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Obesity, ethnicity, and quality of life among breast cancer survivors and women without breast cancer: the long-term quality of life follow-up study

Avonne E. Connor^{1,3}, Richard N. Baumgartner², Christina M. Pinkston², Stephanie D. Boone², and Kathy B. Baumgartner²

Avonne E. Connor: aconnor8@jhu.edu

¹Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, 615 N. Wolfe Street, Office E-6137, Baltimore, MD, USA

²Department of Epidemiology and Population Health, James Graham Brown Cancer Center, University of Louisville, Louisville, KY, USA

³Department of Oncology, Sidney Kimmel Comprehensive Cancer Center, Baltimore, MD 21205, USA

Abstract

Purpose—The purpose of this study was to examine the relationship between obesity and quality of life (QOL) among Hispanic and non-Hispanic white breast cancer survivors and population-based controls from the ‘Long-Term Quality of Life Study’—a 12- to 15-year follow-up study of breast cancer cases/survivors and controls from New Mexico ($n = 451$).

Methods—Using multiple linear regressions, obesity measures [body mass index (BMI) ≥ 30 kg/m²] at baseline and follow-up interview were modeled with composite scores for physical and mental health from the SF-36 Quality of Life Survey. Interaction between ethnicity and BMI and change in BMI were evaluated. All models were adjusted for age, ethnicity, Charlson Index, depression, fatigue, and physical activity.

Results—Baseline obesity ($\beta = -6.58$, $p = 0.04$) was significantly associated with decreased mental health among survivors, but not among controls. Obesity at baseline and follow-up were significantly associated with decreased physical health among survivors (baseline $\beta = -10.51$, $p = 0.004$; follow-up $\beta = -7.16$, $p = 0.02$) and controls (baseline $\beta = -11.07$, $p < 0.001$; follow-up $\beta = -5.18$, $p = 0.04$). No significant interactions between ethnicity and BMI were observed.

Conclusions—Our findings provide unique information about a diverse population of breast cancer survivors and controls and the impact of obesity on the mental and physical aspects of QOL.

Correspondence to: Avonne E. Connor, aconnor8@jhu.edu.

Avonne E. Connor previously affiliated with University of Louisville, School of Public Health and Information Sciences, Department of Epidemiology and Population Health.

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Keywords

Breast cancer; Obesity; Quality of life; Hispanic Americans

Introduction

An estimated 3.1 million women in the USA are living with a history of invasive breast cancer: approximately 2.3 million of these women are aged 60 years and older and fewer than 10 % are younger than 50 years of age [1]. Due to population trends of increasing age and the advances in cancer screening, treatment, and quality of survivorship care, the number of older cancer survivors is expected to double over the next 50 years [2]. Although there are well-known disparities in breast cancer outcomes between Hispanic and non-Hispanic white (NHW) women in the USA [3, 4], more Hispanic women are surviving cancer because of these improvements in screening and access to recommended treatment [5, 6]. Hispanic survivors are projected to account for an increasing proportion of the vastly growing breast cancer survivor population [7–9].

While the majority of breast cancer survivors are aged 60 years or older, limited research has investigated the relationships between specific health behaviors with quality of life (QOL) issues among older survivors, particularly during the long-term post-treatment period [2, 10]. Additionally, research gaps exist in the understanding of QOL among Hispanic breast cancer survivors [8]. Specific factors reported to influence QOL in NHW survivors include age at diagnosis, cancer stage, relationship status and social support, symptom distress and coping strategies [9, 11–14]. However, other data suggest that cultural and contextual factors, such as Hispanic role expectations, greater fear of recurrence, and barriers in patient-physician interaction may play larger roles in QOL among Hispanics, contributing to QOL disparities [7–9, 15, 16]. Additionally, a recent systematic review indicates that Hispanic survivors on average report lower overall QOL compared to NHW survivors [8].

According to national sample estimates, approximately 22 % of breast cancer survivors are obese [17]. Although survivors commonly change their diet and lifestyle after a cancer diagnosis as an attempt to prevent another cancer occurrence and to maintain good health [18], more than 60 % of women may gain weight after their initial diagnosis, which is mostly related to their body's response to breast cancer treatment, including chemotherapy [19]. Evidence also suggests that Hispanic survivors have been reported to be heavier than NHW survivors [20, 21].

In a recent report by Paxton and colleagues, the associations between physical activity and obesity status with health-related QOL were examined among Hispanic, African American, Asian, and NHW breast cancer survivors from the Women's Healthy Eating and Living Study [20]. Overall, it was found that survivors from racial/ethnic minority populations had higher rates of obesity that were associated with poorer health-related QOL. It could therefore be hypothesized that the poor adherence to guidelines for weight management may significantly contribute to the poor QOL outcomes experienced by Hispanic breast cancer survivors.

The purpose of this study was to examine the relationship between obesity and the mental and physical aspects of QOL among Hispanic and NHW breast cancer survivors and population-based controls from the 'Long-Term Quality of Life Study' (LTQOL)—a 12- to 15-year follow-up study of breast cancer cases and controls from New Mexico. By comparing breast cancer survivors to population-based controls, we examined whether the relationships between obesity and QOL are specific to breast cancer survivors or common to women of similar age without a diagnosis of breast cancer.

Materials and methods

Study population

The LTQOL follow-up (2007–2011) was conducted approximately 14.5 years from date of diagnosis for breast cancer cases or date of selection for population-based controls in the New Mexico Women's Health Study (NMWHS) (1992–1994) [22]. The NMWHS was a statewide population-based case–control study of breast cancer in Hispanic and NHW women. The design of this study has been previously described [22–25]. Women who were diagnosed with a new primary breast cancer were ascertained through the New Mexico Tumor Registry (NMTR), a population-based tumor registry and a member of the Surveillance, Epidemiology and End Results (SEER) Program of the National Cancer Institute. Women diagnosed with an invasive or in situ breast carcinoma from January 1, 1992, through December 31, 1994, who were residents of New Mexico and who were between 30 and 74 years of age at diagnosis, were eligible for study inclusion.

All identified Hispanic cases ($n = 491$) and approximately 33 % of identified NHW cases were eligible for the study. Non-Hispanic white cases ($n = 493$) were selected using a stratified random selection process. Of the 984 eligible cases identified, 73 % completed an interview: 339 Hispanic (69 %) and 388 NHW (78 %). Population-based controls were selected using a modified random-digit dialing method and were frequency-matched to cases based on ethnicity, age group, and the seven health planning districts. Of the 1,039 eligible controls, 81 % of the women completed an interview: 391 H (76 %) and 453 NHW (86 %). Specific details on non-participation have been reported previously [22].

The median time between breast cancer diagnosis and the NMWHS baseline interview was 193 days [22]. For baseline data collection, demographic data and body mass index (BMI) at time of interview were collected through in-person interviews at a location chosen by the study participant. Subjects were asked their height in feet and inches and current weight in pounds. Body mass index was calculated based on the following units, weight in kg/height in m^2 . BMI was categorized into three risk groups based on the World Health Organization cut-points for BMI (normal BMI = 24.9; overweight BMI = 25.0–29.9; obese BMI = 30) [26].

The LTQOL follow-up study

The LTQOL study was designed to address survival, recurrence, and specific dimensions of health-related QOL, and to assess covariates such as age, ethnicity, clinical and tumor characteristics, and cultural, social, behavioral and physiological factors. Of the 1,566

NMWS participants, a total of 321 died before follow-up, one had an inaccurate breast cancer diagnosis, and 82 were considered ineligible for the LTQOL study due to various issues (i.e., poor health, language barriers). A total of 457 (187 cases, 270 controls) women of the remaining 1,162 subjects participated in the follow-up survey, of which approximately 96 % of the women completed the telephone interview and 19 subjects completed a shorter self-administered version of the questionnaire. At the conclusion of the follow-up study, it was determined that 19 controls were diagnosed with incident breast cancer after the NMWS interview; however, six of the 19 were excluded due to a diagnosis of breast cancer prior to 1992. Therefore, the present analysis included 200 cases/survivors (69 Hispanic, 131 NHW) and 251 controls (79 Hispanic, 172 NHW).

Informed consent, for all participants, and Health Insurance Portability and Accountability Act (HIPAA) authorization, for those consenting to medical record review, were collected at the time of interview. The NMWS baseline study and the follow-up study were approved and monitored by the IRB committees at the University of New Mexico and University of Louisville.

Questionnaire data

The LTQOL questionnaire collected data on the following: general health, the SF-36 mental and physical health scales, diagnostic and treatment information, menopausal symptoms, the Tedeschi post-traumatic growth inventory, the perceived stress scale, the CES-D scale on depression, medical conditions and pain level, the Hann fatigue scale, the MOS social support scale, health screening procedures, cigarette smoking history, alcohol consumption and fruit and vegetable intake, physical activity in metabolic equivalent (MET) values based on the 2000 Ainsworth Compendium [27], marital status, education, and employment at both baseline and follow-up.

The Charlson Index was used to classify the number and impact of comorbid conditions reported by study participants [28]. Presence of the following conditions were grouped categorically into levels of none, low, moderate, and high based on this weighted index that takes into account the number and seriousness of comorbid diseases [28]: myocardial infarction, congestive heart failure, peripheral vascular disease, dementia, cerebrovascular disease, chronic lung disease, connective tissue disease, ulcer, chronic liver disease, moderate or severe kidney disease, diabetes, diabetes with complication, leukemia, lymphoma, moderate or severe liver disease, metastasis, and AIDS.

Quality of life measures as the outcome

QOL was evaluated using the SF-36 Health Survey [29] designed to measure levels of mental and physical health. The survey consists of eight health concepts separated into physical and mental health domains: physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to personal or emotional problems, general mental health, social functioning, energy/fatigue, and general health perceptions [29]. The scores for each domain can be combined to generate composite scores for mental and physical health. These scores range from 0 to 100, with higher scores representing better

health quality. The reliability and validity of the SF-36 survey have been documented in several cancer survivor populations [30, 31].

Body mass index

For the follow-up interview, BMI was based on self-report of current height in feet and inches and current weight in pounds at time of follow-up interview and converted to weight in kg divided by height in m². For the present analysis, obesity was defined as BMI ≥ 30 kg/m² for both baseline and follow-up BMI.

Statistical methods

Descriptive statistics were calculated for all covariates, and *t* tests and Chi-square tests were used to assess differences between groups. Using multiple linear regression models, obesity measures (BMI ≥ 30 kg/m²) at baseline and follow-up interview, and the change in BMI from baseline to follow-up, were modeled with composite scores for physical and mental health from the SF-36 Quality of Life Survey; results for beta coefficients and standard errors (SE) were reported. Specific covariates were included in multiple linear regression models if they changed the beta coefficient for the main effects by ≥ 10 % [32]. Potential covariates included: age at follow-up (years), ethnicity, history of depression (yes/no), felt fatigued at follow-up interview (yes/no), history of chronic pain reported at follow-up (yes/no), Charlson Index for comorbid conditions, and physical activity (total number of MET hrs). Breast cancer treatment (no surgery; surgery + radiation + chemotherapy; surgery + radiation; surgery + chemotherapy; and surgery only) was also considered as a potential confounder for models restricted to breast cancer cases/survivors; however, it was not found to be a significant confounder for associations between obesity and QOL outcomes among survivors. Interactions between ethnicity and BMI variables were assessed using the likelihood ratio test comparing the model including an interaction term with a reduced model without the term. All models were adjusted for age, ethnicity, Charlson Index for number of comorbid conditions, depression, fatigue, and physical activity. Models were also adjusted for baseline BMI when change in BMI from baseline to follow-up was assessed. All data analyses were performed using SAS version 9.3 (SAS Institute, Cary NC).

Results

Table 1 shows distributions of the variables used in the present analysis by survivor/control status and by ethnicity for the LTQOL follow-up study. The mean ages at follow-up for breast cancer survivors (mean = 64.3, SD = 9.1) and controls (mean = 64.0, SD = 10.0) were not significantly different (*p* = 0.77). The mean time from baseline to follow-up interview was significantly different (*p* < 0.001) between case/survivor and control groups, however, within these groups, there were no significant differences observed by ethnicity. A total of 27 survivors and 40 controls were obese at the time of the NMWHS baseline interview, while 37 survivors and 58 controls were obese at follow-up. Hispanic survivors were more likely to be diagnosed with regional stage of disease compared to NHW survivors (*p* = 0.02). Hispanic survivors compared to controls also were more likely to report lower scores for mental (*p* = 0.003) and physical health (*p* = 0.02).

Table 2 shows the associations between BMI at baseline and follow-up and mental health QOL among survivors and controls. For fully adjusted models, obesity at baseline ($\beta = -6.58$, $SE = 3.24$, $p = 0.04$) was significantly associated with decreased mental health among survivors, but not among controls. Table 3 shows associations with physical health QOL. Obesity at baseline and follow-up were significantly associated with decreased physical health among survivors (baseline $\beta = -10.51$, $SE = 3.56$, $p = 0.004$; follow-up $\beta = -7.16$, $SE = 3.11$, $p = 0.02$) and controls (baseline $\beta = -11.07$, $SE = 2.81$, $p < 0.001$; follow-up $\beta = -5.18$, $SE = 2.53$, $p = 0.04$).

In multivariable models that assessed case/survivor versus control status as a main predictor of mental QOL, no significant associations were observed for survivor status adjusting for baseline obesity (survivor status $\beta = -1.86$, $SE = 1.44$, $p = 0.20$) and other covariates or follow-up obesity (survivor status $\beta = -1.70$, $SE = 1.46$, $p = 0.25$). Additionally, no significant associations were observed for the relationships between survivor status and physical health QOL adjusting for covariates and baseline BMI (survivor status $\beta = -1.07$, $SE = 1.52$, $p = 0.48$) and follow-up BMI (survivor status $\beta = -0.88$, $SE = 1.55$, $p = 0.57$) (data not shown). No significant interactions between ethnicity and BMI were observed overall with fully adjusted models; however, our results presented in Table 1 indicate ethnic differences for QOL among breast cancer cases/survivors independent of BMI. We also did not observe any significant associations between change in BMI from baseline to follow-up and QOL.

In fully adjusted models, the Charlson Index and physical activity variables had the strongest impact on the magnitude of the point estimates for mental and physical health outcomes. For mental health outcomes, significant beta estimates ranged from -12.44 to -18.01 for moderate to high Charlson Index scores and 0.05 – 0.12 for increasing METS of physical activity. For physical health outcomes, significant beta estimates ranged from -30 to -32 for high Charlson Index scores and 0.07 – 0.13 for physical activity. The two most commonly reported chronic conditions among both survivors and controls were connective tissue disease (43 % of survivors and 34 % of controls) and chronic pulmonary disease (24.6 % of survivors and 17.6 % of controls).

Discussion

In our study of Hispanic and NHW breast cancer survivors and population-based controls, higher BMI at baseline interview was associated with decreased mental health among survivors. Both obesity at baseline and follow-up interview were significantly associated with decreased physical health, regardless of survivor/control status. Results from fully adjusted models did not indicate a significant association between change in BMI from baseline to follow-up interview and QOL scores. Lastly, we did not observe significant interactions between Hispanic ethnicity and BMI with QOL among survivors or controls in our sample. However, our data suggest lower scores on both mental and physical health components in Hispanic than NHW cases independent of BMI and that these differences may be in part mediated by other factors, such as higher levels of comorbidity and lower levels of physical activity.

Our QOL study is one of few breast cancer survivorship studies that has included long-term survivors and, to the best of our knowledge, it is the first to include controls as a comparison group with assessments of baseline and follow-up BMI. Comparison to a population-based sample of controls matched for age and ethnicity allows one to discern whether these associations are specific to breast cancer survivors or common to women regardless of their disease status. Mosher and colleagues [2] examined associations between obesity and other lifestyle factors and QOL among older long-term breast, colorectal, and prostate cancer survivors. The mean time since cancer diagnosis was approximately 9 years, and the mean BMI among the breast cancer survivors was 29.4 kg/m². Overall, their findings indicated that greater BMI was associated with worse physical QOL not only for breast cancer but for all cancers assessed. However, BMI was not found to be associated with mental QOL, as with other similar studies of obesity and QOL among cancer survivors [33]. Our results among survivors demonstrated a significant association between baseline BMI and mental health, whereas there was no association in age-matched controls. Obesity can contribute to certain outcomes such as psychological symptoms including negative self-evaluation, decreasing self-image, anxiety, and depression [34]. It is possible that the results we observed among survivors between baseline obesity and decreased mental health at follow-up could be attributed to the interaction between psychological symptoms associated with obesity and coping with a diagnosis of breast cancer; however, it is interesting that associations between obesity at follow-up and mental QOL were not statistically significant.

In a report by Imayama et al. [35], associations between weight change from baseline to follow-up, BMI at 30-month follow-up interview, and QOL at 40 months post-diagnosis were assessed in a sample of 661 multiracial/ethnic breast cancer survivors who participated in the Health, Eating, Activity, and Lifestyle study. Similar to our findings among survivors, significant associations were observed with high BMI for both physical ($p < 0.0001$) and mental ($p = 0.02$) health component summary scores. Among a subsample of 443 survivors, weight change from baseline to the 30 months post-diagnosis assessment was also examined with QOL, and a significant association was only found for physical health ($p = 0.03$). We also assessed change in BMI from baseline to follow-up interview (approximately 14 years), but did not observe any significant associations in fully adjusted models. These observations could be attributed to the lack of significant BMI changes from baseline to follow-up interview among survivors and controls who participated in our study.

It was previously mentioned that associations between obesity and QOL outcomes were most greatly affected and actually attenuated after controlling for important factors including the number of comorbid conditions measured by the Charlson Index and physical activity. With assessment of the most frequently reported chronic diseases included in the Charlson Index from our study, it was concluded that connective tissue disease, such as rheumatoid arthritis, and chronic pulmonary disease were the top two reported conditions among both survivors and controls. Although these diseases are not among the top chronic diseases in the USA, which include heart disease and stroke, cancer, and diabetes [36], they do represent ailments that occur among this age group of women. It has been reported that cancer survivors are more likely to develop recurrences and secondary primary cancers, heart disease, and other chronic diseases when compared with individuals without a history of cancer [2, 37]. Our findings did not indicate any significant differences between survivors

and controls for prevalence of comorbid conditions. Furthermore, the relationship between obesity and QOL was not found to differ between survivor and control status.

There are strengths and limitations for the present analysis. The LTQOL study is distinct from other breast cancer survivorship cohorts because it allows the evaluation of associations of baseline risk factors, such as BMI, with long-term survival, and the comparison of QOL in survivors with controls. Long-term cancer survivors are generally described as those who are 5 years or more beyond cancer diagnosis [37]; however, our participants have almost three times the follow-up time, as 72 % of the survivors have 15 or more years of follow-up. Based on systematic reviews, very few QOL studies that have included Hispanic long-term survivors [8, 38]. Although not statistically significant in fully adjusted models, our data suggest Hispanic women, particularly cases, tend to have lower mental and physical health scores than their NHW counterparts. This ethnic difference warrants closer examination. We also were able to examine whether Hispanic ethnicity modified associations between obesity and QOL. However, due to sample size constraints, we were unable to stratify analyses by ethnicity among survivor and control groups. Tests of statistical interaction were significant in crude models, but attenuated in fully adjusted models, suggesting that these ethnic disparities may be associated with a higher burden of comorbidity or possibly lower levels of physical activity. Furthermore, our findings may not be generalizable to other breast cancer survivor populations. The individuals who participated in the LTQOL follow-up study may not be comparable to the non-participants in terms of health status and overall, participation rates for the follow-up study were low at 39 %. These limitations increase risk for selection bias. Lastly, women lost to follow-up may have been heavier and less healthy than those with complete follow-up leading to survival bias that would tend to attenuate associations.

Conclusions

Despite our limitations, this study represents one of the more novel approaches to date aimed at investigating the relationship between obesity and QOL among an ethnically diverse population of long-term survivors and population-based controls. Overall, our results indicate that obesity at baseline and follow-up interviews was associated with reduced physical health among our study population, regardless of survivor/control status and that obesity at baseline interview was also associated with reduced QOL for mental health among survivors. Although we did not detect any significant interactions between obesity and Hispanic ethnicity, our findings provide unique information about a diverse population of breast cancer survivors and controls and the impact of obesity on the mental and physical aspects of quality of life.

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Abbreviations

BMI	Body mass index
LTQOL	Long-Term Quality of Life Study
MET	Metabolic equivalent
NMTR	New Mexico Tumor Registry
NMWHS	New Mexico Women's Health Study
NHW	Non-Hispanic white
SE	Standard error
SEER	Surveillance, Epidemiology and End Results
QOL	Quality of life

Table 1
Characteristics of study population, stratified by ethnicity and case/survivor-control status, LTQOL (*n* = 451)

	Cases/survivors <i>n</i> = 200		Controls <i>n</i> = 251		χ^2 <i>p</i> ^a	χ^2 <i>p</i> ^a	χ^2 <i>p</i> ^b
	Hispanic <i>n</i> (%)	NHW <i>n</i> (%)	Hispanic <i>n</i> (%)	NHW <i>n</i> (%)			
Baseline: BMI kg/m ²							
<30	53 (76.8)	120 (91.6)	61 (77.2)	146 (86.9)	0.004	0.05	0.43
30	16 (23.2)	11 (8.4)	18 (22.8)	22 (13.1)			
Follow-up: BMI kg/m ²							
<30	52 (77.6)	109 (83.2)	57 (73.1)	131 (78.0)	0.34	0.40	0.21
30	15 (22.4)	22 (16.8)	21 (26.9)	37 (22.0)			
Charlson index of comorbidities							
None	23 (33.8)	48 (36.6)	34 (43.6)	77 (44.8)	0.63	0.96	0.18
Low	36 (52.9)	71 (54.2)	35 (44.9)	78 (45.4)			
Moderate	7 (10.3)	11 (8.4)	7 (9.0)	12 (7.0)			
High	2 (2.9)	1 (0.8)	2 (2.6)	5 (2.9)			
Self-reported depression							
Yes	21 (30.9)	28 (21.4)	16 (20.5)	50 (29.2)	0.14	0.15	0.65
No	47 (69.1)	103 (78.6)	62 (79.5)	121 (70.8)			
Fatigue present							
Yes	28 (40.6)	55 (42.0)	35 (44.9)	73 (42.4)	0.84	0.71	0.72
No	41 (59.4)	76 (58.0)	43 (55.1)	99 (57.6)			
Stage							
In situ	12 (17.4)	26 (20.2)			0.02		
Localized	31 (44.9)	78 (60.5)					
Regional	26 (37.7)	25 (19.4)					
Breast cancer treatment							
Surgery only	20 (29.0)	47 (36.2)			0.24		
Surgery + radiation	16 (23.2)	30 (23.1)					
Surgery + chemotherapy	11 (15.9)	20 (15.4)					
Surgery + chemo + radiation	21 (30.4)	32 (24.6)					
No surgery	1 (1.5)	1 (0.8)					

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	Cases/survivors <i>n</i> = 200				Controls <i>n</i> = 251				χ^2 <i>p</i> ^a	χ^2 <i>p</i> ^b
	Hispanic <i>n</i> (%)		NHW <i>n</i> (%)		Hispanic <i>n</i> (%)		NHW <i>n</i> (%)			
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		
Age at follow-up	61.5 (9.1)	65.7 (8.9)	0.002	0.002	63.5 (9.7)	64.2 (10.1)	0.60	0.77		
Time since baseline interview (years)	15.1 (1.1)	15.0 (1.1)	0.78	0.78	14.3 (1.3)	14.2 (1.4)	0.69	<0.001		
Mental health composite score	70.0 (22.8)	78.7 (17.3)	0.003	0.003	74.7 (21.1)	78.7 (18.6)	0.14	0.36		
Physical health composite score	67.2 (25.1)	75.3 (20.3)	0.02	0.04	70.1 (23.3)	75.9 (20.5)	0.05	0.47		
Total number of MET hours of activity-2000 Compendium	25.0 (28.8)	34.9 (34.3)	0.04	<0.001	39.1 (54.5)	39.0 (44.4)	0.98	0.06		
Baseline BMI	27.1 (4.8)	24.0 (3.9)			26.7 (5.4)	24.8 (4.9)	0.01	0.56		
Follow-up BMI	28.1 (5.4)	25.7 (4.6)	0.001	0.001	28.0 (7.2)	26.6 (5.2)	0.08	0.26		
Change in BMI	1.12 (4.5)	1.61 (3.3)	0.39	0.39	1.46 (4.4)	1.76 (3.8)	0.59	0.56		

^aEthnic group comparison within survivor/control status, *p* values from Chi-square tests

^bSurvivor/control comparison, regardless of ethnicity, *p* values from Chi-square tests

^cEthnic group comparison within survivor/control status, *p* values from *t* tests

^dSurvivor/control comparison, regardless of ethnicity, *p* values from *t* tests

Table 2
Associations between BMI at baseline and follow-up and mental health QOL among women from the LTQOL study

	Cases/survivors				Controls			
	<i>n</i> = 200				<i>n</i> = 251			
	Parameter Estimates Crude model ^a	Standard error	<i>p</i> value	Parameter Estimates Adjusted model ^b	Standard error	<i>p</i> value	Parameter Estimates Adjusted model ^b	Standard error
<i>Quality of life: SF-36 mental health</i>								
Baseline obesity								
No interaction								
BMI 30 kg/m ²	-13.300	4.000	0.001	-6.582	3.244	0.044	-1.144	2.713
Hispanic ethnicity	-6.027	2.940	0.042	-4.184	2.323	0.073	-2.752	2.121
Interaction of								
BMI × Ethnicity								
BMI 30 kg/m ²	-3.140	5.887	0.594	-3.393	4.750	0.476	-1.652	3.511
Hispanic ethnicity	-3.314	3.132	0.291	-3.288	2.520	0.194	-2.978	2.343
Obese × Hispanic ethnicity	-18.485	7.947	0.021	-5.980	6.504	0.359	1.255	5.490
Follow-up Obesity								
No interaction								
BMI 30 kg/m ²	-2.983	3.559	0.403	2.089	2.854	0.465	0.332	2.376
Hispanic ethnicity	-7.803	2.995	0.01	-4.855	2.339	0.039	-2.984	2.103
Interaction of								
BMI × Ethnicity								
BMI 30 kg/m ²	-1.625	4.549	0.721	2.790	3.641	0.445	2.340	2.911
Hispanic ethnicity	-7.108	3.330	0.034	-4.492	2.619	0.088	-1.544	2.423
Obese × Hispanic ethnicity	-3.511	7.300	0.631	-1.790	5.745	0.756	-5.785	4.853

There are 200 cases and 251 controls at the beginning of this analysis; then with evaluation, 4 missing BMI at baseline and 7 missing BMI at follow-up Bolder estimates are statistically significant (*p* < 0.05)

^aModels adjusted for age and ethnicity

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η Models adjusted for age, ethnicity, Charlson Index (n missing = 2), depression (n missing = 3), fatigue (n missing = 1), total number of MET hrs of activity—2000 Compendium (n missing = 19)

Table 3
Associations between BMI at baseline and follow-up and physical health QOL among women from the LTQOL study

	Cases/survivors				Controls			
	Parameter Estimates Crude model ^a	Standard error	p value	Parameter Estimates Adjusted model ^b	Standard Error	p value	Parameter Estimates Crude model ^a	Parameter Estimates Adjusted model ^b
<i>Quality of life: SF-36 physical health</i>								
<i>Baseline obesity</i>								
<i>No interaction</i>								
BMI 30 kg/m ²	-19.235	4.455	<0.001	-10.505	3.557	0.004	-14.798	-11.067
Hispanic ethnicity	-6.264	3.279	0.058	-3.572	2.548	0.163	-4.660	-4.539
<i>Interaction of</i>								
<i>BMI × Ethnicity</i>								
BMI 30 kg/m ²	-5.296	6.520	0.418	-6.453	5.204	0.217	-10.737	-10.124
Hispanic ethnicity	-2.539	3.469	0.465	-2.433	2.761	0.379	-2.866	-4.120
Obese × Hispanic ethnicity	-25.372	8.800	0.004	-7.599	7.126	0.288	-9.607	-2.331
<i>Follow-up Obesity</i>								
<i>No interaction</i>								
BMI 30 kg/m ²	-12.281	3.929	0.002	-7.164	3.115	0.023	-9.700	-5.180
Hispanic ethnicity	-8.220	3.307	0.014	-4.301	2.553	0.094	-5.126	-5.132
<i>Interaction of</i>								
<i>BMI × Ethnicity</i>								
BMI 30 kg/m ²	-10.472	5.021	0.038	-6.748	3.974	0.091	-6.205	-2.292
Hispanic ethnicity	-7.295	3.676	0.049	-4.086	2.858	0.155	-2.588	-3.061
Obese × Hispanic ethnicity	-4.674	8.058	0.563	-1.063	6.270	0.866	-10.067	-8.319

There are 200 cases and 251 controls at the beginning of this analysis; then with evaluation, 4 missing BMI at baseline and 7 missing BMI at follow-up Bolder estimates are statistically significant ($p < 0.05$)

^aModels adjusted for age and ethnicity

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η Models adjusted for age, ethnicity, Charlson Index (n missing = 2), depression (n missing = 3), fatigue (n missing = 1), total number of MET hrs of activity—2000 Compendium (n missing = 19)