

## Review Article

# Obesity and Cancer Screening according to Race and Gender

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The relationship between obesity and cancer screening varies by screening test, race, and gender. Most studies on cervical cancer screening found a negative association between increasing weight and screening, and this negative association was most consistent in white women. Recent literature on mammography reports no association with weight. However, some studies show a negative association in white, but not black, women. In contrast, obese/overweight men reported higher rates of prostate-specific antigen (PSA) testing. Comparison of prostate cancer screening, mammography, and Pap smears implies a gender difference in the relationship between screening behavior and weight. In colorectal cancer (CRC) screening, the relationship between weight and screening in men is inconsistent, while there is a trend towards lower CRC screening in higher weight women.

## 1. Introduction

Obesity, resulting from inactivity and poor nutrition, is second only to tobacco use as a risk factor for cancer [1]. Obesity is associated with increased mortality for all cancers combined, as well as for cancers of specific sites, including colon/rectum, prostate, breast, and cervix [2, 3]. Race and gender are also associated with poor outcomes for cancer [4, 5]. Compared to their non-Hispanic white counterparts, black men and women are more likely to be obese and to have a higher cancer mortality rate [6–8]. Numerous studies have examined the biological pathways that link obesity to increased cancer risk, but biological pathways are unlikely to provide a complete explanation of the association of obesity and increased cancer mortality. Participation in cancer screening is an important determinant of cancer mortality, and there may be an association between obesity and use of some types of screening. This association seems to vary according to race, gender, and screening test. While numerous studies suggest that obesity constitutes an obstacle

to cancer screening, [3, 9–17] the interplay between obesity and cancer screening is not clear.

Historically, blacks and women have been less likely to undergo cancer screening when compared to their non-Hispanic white or male counterparts [18–21]. Obesity may be one reason for the disparity in screening among race/ethnicity and gender subgroups, either because obesity is more prevalent in these groups or because in some subgroups, it may have a more potent effect. The relationship to obesity and cancer screening is made complex by the fact that cancer screening tests are very different in terms of what is required of an individual in order to complete screening. The relationship between obesity and cancer screening may have a stronger negative association in certain cancer screening tests. For example, disparities appear more pronounced for endoscopic screening than for fecal occult blood test (FOBT) screening [19]. This situation may exist because endoscopic testing is more invasive or harder to do in obese patients relative to other screening tests. Furthermore, socioeconomic factors such as insurance status and health care access,

which can be confounded with race/ethnicity and gender, may contribute to the disparity [19]. Efforts to measure the contribution of race/ethnicity and gender to variation in screening rates should take these factors into account.

In this review, we attempt to build a more comprehensive picture of the relationship of obesity and cancer screening by including the variables of race/ethnicity, gender, and screening test. Here, we review the available literature examining the interactions of race/ethnicity, gender, and obesity with cancer screening rates. Understanding the relationship of obesity and cancer screening relative to race/ethnicity and gender can inform efforts to identify and reduce disparities in cancer screening.

## 2. Materials and Methods

We reviewed articles which presented data on the relationship of any weight measure to screening for any of the following cancers: colon, breast, cervical, or prostate. The MEDLINE database search focused on 1996 through April 2011. First, we extracted 2,048 articles related to obesity, morbid obesity, overweight and BMI. From this group of articles we extracted those having to do with the diagnosis or prevention of neoplasms. We included various types of cancer screening tests (colonoscopy, sigmoidoscopy, gastrointestinal endoscopy, fecal occult blood testing, Pap smears, mammography, and prostate-specific antigen), as well as the more general term “mass screening”. We further limited the search by using terms that describe articles as qualitative research or evaluation studies, resulting in 262 articles. Abstracts and manuscripts were used to exclude articles which did not examine the association between weight and cancer screening in order to obtain the final 29 articles. Studies were organized according to type of cancer screening and stratified according to gender and race. Tables 1, 2, and 3 present the studies on breast, cervical, and prostate cancer screening. Table 4 presents the studies of obesity and colorectal cancer screening.

## 3. Results

**3.1. Cervical Cancer Screening.** We identified one review of research on the relationship of obesity and cervical cancer screening [44] and three additional articles [22–24]. Twelve studies examined the relationship of obesity and screening for cervical cancer, and all of these studies found an association between increased body weight and decreased utilization of Pap smears [12–15, 25, 27–31, 45, 46]. Of the five studies which examined the association of obesity and cervical cancer screening in white women, all reported a negative association. In black women, six studies examined obesity and cervical cancer screening. Four studies reported no association, while two studies reported a negative association between obesity and Pap smear use in black women. Of note, one of these two studies [28] utilized data from the Black Women’s Health Study which includes black women of high socioeconomic status which may be associated with different screening behavior. The other outlying study was

a reanalysis of the same data set using different covariates and inclusion criteria [15, 25]. In summary, the data seems to suggest a negative association between obesity and cervical cancer screening in white women which is not present, or not as strong in black women.

**3.2. Breast Cancer Screening.** We identified one review of research on the relationship of obesity and breast cancer screening [44], and five additional articles [12, 22–24, 29]. None of these 11 studies showed no negative association between weight and mammography use in women. In the three studies that stratified the obesity-screening relationship according to race [16, 17, 27], in one study [17] obesity was associated with decreased utilization of mammography in white women and increased utilization in their black counterparts. In black women, two of these three studies found a positive association between obesity and mammography use, while one study found no effect in black women.

**3.3. Prostate Cancer Screening.** Four studies examined the association between obesity and prostate cancer screening, and all used prostate-specific antigen (PSA) testing as their outcome. Three of the four studies indicated that obese men were more likely to have had a PSA test [9–11] when compared with their normal-weight peers. One study examined obesity and PSA testing in a cohort of men from primary care practices and found a consistent association with obesity and increased PSA testing, regardless of race [10].

**3.4. Colorectal Cancer Screening.** Colorectal cancer (CRC) is currently the only cancer screening recommended for both men and women, and therefore, CRC is the only screening in which the impact of gender and obesity can be directly compared [47]. Sixteen studies were identified that examined the relationship of obesity and colorectal cancer (CRC) screening [22, 24, 32–43, 48, 49], but only six studies stratified the obesity-cancer screening relationship by gender [35, 36, 39, 40, 42, 43]. In men, the relationship between obesity and CRC screening was inconsistent. In men, two studies [36, 43], indicated that obesity was associated with lower CRC screening rates. One study indicated that obesity was associated with higher endoscopic CRC screening rates in men [39], and three studies indicated no association in men [35, 40, 42]. In three studies, fecal occult blood testing (FOBT) was examined independently and there was no association between FOBT use and weight in men [35, 39, 40]. In women, the relationship between obesity and CRC screening was more consistent. In women, four studies demonstrated a negative association between obesity and CRC screening [36, 39, 40, 43], and one study demonstrated higher rates of CRC screening in obese women [42], and one study showed no association [35]. One outlying study was a case-control study that identified cases from two tumor registries and may have had a selection bias towards women being more likely to screen. Four studies conducted on women reported that on endoscopy separately and in three of the four studies, obesity was negatively associated with screening [39, 40, 42, 43]. Three studies specifically reported

TABLE 1: Cervical cancer screening and weight status.

Study	Population/data source	Weight categories <sup>1</sup>	Findings
Chang et al. 2010, [22]	Medicare and Veterans Health Administration (VHA)	OW and OB	There was no significant association between Pap smears and OW or OB.
Banerjea et al. 2008, [23]	Medical Expenditure Panel Survey (MEPS) 2003	OW and OB	OW and OB were negatively associated with Pap smears (OR 0.72 $P < 0.01$ ).
Mitchell et al. 2008, [24]	Canadian Community Health Survey, national population-based household survey in a universal payor system.	OW, OBI, OBII, OBIII	OW, OBI, OBII, and OBIII were negatively associated with Pap smears. OR 0.87 (0.81–0.94), OR 0.79 (0.72–0.88), OR 0.62 (0.54–0.71), OR 0.61 (0.53–0.72).
Ferrante et al. 2007, [12]	NHIS 2000	OW, OBI, OBII, OBIII	OBI and OBIII were negatively associated with Pap smears. OR 0.65 (0.44–0.97), OR 0.43 (0.27–0.70). There was no significant association between receipt of Pap smears and OW and OBII
Wu et al. 2006, [25]	NHIS 2000	OW, OB, OBI, OBII, OBIII	OBII was positively associated with underused Pap smears in African-American women. OR 1.93 (1.03–3.01). There was no significant association in OW, OBI, or OBIII in African-American women. There was no significant association between any weight category and Pap smears for white women.
Amy et al. 2006, [26]	Purposeful sample. Questionnaire administered in focus groups formed on weight criteria.	Other: BMI 25–35, >35–45, >55	There was significant association between receipt of Pap smears and BMI >55 kg/m <sup>2</sup> ( $\chi^2 = 9.98$ , $P < 0.02$ ). There were no significant associations between receipt of Pap smears and BMI >35–45 or >45–55.
Ferrante et al. 2006, [13]	Medical chart review of urban FM practices (mostly black and Hispanics)	nonobese (normal and OW), OBI, OBII, OBIII	There were no significant associations between weight status and Pap smears.
Ostbye et al. 2005, [27]	Health and Retirement Study (HRS) and the Asset and Health Dynamics Among the Oldest Old (AHEAD)	OW, OB, OBI, OBII, OBIII	OW, OBI, OBII, OBIII were negatively associated with Pap smears (ORs 0.78, 0.68, 0.59, 0.50)
Wee et al. 2005, [14]	2000 NHIS data	OW, OB, OBI, OBII, OBIII	OBIII was negatively associated with Pap smears in white women only. RR 0.92 (0.83–0.99). There were no significant associations between weight status and Pap smears in black or Hispanic women.
Datta et al. 2005, [28]	Black Women's Health Study 1995, USA, mailed questionnaire, subscribers to Essence, Black Women's Professional Association and friends/relatives of participants.	OW and OB	OB was associated with increased rate of no Pap smear in last 2 years (OR 1.4–1.7). No association between OW and Pap smears in last 2 years.
Coughlin et al. 2004, [29]	BRFSS 1999, US women $\geq 40$	OW and OB	OB was negatively associated with Pap smear use in the last 2 years (85.9 $P < 0.05$ )
Wee et al. 2000, [15]	NHIS 1994	OW, OB, OBI, OBII, OBIII	OW, OBI, OBII, and OBIII were negatively associated with Pap smears in white women: 3.4% (–6.4% to –0.5%), –9.4% (–13.5% to –5.2%), –8.3% (–14.2% to –2.3%), –8.8% (–16.9% to –0.7%). There was no association between weight status and receipt of Pap smears in black women.

<sup>1</sup>Predictors: OW: Overweight, OB: Obese, OBI: Obese I, OBII: Obese II, OBIII: Obese III.

TABLE 2: Mammography use and weight status.

Study	Population/data Source	Weight categories <sup>1</sup>	Findings
Chang et al. 2010, [22]	National Medicare claims data (Medicare), Veterans Health Administration data (VHA)	OW and OB	OW in Medicare beneficiaries was positively associated with mammography in OR = 1.13 $P = .02$ , but not in VHA data. There was no significant association of mammography in OB (VHA or Medicare) or OW (VHA).
Banerjea et al. 2008,[23]	Medical Expenditure Panel Survey (MEPS) 2003	OW and OB	There were no significant associations between mammography use and OB or OW.
Mitchell et al. 2008, [24]	Canadian Community Health Survey	OW, OB, OBI, OBII, OBIII	There were no significant associations between mammography use and OW, OB (including OBI, OBII, OBIII).
Ferrante et al. 2007, [12]	National Health Interview Survey (NHIS) 2000	OB, OW, OBI, OBII, OBIII	OBIII was negatively associated with mammography. (62.3% $P = 0.0084$ ). There were no associations between mammography and weight status in OW, OBI, or OBII women.
Amy et al. 2006, [26]	Purposeful sample, face-to-face questionnaire in focus groups formed according to weight status	BMI 25–35, >35–45, >55	There were no significant associations between mammogram use and increasing BMI category.
Ferrante et al. 2006, [13]	Medical chart review, urban FM practices, mostly black and Hispanic	OBI, OBII, OBIII, nonobese (normal and overweight collapsed)	There was no significant association between mammography use and weight status.
Zhu et al. 2006, [16]	NHIS 2000	OW, OBI, OBII, OBIII	There was no significant association between weight status and mammography in white or black women.
Ostbye et al. 2005, [27]	Health and Retirement Study (HRS) and the Asset and Health Dynamics Among the Oldest Old (AHEAD)	OW and OB	OBI, OBII, and OBIII were negatively associated with mammogram use (OR 0.73, 0.69, 0.59, resp.). There were no significant associations between mammography use and OW.
Coughlin et al. 2004, [29]	Behavioral Risk Factor Surveillance Survey (BRFSS) 1999	OW and OB	OB was negatively associated with mammography use. 74.6% $P < 0.001$ .
Wee et al. 2004, [17]	NHIS 1998	OW, OBI, OBII, OBIII	OBII was negatively associated with mammography in white women. OR 0.83 (0.68–0.96). OW and OBII were positively associated with mammography in black women. OR 1.19 (1.01–1.32), OR 1.37 (1.13–1.50). There were no other significant associations.
Wee et al. 2000, [15]	NHIS 1994	OW, OB, OBI, OBII, OBIII	There was no association of weight status and mammography in white or black women.
Fontaine et al. 2001, [30]	National Data 1998	OW, OBI, OBII, OBIII	OW and OBIII were positively associated with mammography use. There were no significant associations between OBI, OBII, and mammography use.
Fontaine et al. 1998, [31]	National Data Set (>80% white) 1992	OW, OB	There was no significant association between weight status and mammography use.

<sup>1</sup> Predictors: OW: Overweight, OB: Obese (unless otherwise specified, includes OBI, OBII, OBIII), OBI: Obese I, OBII: Obese II, OBIII: Obese III.

FOBT use in women: one indicated a negative association between obesity and screening, while the other two indicated no association between obesity and FOBT use in women [35, 39, 40]. These studies suggest that body weight may have a different impact on the likelihood of undergoing CRC screening in men and women. In women, the majority of the literature suggests a negative association between obesity and CRC screening, whereas in men there is little consistency in the association of obesity and CRC screening.

While many studies examine the relationship of obesity to cancer screening, we identified only two that explored the impact of race and obesity on CRC screening. In the New York Cancer Project, Vlahov et al. [38] reported that obesity did not impact CRC screening in blacks, whites, or Hispanics. These authors did not examine men and women separately. Leone et al. [34] found that obesity was associated with lower rates of CRC screening in white women but not their black counterparts. No studies were identified in the

TABLE 3: Prostate-specific antigen testing and weight status.

Study	Population/data Source	Weight categories <sup>1</sup>	Findings
Muus et al. 2009, [32]	National face-to-face survey of American Indian and Alaskan men in USA	OW, OB, OBI, OBII, OBIII	There was no significant association between receipt of PSA and OW, OB.
Scales et al. 2007, [9]	BRFSS 2002, men $\geq 40$	OW and OB	OW was positively associated with PSA testing. OR 1.46 [1.33–1.61].
Fowke et al. 2006, [10]	In-person interviews, men from 25 health centers in USA (85% black)	OW, OBI, OBII, OBIII	OW, OBI, OBII were positively associated with PSA testing in black men. 1.26 (1.10–1.44), 1.38 (1.18–1.62), 1.37 (1.10–1.72) OBII was positively associated with PSA testing in white men. OR 1.67 [1.06–2.63]. There were no other significant associations.
Fontaine et al. 2005, [11]	BRFSS 2001, men $\geq 50$	OW, OBI, OBII, OBIII	OW, OBI, OBII, and OBIII were positively associated with PSA testing. OR 1.13 [1.04–1.35], OR 1.26 [1.06–1.36], 1.14 [1.02–1.06].

<sup>1</sup>Predictors: OW: Overweight, OB: Obese, OBI: Obese I, OBII: Obese II, OBIII: Obese III.

CRC screening literature which examined the relationship of obesity and screening according to both race and gender.

#### 4. Discussion

The relationship between obesity and cancer screening is complex. The type of screening test strongly influences this relationship. In cervical cancer screening, increasing weight is consistently associated with lower rates of obtaining Pap smears. In breast cancer screening, there is a less consistent association between increased weight and decreased mammography. Conversely, prostate cancer screening, measured by PSA testing, seems to increase as weight increases. Comparing cervical, breast, and prostate cancer, men seem to behave opposite of women, suggesting that gender influences the relationship between screening and weight. However, CRC screening, the only example of cancer screening which would allow comparison by gender, does not elucidate the impact of gender. In fact, the relationship of weight status and screening in CRC is the least consistent of all the screening tests. Other variables, such as race, may be an important source of this inconsistency.

In mammography and Pap smears, race affects the relationship between screening and weight. Increased weight appears to be more of a barrier in white women in both mammography and Pap smears. In part, this may be explained by differences in perception of weight. Cancer screening is a behavioral outcome, influenced by personal factors. Women who see themselves as too heavy are more likely to feel embarrassment regarding examination [50, 51]. White and black women perceive their weight differently. White women consider themselves overweight at a lower BMI, compared to black women [52, 53]. So, white women may become resistant to screening at a lower BMI. White women report body dissatisfaction at a lower BMI relative to their black counterparts [54, 55]. This may create a “dose-response” effect of obesity and screening behavior with different thresholds for different races, at least in women, which would be consistent with a similar “dose-response”

effect in cancer morbidity and mortality. However, this race effect in women is not seen in men.

The association of weight status and prostate cancer is relatively unique in that there appears to be a positive association with testing as weight increases, and this effect persists when men are stratified by race. This may be explained by differences in access and utilization of health care. As weight increases, other comorbid conditions increase, so that heavier men may be higher utilizers of health care. By having more encounters with the health care system, these men are more likely to be counseled or encouraged to be tested.

CRC screening, the only screening which permits the examination of both race and gender (e.g., white men, white women, black men, and black women) should elucidate the combined and often contradictory effects of both race and gender on cancer screening. However, CRC screening reveals a confusing pattern of association between weight status and testing. CRC screening is a more complex test to study as there are several test choices, and this implicitly makes for more complicated analyses. Indeed, the literature varies in outcome reported with most studies reporting overall screening (stool testing or endoscopy) and some studies reporting these test options separately. Those studies which distinguish according to endoscopy and stool testing suggest that endoscopy, not FOBT, is more likely influenced by weight status. So, any differential effects based on race or gender may be suppressed when examining a composite variable such as overall CRC screening (endoscopy and stool blood test).

With the exception of cervical cancer screening, there is no clear, consistent pattern of association between obesity and cancer screening. There were no studies of obesity and cancer screening which examined the combined effect of race/ethnicity and gender. This is an important gap in the literature, as finding from this review suggests that screening behavior across race-gender subgroups, for example, black men, black women, white men, and white women, is likely to be very different.

Utilization and/or access to health care are important determinants of cancer screening [34, 41]. However, such

TABLE 4: Colorectal cancer screening and weight status.

Study	Population/data source	Weight categories <sup>1</sup>	Outcome	Findings
Chang et al. 2010, [22]	National Medicare Claims (Medicare), Veterans Health Administration (VHA), ≥65 years old	OW and OB	Colorectal cancer screening	There was increased CRC screening in overweight VHA care recipients OR 1.12 $P = 0.002$ . There were no other significant associations between CRC screening and OB (VHA and Medicare) and OW Medicare beneficiaries.
Adams-Campbell et al. 2010, [33]	Black Women's Health Study	OW and OB	Colonoscopy in past 2 years	There were no significant associations between colonoscopy and OW, OB.
Leone 2009, [34]	NHIS 2005, women only	Collapsed OW and OB	Colorectal cancer screening colonoscopy, endoscopy, or FOBT	OB was negatively associated with CRC screening in white but not black women. OR-0.66 $P = 0.001$ .
Muus et al. 2009, [32]	National face-to-face survey, American Indian and Alaskan native men in USA.	OW, OB, OBI, OBII, OBIII	FOBT	There were no significant associations between receipt of FOBT and OW, OB (I, II, III).
Banerjea et al. 2008, [23]	Medical Expenditure Survey (MEPS) 2003 and subset of NHIS (women only)	OW and OB	Colorectal cancer screening	OW was negatively associated with CRC screening. OR 0.80 [0.66–0.97].
Mitchell et al. 2008, [24]	Canadian Community Health Survey	OW, OB, OBI, OBII, OBIII	FOBT	There was no significant association between receipt of FOBT testing and OW, OB (I, II, III).
James et al. 2008, [35]	Wellness for African-Americans through Churches (WATCH)	OW, OB, OBI, OBII, OBIII	FOBT	There was no significant association between FOBT and OW, or OB (I, II, III) in men or women.
James et al. 2008, [35]	WATCH	OW, OB, OBI, OBII, OBIII	Colorectal cancer screening	There was no significant association between receipt of overall CRC screening and OW, or OB (I, II, III) in men or women.
James et al. 2008, [35]	WATCH	OW, OB, OBI, OBII, OBIII	Sigmoidoscopy	There was no significant association between receipt of sigmoidoscopy and OW, or OB (I, II, III) for men or women.
James et al. 2008, [35]	WATCH	OW, OB, OBI, OBII, OBIII	Past-year CRC screening	There was no significant association between past-year CRC screening and OW, or OB (I, II, III) in women or men.
Ferrante et al. 2006, [36]	Medical records of New Jersey and Pennsylvania primary care practice patients ≥50	Collapsed OW and OB	Colorectal cancer screening	OB was negatively associated with CRC screening. OR 0.75 $P = 0.004$ .
Menis et al. 2006, [37]	Maryland Cancer Survey 2002, population-based random-digit dial telephone survey	OB and OW	Colorectal cancer screening	There was no significant association of CRC screening with OW or OB.
Vlahov et al. 2005, [38]	New York Cancer Project	OB only	Endoscopy	There was no significant association between obesity and endoscopy.
Heo et al. 2004, [39]	Behavioral Risk Factor Surveillance Survey (BRFSS) 2001	OW, OB, OBI, OBII, OBIII	FOBT	There were no significant associations between BMI category and in men or women.
Heo et al. 2004, [39]	BRFSS 2001	OW, OB, OBI, OBII, OBIII	Sigmoidoscopy	OW and OBII were positively associated with sigmoidoscopy in last 5 years in men. OR 1.25 [1.05–1.51], 1.21 [1.03–1.75]. OBI and OBII were negatively associated with sigmoidoscopy in last 5 years in women. OR 0.86 [0.78–0.94], OR 0.88 [0.79–0.99].

TABLE 4: Continued.

Study	Population/data source	Weight categories <sup>1</sup>	Outcome	Findings
Rosen and Schneider 2004, [40]	BRFSS 1999	Morbidly OB (BMI $\geq$ 35)	Endoscopy	Morbid obesity was negatively associated with endoscopy in women only. RD $-4.9$ [ $-7.7$ to $-1.9$ ]. There was no significant association between morbid obesity and endoscopy in men.
Rosen and Schneider 2004, [40]	BRFSS 1999	Morbidly OB (BMI $\geq$ 35)	FOBT	Morbid obesity in women only was negatively associated with FOBT. RD $-3.7$ [ $-7.7$ to $-1.9$ ]. There was no significant association between FOBT and morbid obesity in men.
Rosen and Schneider 2004, [40]	BRFSS 1999	Morbidly OB (BMI $\geq$ 35)	Colorectal cancer screening	Morbid obesity in women only was negatively associated with overall CRC screening. RD $-5.6$ [ $-8.5$ to $-2.6$ ]. There was no association between overall CRC screening and morbid obesity in men.
Seeff et al. 2004, [41]	NHIS 2000	OW and OB	Overall CRC	There were no significant associations between receipt of CRC screening and OW or OB.
Seeff et al. 2004, [41]	NHIS 2000	OW and OB	FOBT	There was no significant association between receipt of FOBT and OW or OB.
Seeff et al. 2004, [41]	NHIS 2000	OW and OB	Endoscopy	There was no significant association between receipt of endoscopy and OW or OB.
Slattery et al. 2004, [42]	2 population-based case-control studies of colorectal cancer patients, interviewer-administered questionnaire	OW and OB	Sigmoidoscopy	OW and OB in women were positively associated with sigmoidoscopy (OR 1.8 and 2.3, resp., $P < 0.01$ ). There was no significant association between sigmoidoscopy and OW or OB in men.
Chao et al. 2004, [43]	Cancer Prevention Study (CPS) II Nutrition Cohort 1997	OW and OB, collapsed OBI and II, morbid obesity $\geq$ 40	Endoscopy	OBI and OBII were negatively associated with endoscopy in men. OR 0.88 [ $.82$ – $.94$ ]. OBI and OBII were negatively associated with endoscopy in women. OR 0.8 [ $.81$ – $.91$ ]. Morbid obesity in women was negatively associated with endoscopy. OR 0.71 [ $0.59$ – $0.85$ ].

<sup>1</sup>Predictors: OW: Overweight, OB: Obese, OBI: Obese I, OBII: Obese II, OBIII: Obese III.

factors are difficult to measure and control for in small data sets. So, smaller studies often cannot include these measures, and this is a particular problem in analyzing racial subgroups which are likely to be a small subset. Obesity is more prevalent in minority and underserved groups, who have less access to health care. Different patterns of access and utilization in weight groups are likely to confound the relationship of obesity and cancer screening, making interpretation of the literature even more challenging.

Physician recommendation is an extremely important determinant of CRC screening [56–64]. However, physicians often have negative beliefs about obese patients such as the belief that the patient lacks self-control and that the

patient is unlikely to make recommended behavior changes [50, 51, 65]. In addition, a patient's obesity appears to change the quality of the office visit. Bertakis and Azari demonstrated that the qualitative content of a visit is different in obese patients compared to their normal-weight counterparts [66]. With obese patients, the visit included less educational time and focused more on technical tasks such as physical examination. This suggests that doctors may devote less time and effort in discussions such as cancer screening. Obese patients, when questioned about satisfaction with their medical care prior to a new patient visit, were less satisfied with their medical care compared to their normal-weight counterparts [66]. This suggests

a preexisting dissatisfaction which could mean that obese patients arrive to the physician's office less ready to screen. If obese patients have any particular reluctance to screen and there is less time devoted to addressing those barriers or concerns, the likely result would be lower screening. Yet Ferrante et al. found that lower rates of cancer screening persist even after controlling for physician recommendation [12] suggesting that there may be still more to the picture.

There are some obvious differences in the relationship between weight and screening in different types of screening tests. Obese women perceive their weight as a barrier to screening, and these women cite negative attitudes of providers and inappropriately sized equipment as specific concerns [26]. These concerns seem more likely to be activated in the case of cervical cancer screening.

The relationship between obesity and cervical cancer screening is consistently negative. In contrast, the relationship between obesity and prostate cancer screening is generally positive. A blood test such as PSA is relatively easy to do, whereas cervical cancer screening is invasive and includes exposure of intimate body parts to a physician with whom the patient expects to have an ongoing relationship. So, the invasiveness or embarrassment associated with testing may be important.

The data review on prostate cancer screening and colorectal cancer screening suggests that men may be more resistant to any barriers presented by obesity. In one of the studies where there is a positive relationship between obesity and screening in men, this effect was reduced when the authors controlled for hypertension and hyperlipidemia [10]. Perhaps, for men, obesity-related conditions increase access or exposure to the health care system and, therefore, obesity facilitates cancer screening in men.

## 5. Conclusions

Inconsistent methods may be a significant source of variation in this literature. In fact, two studies examined the same data set and found different outcomes based on such different inclusion/exclusion criteria [14, 25]. More research is needed to create a comprehensive understanding of obesity and cancer screening. Specifically, work is needed to examine obesity and cancer screening in race-gender subgroups such as white men, white women, black men, and black women, and such an analysis needs to account for the effects of the doctor-patient relationship, access to care, and type of screening test. Regardless of effect on screening, obesity is clearly associated with increased cancer morbidity and mortality. So, as obesity becomes increasingly prevalent, it becomes increasingly important to understand and eliminate barriers to screening in obese individuals.

## Conflict of Interests

All authors declare that there are no competing financial interests in relation to the work described.

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