 690)	
	Odds ratio (95% CI)	***P*-value***	**Odds ratio (95% CI)**	***P*-value***
College degree	1.49 (1.06–2.08)		1.03 (0.42–2.56)	
Graduate/professional	0.82 (0.48–1.40)		1.34 (0.59–5.32)	
Recreational physical activity				
None/unable to exercise	1.00	0.06	1.00	0.06
<675	1.26 (0.97–1.63)		2.41 (1.12–5.17)	
≥675	1.35 (1.02–1.78)		1.77 (0.59–5.32)	

*Adjusted *P*-value based on Wald Chi-Square test