



Perceived risk of colorectal and breast cancers among women who are overweight or with obesity[☆]

Ingrid J. Hall^{a,*}, Ashwini Soman^a, Judith Lee Smith^a, Arica White^a, Anatasha Crawford^{b,1}

^a Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA 30341, United States of America

^b Research fellow, Oak Ridge Institute for Science Education (ORISE), Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA 30341, United States of America

ARTICLE INFO

Keywords:

BMI
Cancer screening
Obesity
Overweight
Perceived risk

ABSTRACT

Many overweight women or women with obesity do not acknowledge their high weight status and may be unaware of their elevated cancer risk. We explored the relationship between weight status and women's perceived risk of colorectal (CRC) and breast cancers, overall and by race/ethnicity, in a nationally representative sample.

Data was combined from NHIS 2005, 2010, and 2015 sample adult questionnaires and cancer control supplements. The analytic sample included females aged 18 years and over without reported history of cancer diagnosis. Multivariable logistic regression was performed and adjusted estimates for perceived risk of CRC and breast cancers were examined, stratified by body mass index and race/ethnicity. Data were reported using predicted marginal risk ratio (PMR).

Colorectal cancer risk perception remained lowest among Non-Hispanic (NH) Black women regardless of weight status (PMR = 0.53 obesity, 0.65 overweight, 0.55 normal) compared to NH White women after adjustment for all covariates. Hispanic women who were overweight or had obesity also saw themselves at lower risk of CRC compared to NH White women, however these findings were statistically insignificant. Breast cancer risk perception also remained low for NH Blacks and Hispanics at any weight compared with NH Whites.

Greater effort is needed to develop, disseminate, and widely adopt or institutionalize multilevel weight management interventions and programs. These programs increase awareness of excess weight as a risk factor for cancer and empower women in diverse communities to achieve and maintain a healthy weight by adopting healthy behaviors related to nutrition and physical activity.

1. Introduction

Excess weight is a risk factor for several cancers (Colditz and Peterson, 2017; Kyrgiou et al., 2017; Beavis et al., 2016; Gao et al., 2016; Lauby-Secretan et al., 2016; Li et al., 2016; Wang et al., 2016), with colorectal cancer (CRC) and postmenopausal breast cancer ranking prominently among cancers with the greatest public health burden (Renehan and Soerjomataram, 2016; De Ridder et al., 2016; Jarvis et al., 2016; Gathirua-Mwangi et al., 2015). For women, the incidence of cancers associated with obesity increased for postmenopausal breast cancer concomitant with the increasing prevalence of obesity (Steele et al., 2017). A projection of the future health and economic burden of obesity estimated that continuation of existing trends in obesity will

lead to about 500,000 additional cases of cancer among men and women in the United States by 2030 (Wang et al., 2011).

In 2016, the prevalence of obesity was over 40% among adult women (Hales et al., 2017). Obesity-related cancers accounted for > 55% of all cancers diagnosed among women, and postmenopausal breast cancer comprised 31% of these diagnoses (Steele et al., 2017). Obesity also substantially increased individual risk relative to that of normal weight, where risk of CRC increased by 30% (Ma et al., 2013). Higher body mass index (BMI) was also associated with a modest increase in individual risk of breast cancer. For example, a 5-unit increase in BMI (1 kg/m²) was associated with a 10–12% increase in risk (Kyrgiou et al., 2017; Keum et al., 2015; Renehan et al., 2008). Women with obesity have a 20–40% increased risk of postmenopausal breast

[☆] The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

* Corresponding author at: 4770 Buford Hwy MS F76, Chamblee, GA 30341, United States of America.

E-mail address: iah9@cdc.gov (I.J. Hall).

¹ Current address: 5901 Peachtree Dunwoody Rd NE, Atlanta, GA 30328.

<https://doi.org/10.1016/j.pmedr.2019.100845>

Received 19 November 2018; Received in revised form 25 February 2019; Accepted 14 March 2019

Available online 22 March 2019

2211-3355/ © 2019 Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

cancer compared to those of normal weight (Munsell et al., 2014).

A majority (81%) of Americans named obesity as the top health issue, equal to cancer, and agreed that obesity increased risk of early death (Rosenthal et al., 2017). Other researchers have reported a dose-response trend where increased weight, overweight, and obesity have been positively correlated with increased perceived cancer risk (Bittner Fagan et al., 2012; Silverman et al., 2017; Consedine et al., 2004). Despite published literature, many patients who are overweight or have obesity do not acknowledge their high weight status and may be unaware of their elevated risk (Rosenthal et al., 2017; Henretta et al., 2014; Bittner Fagan et al., 2012; Leite-Pereira et al., 2011; Messina et al., 2012). Rosenthal et al. (2017) reported that 47% of a study sample with patients who have obesity considered themselves only overweight rather than obese. Henretta et al., 2014 reported that although nearly 50% of bariatric surgery candidates in their study responded that obesity increased the risk of breast, cervical, or CRC, 35–45% reported their personal likelihood of developing cancer not likely or not possible (Henretta et al., 2014). Messina et al. (2012) reported that obese women were less aware than normal weight women that obesity increased risk for CRC (OR = 0.5, 95% CI: 0.3–0.9), while other estimates suggest only 52% of Americans are aware of the obesity-cancer link (AICR).

Although these findings are compelling, few studies have examined perceived risk of cancer among a racially diverse group of women who were overweight or had obesity. Honda and Neugut (2004) reported that racial/ethnic minorities were less likely to perceive cancer risk. Obesity prevalence varies by race with age-adjusted prevalence of obesity estimated to be 54.8%, 50.6%, 38.0%, and 14.8% among non-Hispanic (NH) Black, Hispanic, NH White, and NH Asian women respectively (Hales et al., 2017). Literature shows that body image and perception of overweight and obesity also vary by race (Fiery et al., 2016; Baruth et al., 2015; Schaefer et al., 2015). This variation may affect the likelihood of some overweight women or women with obesity to perceive themselves at risk for cancer. The purpose of this analysis is to explore perceived risk of colorectal and breast cancers among women who were normal weight, overweight, or had obesity and whether the relationship varies by race/ethnicity in a nationally representative sample.

2. Methods

2.1. National health interview survey

The National Health Interview Survey (NHIS) is the principal source of information on the health of a nationally representative cross-sectional sample of the civilian noninstitutionalized US population. Initiated by Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS) and conducted annually by the U.S. Bureau of the Census, the NHIS collects demographic and health information during in-person interviews for each participating household. A family core questionnaire is administered to each family within the sampled household. One adult is randomly selected from each family who is then administered the sample adult questionnaire and additional supplement(s) such as the cancer control supplement which contains detailed questions on cancer screening behaviors and risk perception. NHIS oversamples minority race/ethnic groups to allow for more precise estimation of health and behaviors in these populations. The final response rate for the sample adult components for the NHIS 2005, 2010, and 2015 cycles was 69.0, 60.8, and 55.7%, respectively (NCHS).

2.2. Analysis variables

The analytic sample for this study included females aged 18 years and over without any reported history of cancer diagnosis. In order to have sufficient sample sizes of racial and ethnic subgroups, we used the

cancer control supplements administered in 2005, 2010, and 2015. To assess the respondents' perceived risk of getting cancer, we used two questions, "Compared to the average woman your age, would you say that you are more likely to get breast cancer (or colorectal cancer), less likely, or about as likely?" Respondents who reported more likely were coded as "High Perception" and we combined the categories of about as likely, less likely, and don't know as "Low". Respondents who reported "Don't Know" were not different on relevant study variables from those who reported less likely and therefore, were combined into "Low" category. BMI was categorized as underweight (< 18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0 kg/m²–29.9 kg/m²), and obese (≥ 30.0 kg/m²) (CDC). Race was categorized as Hispanic, Non-Hispanic (NH) White, NH Black, NH Asian, and NH Other by combining race and ethnicity variables. However, our stratified analyses could not examine NH Asian and NH Other due to lack of power. Non-cancer chronic comorbidities are categorized into none, one, two, and three or more and included the weight-related conditions of hypertension, coronary heart disease, myocardial infarction, stroke, emphysema, asthma, and diabetes. Family household income from NHIS imputed income files was used to calculate poverty level. Family history of breast cancer in first degree female relatives and family history of colorectal cancer in male and female first degree relatives was used for analyses of respective risk perception variables.

2.3. Statistical analysis

We combined data from NHIS 2005, 2010, and 2015 sample adult questionnaires and cancer control supplements. The sampling scheme of NHIS changed after year 2005. Adjustments to design variables were made to account for these changes and allowed for pooled analysis. A test of trend was performed using logistic regression to detect changes in CRC and breast cancer risk perception between years 2005, 2010, and 2015. Risk perception for both cancers did not change significantly between year 2005 and 2010 however, breast and CRC risk perception declined slightly in 2015 compared to 2005, and this difference was statistically significant ($p < 0.05$). To account for these changes, all multivariable analyses were adjusted for survey year. We examined distribution of BMI across race/ethnicity categories. Bivariate analyses of breast and CRC risk perception variables were performed, stratified by race/ethnicity and all races combined. Multivariable logistic regression was performed and adjusted estimates for risk perception, stratified by BMI and race/ethnicity, were provided using predicted marginal risk ratio (PMR). All analyses were conducted using SAS version 9.3 and SAS-callable SUDAAN version 11.0.

3. Results

Distribution of risk perception, obesity, and demographic characteristics varied by race in the study sample (Table 1). A greater proportion of NH White women (6.8%) perceived themselves at higher risk of CRC than Hispanic (4.6%) and NH Black (3.9%) and women. Similar findings were observed for breast cancer risk perception among NH Black, Hispanic, and NH White women (8.9%, 7.9%, and 11.5%, respectively). Nearly 30% of our study sample had obesity with highest prevalence among NH Blacks (40.7%), followed by Hispanic (31.6%), and NH White (24.7%) women.

Hispanics were the youngest group, with 73% of sample under 49 years of age. Overall, 30% of Hispanics reported having obesity, 37% had college or higher education, and 63% were below 200% of poverty line. Among NH Whites, 55% were under 49 years, 25% reported having obesity, 64% had college or higher education, and 32% were below 200% poverty line. Among NH Blacks, 64% were 49 years or younger, 41% had obesity, 55% had college or higher education, and 60% were below 200% poverty line.

Adjusted estimates of perceived risk by BMI status were examined by race (Tables 2a and 2b). NH White women with obesity were more

Table 2a
Adjusted estimates of colorectal cancer risk perception by race and BMI.

	White			Black			Hispanic			All Races		
	PMR	Low CI	Up CI	PMR	Low CI	Up CI	PMR	Low CI	Up CI	PMR	Low CI	Up CI
BMI												
1) < 18.5/underweight	1.09	0.76	1.52	0.98	0.34	2.78	0.81	0.34	1.96	1.01	0.74	1.39
2)18.5–24.9//normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
3)25.0–29.9/overweight	1.11	0.96	1.28	1.16	0.76	1.79	1.25	0.89	1.74	1.14	1.01	1.28
4)30.0–99.4/obese	1.27	1.1	1.47	1.18	0.78	1.79	1.29	0.96	1.73	1.25	1.1	1.42

*Adjusted for age, education, marital status, poverty, insurance, smoking, family history of cancer, usual place of care, number of chronic conditions and survey year.

likely to perceive themselves at risk for CRC than their normal and overweight counterparts. Neither NH Black nor Hispanic women with obesity perceived themselves at risk for CRC. In comparison, NH White women and Hispanic women with obesity, as well as those overweight, were more likely to perceive risk of breast cancer than their normal weight counterparts. In contrast, NH Black women did not perceive higher risk of breast cancer at any weight compared to those at normal weight.

Multivariable adjusted analyses examined risk perception stratified by race/ethnicity and BMI (Table 3). Colorectal cancer risk perception remained lowest among NH Black women regardless of weight status (PMR = 0.53 obese, 0.65 overweight, 0.55 normal) compared to NH White women after adjustment for all covariates. Hispanic women who were overweight or had obesity also saw themselves at lower risk of CRC compared to NH White women, however these findings were not statistically significant. Normal weight Hispanic women had lower risk perception of CRC than NH White women (PMR = 0.75, 95% CI 0.6–0.95). Breast cancer risk perception also remained lower for NH Blacks and Hispanics at any weight compared with NH Whites. There were no significant differences in risk perception by race/ethnicity for either cancer among underweight women.

Risk perception of both CRC and breast cancer was higher among the youngest age group (18–29 years) and declined with increasing age. Risk perception of CRC increased with years of education with college graduates reporting highest risk perception (PMR = 1.44, 95% CI 1.18–1.74) compared to those with less than a high school education. No differences in breast cancer risk perception by education were detected. Current smokers reported greater risk perception of CRC (PMR = 1.30, 95% CI 1.14–1.47) and breast cancer (PMR = 1.32, 95% CI 1.22–1.44) than never smokers. Respondents with family history of CRC had eight times the risk perception for CRC (PMR = 8.25, 95% CI 7.51–9.07) than those without a family history of CRC. A similar pattern was observed for those with a family history of breast cancer and risk perception of breast cancer (PMR = 6.29, 95% CI 5.89–6.71) compared to those without a family history of breast cancer. Risk perception also increased with number of weight-related comorbidities. Persons with 3 or more comorbidities had a PMR of 1.92 (95% CI 1.58–2.34) for CRC and 1.50 (95% CI 1.27–1.76) for breast cancer compared to those with no reported weight-related comorbidities.

Fig. 1 displays prevalence of obesity (BMI ≥ 30) across multiple study years by race/ethnicity. Obesity prevalence increased over time

for NH White (22.1% in 2005 to 27.4% in 2015) and NH Black women (35.7 in 2005 to 43.9% in 2015) at a similar rate. Risk perception of CRC and breast cancer appeared to decrease across study years even as obesity prevalence increased, although the decline was not statistically significant. In 2015, NH Black women with obesity had the lowest perceived risk of CRC of all racial/ethnic groups and lower perceived risk of breast cancer than NH White women. Among Hispanics with obesity, prevalence of obesity was relatively stable across study years, risk perception of CRC and breast cancer was lower among Hispanics than NH White women with a slight but non-significant increase in CRC risk perception over time.

4. Discussion

Our findings show that the prevalence of obesity has increased similarly for NH Black and NH White women over the past 15 years, although at a much higher magnitude for NH Blacks. However, at any weight, NH Black women perceived themselves less likely to be at risk of CRC and breast cancer than NH White women. Even among those with obesity and presumably at highest risk (Kyrgiou et al., 2017, Steele et al., 2017), NH Black women were least likely to perceive themselves at higher risk, possibly not recognizing excess weight as a risk factor for CRC and breast cancer. A similar observation was noted among Hispanic women with obesity who were also less likely to perceive themselves at risk of CRC and breast cancer compared with NH White women. An alternate explanation is that the low prevalence of family history, a strong predictor of perceived risk, among Hispanics and NH Blacks may account for low perceived risk among these groups.

Few studies examining excess weight and perceived cancer risk have assessed risk perception of multiple cancers in a racially and ethnically diverse sample. Silverman et al. (2017) examined general cancer risk perception among a predominantly NH White and educated sample. Bittner Fagan et al. (2012) examined risk perception of CRC and cancer in general in a sample that did not include Hispanics. Findings in these studies varied. Silverman found that overall, subjects with obesity were more likely to have an increased relative risk perception of cancer compared to normal weight persons, while Bittner Fagan et al. reported that there was no increased risk perception among individuals who were overweight or had obesity. However, in the latter study, NH Black women with obesity appeared to recognize their increased risk. In contrast, our findings showed that NH Black women with obesity were

Table 2b
Adjusted estimates of breast cancer risk perception by race and BMI.

	White			Black			Hispanic			All Races		
	PMR	Low CI	Up CI	PMR	Low CI	Up CI	PMR	Low CI	Up CI	PMR	Low CI	Up CI
BMI												
1) < 18.5/underweight	0.85	0.63	1.17	0.64	0.27	1.44	1.13	0.57	2.24	0.83	0.64	1.1
2)18.5–24.9//normal	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
3)25.0–29.9/overweight	1.2	1.07	1.34	1.14	0.17	1.52	1.28	1.02	1.61	1.28	1.1	1.32
4)30.0–99.4/obese	1.32	1.19	1.47	1.28	0.17	1.68	1.31	1.03	1.68	1.31	1.19	1.43

*Adjusted for age, education, marital status, poverty, insurance, smoking, family history of cancer, usual place of care, number of chronic conditions and survey year.

Table 3
Adjusted estimates of colorectal and breast cancer risk perception, NHIS 2005, 2010 and 2015.

	CRC Risk perception			BRC Risk Perception		
	PMR	Low CI	UP CI	PMR	UP CI	Low CI
BMI (kg/m ²) and race/ethnicity						
Obese						
NH White	Ref	Ref	Ref	Ref	Ref	Ref
Hispanic	0.88	0.72	1.09	0.73	0.61	0.86
NH Black	0.53	0.42	0.67	0.73	0.63	0.86
Overweight						
NH White	Ref	Ref	Ref	Ref	Ref	Ref
Hispanic	0.97	0.75	1.26	0.76	0.63	0.92
NH Black	0.65	0.48	0.88	0.74	0.6	0.9
Normal						
NH White	Ref	Ref	Ref	Ref	Ref	Ref
Hispanic	0.75	0.6	0.95	0.68	0.58	0.79
NH Black	0.55	0.39	0.78	0.79	0.64	0.98
Underweight						
NH White	Ref	Ref	Ref	Ref	Ref	Ref
Hispanic	0.59	0.21	1.6	0.89	0.44	1.79
NH Black	0.28	0.04	2.17	0.47	0.47	1.27
Age (years)						
18–29	2.45	1.93	3.12	5.64	4.56	6.97
30–39	2.56	2.06	3.18	4.99	4.06	6.14
40–49	2.29	1.86	2.83	4.29	3.5	5.26
50–59	2.08	1.68	2.58	3.2	2.61	3.92
60–69	1.65	1.33	2.05	2.04	1.66	2.51
70–85	Ref	Ref	Ref	Ref	Ref	Ref
Education						
< High School	Ref	Ref	Ref	Ref	Ref	Ref
Highschool/GED	1.09	0.92	1.3	0.97	0.87	1.09
Some college	1.21	1.02	1.44	1.04	0.92	1.17
College graduate and more	1.44	1.18	1.74	1.06	0.93	1.21
Marital status						
Never married	Ref	Ref	Ref	Ref	Ref	Ref
Married/living with partner	1.04	0.89	1.22	1.11	1.01	1.22
Widowed/divorced/separated	1.01	0.85	1.19	1.21	1.08	1.36
Insurance						
Private	Ref	Ref	Ref	Ref	Ref	Ref
Public	1.15	0.99	1.33	1.09	0.97	1.22
Public + private	0.98	0.88	1.1	1.12	1.03	1.22
None	1.13	0.95	1.33	1.09	0.96	1.23
Poverty						
< 200%	1.07	0.94	1.22	1.08	0.97	1.2
200–400%	1	0.87	1.15	0.99	0.9	1.09
400% or more	Ref	Ref	Ref	Ref	Ref	Ref
Smoking						
Current	1.3	1.14	1.47	1.32	1.22	1.44
Former	1.22	1.08	1.38	1.03	0.94	1.13
Never	Ref	Ref	Ref	Ref	Ref	Ref
Family HX: colorectal cancer						
Yes	8.25	7.51	9.07	~	~	~
None	Ref	Ref	Ref	~	~	~
Family HX: breast CA 1Dgr Female						
Yes	~	~	~	6.29	5.89	6.71
None	~	~	~	Ref	Ref	Ref
Usual place of care						
Clinic	Ref	Ref	Ref	Ref	Ref	Ref
Doc office/HMO	0.95	0.84	1.08	1.02	0.93	1.12
ER/out patient	0.98	0.69	1.41	0.98	0.76	1.26
Other	1.18	0.74	1.89	1.06	0.79	1.41
No place	0.9	0.75	1.08	1.04	0.92	1.19
Number of chronic comorbidities						
None	Ref	Ref	Ref	Ref	Ref	Ref
1	1.27	1.13	1.43	1.28	1.17	1.39
2	1.63	1.38	1.92	1.43	1.26	1.63
3 or more	1.92	1.58	2.34	1.5	1.27	1.76
Year						

Table 3 (continued)

	CRC Risk perception			BRC Risk Perception		
	PMR	Low CI	UP CI	PMR	UP CI	Low CI
2005	Ref	Ref	Ref	Ref	Ref	Ref
2010	0.93	0.83	1.05	0.99	0.91	1.07
2015	0.79	0.7	0.89	0.88	0.81	0.96

the least likely to perceive (or recognize) higher risk of CRC or breast cancer.

Interestingly, as obesity prevalence increased over time, there was no concomitant increase in perceived risk of cancer in our study sample. A possible explanation for this could be normalization of overweight and obesity in the general population, and among the observed subgroups specifically. In addition, respondents were asked to assess their risk compared to an “average” woman. Over the years, this average woman now likely weighs more. Extensive literature has shown that NH Black women tend to have positive body image perceptions regardless of weight classification (Chugh et al., 2013, Fiery et al., 2016, Schaefer et al., 2015, Lynch and Kane, 2014, Goldkamp et al., 2015). In these studies, NH Black women were more likely to underestimate their BMI and less likely to compare themselves to others, classify themselves with obesity, or engage in unfavorable body talk (Fiery et al., 2016, Schaefer et al., 2015, Lynch and Kane, 2014, Goldkamp et al., 2015) compared to NH Whites or Hispanics. Such tendency to underestimate or acknowledge being overweight or having obesity coupled with lack of appropriate risk perception related to excess weight for multiple diseases including cancer (Harris et al., 2016) may explain somewhat stable or declining risk perception trends.

Women who are overweight or have obesity are at increased risk of CRC and breast cancer and need information about risks associated with excess weight. Given the current prevalence of overweight and obesity among NH Blacks and Hispanics and projected future increases in prevalence (Wang et al., 2011), the need is even more salient for these groups. Increased awareness of the link between excess weight and cancer and appropriate risk perception may lead to a change in dietary habits, physical activity levels that meet current guidelines, or participation in timely, recommended cancer screening. In particular, given the higher risk of cancer mortality (Miller et al., 2017) in NH Black women, all opportunities can be taken to raise awareness of risk conferred by excess weight and encourage cancer screening. An additional concern is evidence that suggests high BMI to be associated with triple negative breast cancer in postmenopausal women (Phipps et al., 2011). Triple negative breast cancer occurs disproportionately in younger, NH Black, and Hispanic women (Lara-Medina et al., 2011), and is associated with poorer survival (Phipps et al., 2011).

Our data also show that risk perception for CRC and breast cancer increased with number of comorbidities. It is possible that women with multiple comorbidities consider themselves more susceptible to cancer in addition to or because of their other chronic conditions. Women with multiple comorbidities likely have greater interaction with providers and the healthcare system. These interactions are opportunities to discuss the elevated risk for cancer posed by excess weight, to provide weight management counseling, and cancer screening. However, one study found decline in weight management counseling in primary care settings (Fitzpatrick and Stevens, 2017).

Strengths of this study include diversity in racial/ethnic composition of the sample as well as in education and income not explored in previous studies. Racial/ethnic diversity is important given the previously mentioned variation in perception of body image (Fiery et al., 2016, Schaefer et al., 2015). In addition, Honda and Neugut (2004) reported that racial/ethnic minorities were less likely to perceive cancer risk. A survey of 755 NH Black churchgoers revealed that 48% perceived their cancer risk to be lower than an average person their age

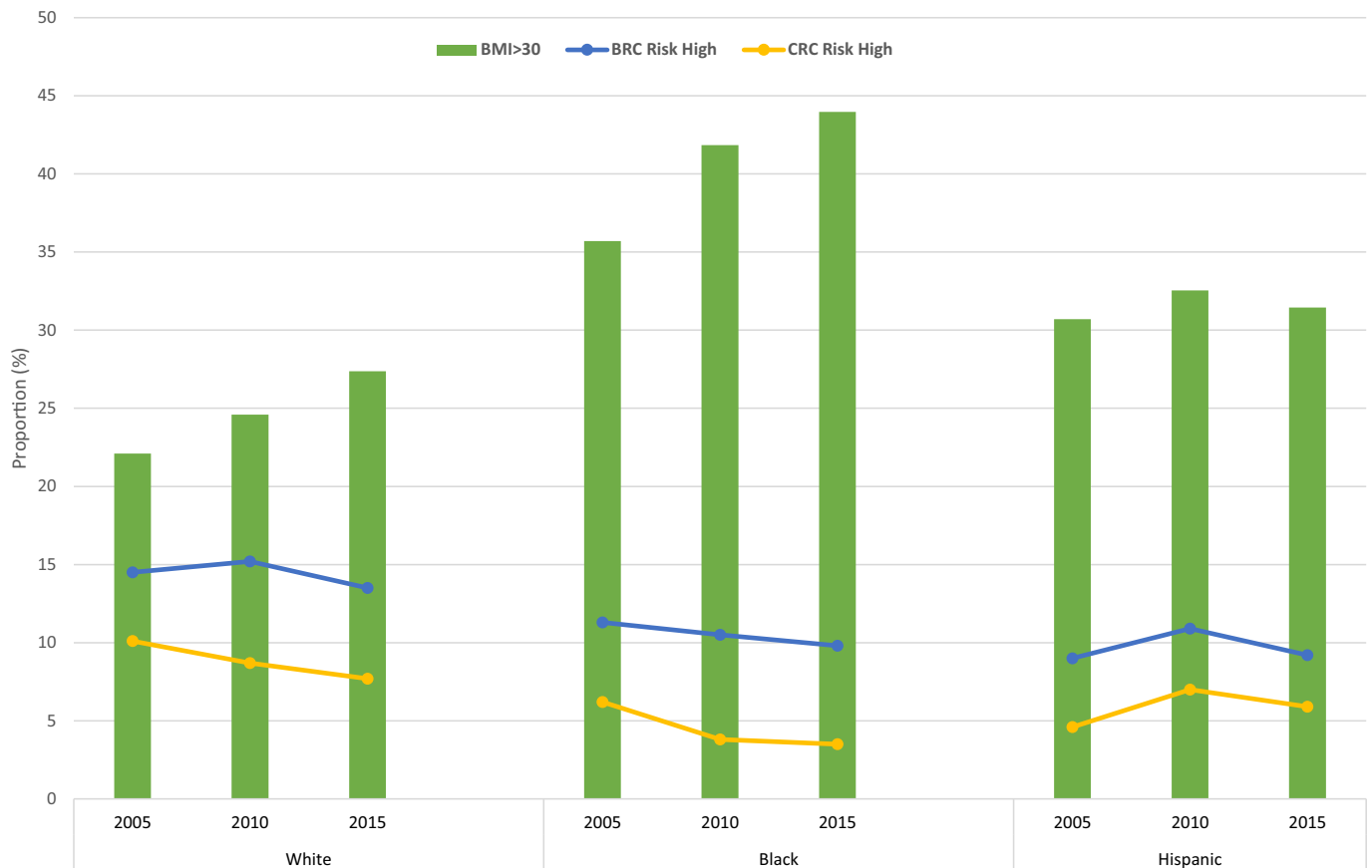


Fig. 1. Obesity and risk perception by race and ethnicity, NHIS 2005, 2010, and 2015.

In 2015, NH Black women with obesity had the lowest perceived risk of CRC of all racial/ethnic groups and lower perceived risk of breast cancer than NH White women. Among Hispanics with obesity, prevalence of obesity was relatively stable across study years, risk perception of CRC and breast cancer was lower among Hispanics than NH White women with a slight but non-significant increase in CRC risk perception over time.

(Lucas-Wright et al., 2014). Our sample also included young adults as it is important to be aware of their risk perception at younger age. Weight gain in early adulthood has been linked to major health outcomes later in life (Zheng et al., 2017). For every 2 years of obesity, the hazard ratio for cancer has been estimated to increase by 7% (Abdullah et al., 2011). Arnold et al. (2016) estimated a 5% increase in breast cancer risk for every 10 years of obesity duration and 8% among those at higher BMI. Additionally, there is some evidence that body fatness at young age (≤ 30 years) may impact adult CRC risk (Hidayat et al., 2017). Taken together it is important for providers to understand potential differences in risk perception among minority women and those of younger age in order to intervene with culturally appropriate messages to minimize cancer risk due to obesity and longer obesity duration. We were also able to assess cancer specific risk perception rather than perception of general cancer risk, and our analysis also included family history of breast and CRC rather than general family history of any cancer. These additions to the analysis led to greater specificity of risk perception estimates specific to the cancers of interest.

Limitations of the study include use of self-reported data (Northrup, 1996) that may lead to misclassification of BMI due to incorrect reporting of weight and height. We were unable to include NH Asians and NH Others in analyses due to low power. In particular, we were not able to include American Indian and Alaskan Natives who have a higher prevalence of overweight and obesity. Another limitation was the inability to directly assess awareness of obesity as a risk factor for cancer as this question was not asked of respondents.

Public health opportunities exist to educate women about the risk posed by excess weight for some cancers and actions they can take to reduce their risk. Many of these opportunities for preventive care in

clinical settings are outlined in Massetti et al. and focus on monitoring BMI, counseling and early referral for avoidance of weight gain, and reinforcement of public health messages (Massetti et al., 2017). The USPSTF recommends screening all adults 18 and older for obesity with referral for individuals with BMI of 30 kg/m² or greater to intensive, multicomponent behavioral interventions (USPSTF) to promote improvements in weight status. Greater routine adoption of these recommendations could be fruitful given that Harris et al. report that physician-informed weight status resulted in greater odds of accurate weight perception (Harris et al., 2016). Counseling about the role of excess weight in cancer and other chronic conditions can be included in health discussions to inform young women prior to screening age or onset of disease. There may be opportunities to bundle messages so that women, younger and older, are not overwhelmed with multiple messages (Massetti et al., 2017, Fitzpatrick and Stevens, 2017). Greater effort is needed to develop, disseminate, and widely adopt or institutionalize multilevel interventions and programs that increase awareness of excess weight as a risk factor for cancer and other chronic conditions and empower women, particularly those at greatest risk, to achieve and maintain a healthy weight and adopt healthy behaviors related to nutrition and physical activity.

Conflicts of interest

None.

References

Abdullah, A., Wolfe, R., Stoelwinder, J.U., et al., 2011. The number of years lived with

- obesity and the risk of all-cause and cause-specific mortality. *Int. J. Epidemiol.* 40, 985–996.
- American Institute for Cancer Research, 2015. The AICR 2015 Cancer Risk Survey Report. American Institute for Cancer Research, Washington, DC. <http://www.aicr.org/assets/docs/pdf/education/aicr-awareness-report-2015.pdf>, Accessed date: 30 April 2018.
- Arnold, M., Jiang, L., Stefanick, M.L., Johnson, K.C., Lane, D.S., LeBlanc, E.S., Prentice, R., Rohan, T.E., Snively, B.M., Vitolins, M., Zaslavsky, O., Soerjomataram, I., Anton-Culver, H., 2016. Duration of adulthood overweight, obesity, and cancer risk in the Women's Health Initiative: a longitudinal study from the United States. *PLoS Med.* 13 (8), e1002081. <https://doi.org/10.1371/journal.pmed.1002081>. (eCollection 2016 Aug. Aug 16).
- Baruth, M., Sharpe, P.A., Magwood, G., Wilcox, S., Schlaff, R.A., 2015. Body size perceptions among overweight and obese African American women. *Ethn. Dis.* 25 (4), 391–398. <https://doi.org/10.18865/ed.25.4.391>. (Nov 5).
- Beavis, A.L., Smith, A.J., Fader, A.N., 2016. Lifestyle changes and the risk of developing endometrial and ovarian cancers: opportunities for prevention and management. *Int. J. Women's Health* 8, 151–167. <https://doi.org/10.2147/IJWH.S88367>. (eCollection 2016. May 23).
- Bittner Fagan, H., Sifri, R., Wender, R., Schumacher, E., Reed, J.F., 2012. Weight status and perception of colorectal cancer risk. *J. Am. Board Fam. Med.* 25, 792–797.
- Centers for Disease Control and Prevention Overweight and obesity. defining adult overweight and obesity. <https://www.cdc.gov/obesity/adult/defining.html>, Accessed date: 31 August 2018.
- Chugh, M., Friedman, A.M., Clemon, L.P., Ferrante, J.M., 2013. Women weigh in: obese African American and white women's perspectives on physicians' roles in weight management. *J. Am. Board Fam. Med.* 26 (4), 421–428. <https://doi.org/10.3122/jabfm.2013.04.120350>. Jul-Aug.
- Colditz, G.A., Peterson, L.L., 2017. Obesity and Cancer: evidence, impact, and future directions. *Clin. Chem.* <https://doi.org/10.1373/clinchem.2017.277376>. pii: clinchem.2017.277376. (Epub ahead of print. Oct 16).
- Consedine, N.S., Magai, C., Conway, F., Neugat, A.L., 2004. Obesity and awareness of obesity as risk factors for breast cancer in six ethnic groups. *Obes. Res.* 12 (10), 1680–1689 (Oct).
- De Ridder, J., Julián-Almárcegui, C., Mullee, A., Rinaldi, S., Van Herck, K., Vicente-Rodríguez, G., Huybrechts, 2016. Comparison of anthropometric measurements of adiposity in relation to cancer risk: a systematic review of prospective studies. *Cancer Causes Control* 27 (3), 291–300. <https://doi.org/10.1007/s10552-015-0709-y>. (Epub 2016 Jan 13. Mar).
- Fiery, M.F., Martz, D.M., Webb, R.M., 2016. Curtin L. a preliminary investigation of racial differences in body talk in age-diverse U.S. adults. *Eat. Behav.* 21, 232–235. <https://doi.org/10.1016/j.eatbeh.2016.03.004>. (Epub 2016 Mar 6. Apr).
- Fitzpatrick, S.L., Stevens, V.J., 2017. Adult obesity management in primary care, 2008–2013. *Prev. Med.* 99, 128–133. <https://doi.org/10.1016/j.ypmed.2017.02.020>. Jun. (Epub 2017 Feb 21).
- Gao, Y., Dai, X., Chen, L., Lee, A.C., Tong, M., Wise, M., Chen, Q., 2016. Body mass index is positively associated with endometrial Cancer in Chinese women, especially prior to menopause. *J. Cancer* 7 (9), 1169–1173. <https://doi.org/10.7150/jca.15037>. (eCollection 2016. Jun 6).
- Gathirua-Mwangi, W.G., Zollinger, T.W., Murage, M.J., Pradhan, K.R., Champion, V.L., 2015. Adult BMI change and risk of breast Cancer: National Health and nutrition examination survey (NHANES) 2005–2010. *Breast Cancer* 22 (6), 648–656. <https://doi.org/10.1007/s12282-015-0638-3>. (Epub 2015 Sep 8. Nov).
- Goldkamp, J., Anderson, S., Lifits-Podorozhansky, Y., Gavard, J.A., 2015. Women's perceptions regarding obesity and comorbidities and provider interaction. *J. Obstet. Gynecol. Neonatal Nurs.* 44 (6), 784–792. <https://doi.org/10.1111/1552-6909.12751>. Nov–Dec. (Epub 2015 Sep 24).
- Hales, C.M., Carroll, M.D., Fryar, C.D., Ogden, C.L., 2017. Prevalence of Obesity among Adults and Youth: United States, 2015–2016. NCHS data brief, no 288 National Center for Health Statistics, Hyattsville, MD.
- Harris, C.L., Strayhorn, G., Moore, S., Goldman, B., Martin, M.Y., 2016. Perceived physician-informed weight status predicts accurate weight self-perception and weight self-regulation in low-income, African American women. *J. Health Care Poor Underserved* 27 (3), 1441–1463. <https://doi.org/10.1353/hpu.2016.0140>.
- Henretta, M.S., Copeland, A.R., Kelley, S.L., Hallowell, P.T., Modesitt, C.C., 2014. Perceptions of obesity and cancer risk in female bariatric surgery candidates: highlighting the need for physician action for unsuspectingly obese and high risk patients. *Gynecol. Oncol.* 133 (1), 73–77. <https://doi.org/10.1016/j.ygyno.2014.01.016>. Apr.
- Hidayat, K., Yang, C.M., Shi, B.M., 2017. Body fatness at an early age and risk of colorectal cancer. *Int. J. Cancer.* <https://doi.org/10.1002/ijc.31100>. Oct 12. (Epub ahead of print).
- Honda, K., Neugat, A.L., 2004. Associations between perceived cancer risk and established risk factors in a national community sample. *Cancer Detect. Prev.* 28 (1), 1–7.
- Jarvis, D., Mitchell, J.S., Law, P.J., Palin, K., Tuuppanen, S., Gylfe, A., Hänninen, U.A., et al., 2016. Mendelian randomisation analysis strongly implicates adiposity with risk of developing colorectal cancer. *Br. J. Cancer* 115 (2), 266–272. <https://doi.org/10.1038/bjc.2016.188>. Jul 12. (Epub 2016 Jun 23).
- Keum, N., Greenwood, D.C., Lee, D.H., Kim, R., Aune, D., Ju, W., Hu, F.B., Giovannucci, E.L., 2015. Adult weight gain and adiposity-related cancers: a dose-response meta-analysis of prospective observational studies. *J. Natl. Cancer Inst.* 107 (2). <https://doi.org/10.1093/jnci/djv088>. pii: djv088. Mar 10. (Print 2015 Feb).
- Kyrgiou, M., Kalliala, I., Markozannes, G., Gunter, M.J., Paraskevidis, E., Gabra, H., Martin-Hirsch, P., Tsilidis, K.K., 2017. Adiposity and cancer at major anatomical sites: umbrella review of the literature. *BMJ* 356, j477. <https://doi.org/10.1136/bmj.j477>. Feb 28.
- Lara-Medina, F., Pérez-Sánchez, V., Saavedra-Perez, D., Blake-Cerda, M., Arce-Salinas, C., Motola-Kuba, D., Villarreal-Garza, C., Lluich, A., Bargallo, E., Aguilar, J., Mohar, A., Arrieta, O., 2011. Triple-negative breast cancer in Hispanic patients. *Cancer* 117, 3658–3669. <https://doi.org/10.1002/cncr.25961>.
- Lauby-Secretan, B., Scoccianti, C., Loomis, D., Grosse, Y., Bianchini, F., Straif, K., International Agency for Research on Cancer Handbook Working Group, 2016. Body fatness and cancer—viewpoint of the IARC working group. *N. Engl. J. Med.* 375, 794–798.
- Leite-Pereira, F., Medeiros, R., Dinis-Ribiero, M., 2011. Overweight and obese patients do not seem to adequately recognize their own risk for colorectal cancer. *J. Cancer Educ.* 26, 767–773.
- Li, L., Gan, Y., Li, W., Wu, C., Lu, Z., 2016. Overweight, obesity and the risk of gallbladder and extrahepatic bile duct cancers: a meta-analysis of observational studies. *Obesity (Silver Spring)*. <https://doi.org/10.1002/oby.21505>. Jul 9. (Epub ahead of print).
- Lucas-Wright, A., Bazargan, M., Jones, L., Vadgama, J.V., Vargas, R., Sarkissyan, M., Smith, J., Yazdanzhenas, H., Maxwell, A.E., 2014. Correlates of perceived risk of developing cancer among African-Americans in South Los Angeles. *J. Community Health* 39 (1), 173–180. <https://doi.org/10.1007/s10900-013-9756-z>. Feb.
- Lynch, E.B., Kane, J., 2014. Body size perception among African American women. *J. Nutr. Educ. Behav.* 46 (5), 412–417. <https://doi.org/10.1016/j.jneb.2014.03.002>. Sep-Oct.
- Ma, Y., Yang, Y., Wang, F., et al., 2013. Obesity and risk of colorectal cancer: a systematic review of prospective studies. *PLoS One* 8 (1), e53916.
- Masseti, G.M., Dietz, W.H., Richardson, L.C., 2017. Excessive weight gain, obesity, and cancer: opportunities for clinical intervention. *JAMA.* <https://doi.org/10.1001/jama.2017.15519>. Oct 3.
- Messina, C.R., Lane, D.S., Anderson, J.C., 2012. Body mass index and screening for colorectal cancer: gender and attitudinal factors. *Cancer Epidemiol.* 36 (4), 400–408. <https://doi.org/10.1016/j.canep.2012.02.002>. Aug. (Epub 2012 Mar 2).
- Miller, J.W., Smith, J.L., Ryerson, A.B., Tucker, T.C., Allemani, C., 2017. Disparities in breast cancer survival in the United States (2001–2009): findings from the CONCORD-2 study. *Cancer* 123 (Suppl. 24), 5100–5118. <https://doi.org/10.1002/cncr.3098>. Dec 15.
- Munsell, M.F., Sprague, B.L., Berry, D.A., Chisholm, G., Trentham-Dietz, A., 2014. Body mass index and breast cancer risk according to postmenopausal estrogen-progestin use and hormone receptor status. *Epidemiol. Rev.* 36, 114–136.
- National Center for Health Statistics, 2015. Survey Description, National Health Interview Survey. Hyattsville, Maryland 2016. https://www.cdc.gov/nchs/nhis/about_nhis.htm.
- Northrup, David A., 1996. *The Problem of the Self-Report in Survey Research.* 11 (3) Institute for Social Research.
- Phipps, A.I., Chlebowski, R.T., Prentice, R., McTiernan, A., Stefanick, M.L., Wactawski-Wende, J., Kuller, L.H., Adams-Campbell, L.L., Lane, D., Vitolins, M., Kabat, G.C., Rohan, T.E., Li, C.I., 2011. Body size, physical activity, and risk of triple-negative and estrogen receptor–positive breast cancer. *Cancer Epidemiol. Biomark. Prev.* 20 (3), 454–463. <https://doi.org/10.1158/1055-9965.EPI-10-0974>. (Published March 2011).
- Renahan, A.G., Soerjomataram, I., 2016. Obesity as an avoidable cause of cancer (attributable risks). *Recent Results Cancer Res.* 208, 243–256.
- Renahan, A.G., Tyson, M., Egger, M., Heller, R.F., Zwahlen, M., 2008. Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. *Lancet* 371 (9612), 569–578.
- Rosenthal, R.J., Morton, J., Brethauer, S., Mattar, S., De Maria, E., Benz, J.K., Titus, J., Sterrett, D., 2017. Obesity in America. *Surg. Obes. Relat. Dis.* 13 (10), 1643–1650. <https://doi.org/10.1016/j.soard.2017.08.002>. Oct. (Epub 2017 Aug 12).
- Schaefer, L.M., Thibodaux, L.K., Krenik, D., Arnold, E., Thompson, J.K., 2015. Physical appearance comparisons in ethnically diverse college women. *Body Image* 15, 153–157. <https://doi.org/10.1016/j.bodyim.2015.09.002>. Sep. (Epub 2015 Oct 23).
- Silverman, K.R., Ohman-Strickland, P.A., Christian, A.H., 2017. Perceptions of cancer risk: differences by weight status. *J. Cancer Educ.* 32, 357–363. <https://doi.org/10.1007/s13187-015-0942-9>.
- Steele, C.B., Thomas, C.C., Henley, S.J., Massetti, G.M., Galuska, D.A., Agurs-Collins, T., Puckett, P., Richardson, L.C., 2017. *Vital Signs: trends in incidence of cancers associated with overweight and obesity — United States, 2005–2014.* *MMWR Morb. Mortal. Wkly Rep.* 66, 1052–1058. <https://doi.org/10.15585/mmwr.mm6639e1>.
- U.S. Preventive Services Task Force Draft recommendation statement. Weight loss to prevent obesity-related morbidity and mortality in adults: behavioral interventions. <https://www.uspreventiveservicestaskforce.org/Page/Document/draft-recommendation-statement/obesity-in-adults-interventions1>, Accessed date: 30 August 2018.
- Wang, Y.C., McPherson, K., Marsh, T., Gortmaker, S.L., Brown, M., 2011. Health and economic burden of the projected obesity trends in the USA and the UK. *Lancet* 378, 815–825.
- Wang, J., Yang, D.L., Chen, Z.Z., Gou, B.F., 2016. Associations of body mass index with cancer incidence among populations, genders, and menopausal status: a systematic review and meta-analysis. *Cancer Epidemiol.* 42, 1–8. <https://doi.org/10.1016/j.canep.2016.02.010>. Jun. (Epub 2016 Mar 3).
- Zheng, Y., Manson, J.E., Yuan, C., Liang, M.H., Grodstein, F., Stampfer, M.J., Willett, W.C., Hu, F.B., 2017. Associations of weight gain from early to middle adulthood with major health outcomes later in life. *JAMA* 318 (3), 255–269. <https://doi.org/10.1001/jama.2017.7092>.