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Weight Loss After Bariatric Surgery: Do Clinical and Behavioral Factors Explain Racial Differences?

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Abstract

Background—Prior studies have suggested less weight loss among African American compared to Caucasian patients; however, few studies have been able to simultaneously account for baseline differences in other demographic, clinical, or behavioral factors.

Methods—We interviewed patients at two weight loss surgery (WLS) centers and conducted chart reviews before and after WLS. We compared weight loss post-WLS by race/ethnicity and examined baseline demographic, clinical (BMI, comorbidities, quality of life), and behavioral (eating behavior, physical activity level, alcohol intake) factors that might explain observed racial differences in weight loss at 1 and 2 years after WLS.

Results—Of 537 participants who underwent either Roux-en-Y Gastric Bypass (54%) or gastric banding (46%), 85% completed 1-year follow-up and 73% completed 2-year follow-up. Patients lost a mean of 33.00% of initial weight at year 1 and 32.43% at year 2 after bypass and 16.07% and 17.56 % respectively after banding. After adjustment for other demographic characteristics and type of surgery, African Americans lost an absolute 5.93 ± 1.49% less weight than Caucasian patients after bypass ($p < 0.001$) and 4.72 ± 1.96% less weight after banding. Of the other demographic, clinical, behavioral factors considered, having diabetes and perceived difficulty

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Compliance with Ethical Standards

Conflict of Interest Author 3 reports grants from National Institutes of Health, from Myos, from Aspire Bariatrics, and from GI Dynamics; grants and personal fees from Amylin, from Sanofi-Aventis, from Orexigen, and from Takeda; personal fees from Merck, from Johnson & Johnson, from Arena, from Nutrisystem, from Zafgen, from EnteroMedics, and from NovoNordisk for work unrelated to the current project. Author 2 reports stock options as a consultant for Allurion. All other authors declare they have no conflict of interest.

Ethical Statement All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent Statement Informed consent was obtained from all individual participants included in the study.

making dietary changes at baseline were associated with less weight loss among gastric bypass patients whereas having a diagnosis of anxiety disorder was associated with less weight loss among gastric banding patients. The association between race and weight loss did not substantially attenuate with additional adjustment for these clinical and behavioral factors, however.

Conclusion—African American patients lost significantly less weight than Caucasian patients. Racial differences could not be explained by baseline demographic, clinical, or behavioral characteristics we examined.

Keywords

Bariatric surgery; Roux-Y gastric bypass; Gastric banding; Weight loss; Race

Introduction

Bariatric or weight loss surgery (WLS) is the most effective treatment for obesity and produces substantial weight loss [1, 2]. Nonetheless, WLS is not universally effective and outcomes can vary even after accounting for surgery type [1–4]. In particular, prior studies consistently suggest that weight loss varies by race with African Americans (AA) losing less weight than Caucasian patients [4–6]. A meta-analysis of 14 prospective and retrospective observational studies found that African Americans sustained 8% less excess weight loss than Caucasians post-WLS [5]. Data on differences between Hispanic and Caucasians have been more mixed with studies suggesting modest to no differences in weight loss [7, 8]. Even less data are available on how WLS affects quality of life (QOL) outcomes across different racial groups. Given that AA patients tend to report less adverse QOL effects associated with their obesity than their Caucasian counterparts at baseline [9, 10], it stands to reason that AAs may also derive less QOL benefit from WLS.

The reasons that underlie racial differences in weight loss are uncertain. Studies demonstrating racial differences have often been unable to account adequately for baseline socioeconomic, clinical, or behavioral factors that may either confound or contribute to the association between race and weight loss outcomes. In addition to demographic factors, clinical factors such as higher initial BMI and diabetes status have been found to predict weight loss post-WLS [11, 12]. Some studies also suggest that behavioral factors including eating behaviors and physical activity level and psychosocial factors including self-esteem and depressive symptoms may play a role although other studies show no association [6, 13–16]. Few studies documenting racial differences in weight loss have been able to adjust for these potential contributors simultaneously.

In this context, we compared weight loss and QOL outcomes up to 2 years after bariatric surgery among more than 450 Caucasian, African American, and Hispanic patients who underwent either Roux-en-Y gastric bypass or laparoscopic adjustable gastric banding. We also explored baseline clinical and behavioral factors that might explain observed racial and demographic variations in weight loss outcomes.

Methods

Study Sample, Recruitment, and Data Collection

We analyzed data from the Assessment of Bariatric Surgery Study (ABS Study), a longitudinal cohort study of patients who were being evaluated for weight loss surgery. The aims of the ABS study were to understand patients' perception and decision-making around WLS and the longitudinal effect of WLS on QOL and other health outcomes with a focus on understanding differences between African American and Caucasian patients. Details of the study have been previously described [17]. Study subjects were systematically recruited from two academic WLS centers in Boston, one of which serves a large racial minority and socially disadvantaged urban population. Eligible patients had to be age 18 to 65 years at recruitment, speak English, and have the permission of their physician for us to contact the patient.

Data were collected via 1-h telephone interviews at baseline and annually thereafter and via medical record review after verbal informed consent was obtained. Telephone interviews collected information on patients' demographics, self-reported height and weight, QOL, health and eating behaviors, and patients' perspectives on their weight, weight loss, and WLS. A trained study nurse conducted medical record reviews to abstract additional clinical information including comorbidities and serial weight measurements.

Institutional review boards (IRB) at the Beth Israel Deaconess Medical Center, Boston Medical Center, and University of Massachusetts Center for Survey Research (all in Boston, MA) approved the study.

Measures

Demographic Factors

Patients' age at surgery was determined by subtracting their date of birth recorded in the medical record from their date of surgery. Patient sex was abstracted from the medical record and other demographic factors such as race and ethnicity, education, household income and marital status were elicited at the baseline interview.

Body Weight, Weight Change, and Other Clinical Measures

To arrive at our primary outcome of weight loss after WLS, we abstracted baseline pre-operative body weight and height and post-surgical follow-up weights at the annual clinical visits from the medical record. For patients for whom measured weights were unavailable at follow-up or did not occur within a pre-specified time period (30 days before or 90 days after the respective 1 or 2 year post-surgery date), we used self-reported weight obtained during their annual follow-up interviews (n = 132 at year 1 and n = 169 at year 2) and adjusted for the fact that self-reported weight was used in analyses. Our primary outcome of percent of total body weight loss at follow-up was calculated by subtracting patients' follow-up weight from their baseline weight, dividing that difference by the baseline weight, and then multiplying the result by 100. Baseline body mass index (BMI) was calculated using pre-operative weight and height.

We abstracted surgery type and date of surgery from the medical record. Because the overwhelming majority of patients underwent either Roux-en-Y gastric bypass or gastric banding during the study period (99%), we excluded those who underwent sleeve gastrectomy ($n = 6$).

To characterize patients' illness burden at baseline, we also abstracted from the medical record common obesity—related comorbidities and those comprising the Charlson Comorbidity Index such as diabetes, hypertension, asthma, obstructive sleep apnea, gastroesophageal reflux disease (GERD), depression, anxiety, arthritis, chronic back pain, anemia, coronary artery disease, stroke, and peripheral vascular disease.

Quality of Life

We assessed QOL via the Impact of Weight on Quality of Life-lite (IWQOL-lite), a 31-item instrument developed to capture five domains specific to obesity, namely physical function, self-esteem, sexual life, public distress, and work [18]. Responses were scored on a 0–100 scale according to standard methods in each of the subscales and in their global scores; higher scores indicate better QOL. Our secondary outcome of change in QOL score post-WLS was calculated by subtracting patients' follow-up score from their baseline score.

Health Behaviors

We assessed eating behaviors including cognitive restraint, emotional eating, and uncontrolled eating adapting the 18-item revised SOS Three Factor Eating Questionnaire R-18 (TFEQ-R18) in telephone interviews [19]. Respondents were asked to rate a series of statements about how often they engage in certain eating behaviors (definitely true, mostly true, mostly false, definitely false). Global scores for each eating behavior ranged from 0 to 100. Higher scores reflected higher levels of each eating behavior. We also measured patients' perceived difficulty making three dietary changes that would facilitate weight control, i.e., limiting portion size, limiting the amount of carbohydrates or starches in food, and increasing dietary protein. Respondents were asked to rate on a scale of 0–10 for each change (where 0 is not at all difficult and 10 is extremely difficult) how difficult it was to make each dietary change. Higher scores reflected greater difficulty making dietary changes.

In addition, we assessed patients' smoking behavior, physical activity level, and alcohol use. Physical activity level was elicited using Paffenbarger's Seven Day Physical Activity Recall and METS of activity level was estimated per day for each subject [20]. Alcohol intake was assessed using a modified version of the AUDIT-C which we previously described in detail [21]. Scores for the AUDIT-C range from 0 to 12—based on frequency of drinking and usual quantity of intake in the past year and episodes of binge drinking in the past month. We defined high risk drinking as a score of ≥4 in men and ≥3 in women (since these scores have high sensitivity and specificity in identifying heavy drinking and/or active alcohol abuse or dependence) or an affirmative response to any of seven follow-up items on alcohol dependency or harmful drinking.

Data Analysis

We used chi-square statistics to characterize our sample overall and across race and ethnicity. We then used Wilcoxon rank sum tests to characterize differences in mean values including total mean percent body weight loss and mean change in QOL scores at year 1 and year 2 by race/ethnicity and by other demographic, clinical, and behavioral factors of interest stratified by surgery type. We considered associations at a $p < 0.05$ to be statistically significant.

To identify baseline factors that might explain any observed variations in weight loss by race and ethnicity, we conducted a series of multivariable repeated measures analysis using generalized estimating equations (GEE) with percent weight loss as the outcome stratified by surgery type. Analyses included all available year 1 and year 2 weight data and were conducted using SAS Version 9.3. Our initial model included race and ethnicity as the primary predictor and adjusted for demographic factors such as age, sex, education, household income, marital status, and clinical factors such as pre-surgical baseline BMI, surgery type, site, and whether the follow-up weight came from the patient's medical chart or was self-reported in their interview. In a second model, we additionally adjusted for comorbid conditions that were independently associated with weight loss in ancillary analyses; we used a forward selection (p <0.10) and backward elimination ($p < 0.05$) approach to identify statistically significant comorbidities. In subsequent models, we then considered patients' baseline QOL score, physical activity, and alcohol behavior, and examined the impact of adding statistically significant predictors on the association between race and ethnicity and the outcome. In separate analyses, we examined whether observed racial differences in weight loss could be explained by baseline differences in eating behaviors (continuous) and perceived difficulty at making dietary changes (continuous).Because of the expected collinearity among these dietary variables, we examined the influence of each factor individually in separate models.

To examine whether change in QOL scores varied by race and ethnicity, we conducted additional multivariable repeated measures analyses of the association between race and ethnicity and change in overall QOL scores at 1 and 2 years stratified by surgery type. Models were adjusted for age, sex, education, income, and baseline QOL scores. In subsequent analyses, we examined the association between race and ethnicity and individual QOL domains/subscales.

Results

Of 537 enrolled participants who underwent either Roux-en-Y Gastric Bypass (54%) or gastric banding (46%), 457 patients (85%) had body weights assessed at 1-year follow-up and 394 (73%) at 2-year follow-up. Of these, 325 were Caucasian, 80 were African American and 52 were Hispanic. Table 1 presents baseline patient characteristics overall and by race and ethnicity. African Americans were significantly and substantially more likely to undergo gastric bypass than gastric banding. Table 2 presents weight loss 1 and 2 years after WLS across various baseline factors stratified by surgery type. On average, patients who underwent gastric bypass lost significantly more weight than those who underwent gastric banding ($p < 0.001$ for differences at year 1 and 2). In unadjusted analyses, African

Americans lost less weight than Caucasian patients after both surgeries although only the difference for gastric bypass reached statistical significance ($P < 0.05$). Older adults and those reporting higher difficulty making dietary change at baseline also lost significantly less weight.

Table 3 presents the association between race/ethnicity and weight loss by WLS type after sequential adjustment for other potential correlates of weight loss. Racial differences were more pronounced among patients who underwent gastric bypass where African American and Hispanic patients lost at least 5% less weight than Caucasian patients. Of the other demographic, clinical, behavioral factors considered, having diabetes was associated with less weight loss among gastric bypass patients whereas having a diagnosis of anxiety disorder was associated with less weight loss among gastric banding patients. These estimates did not change meaningfully (i.e., by 10% or more) with sequential adjustment.

Eating behaviors as measured by the TEFQ-18 were not significantly associated with weight loss outcomes (Table 4). However, patients' difficulty limiting different dietary intake was significantly associated with less weight loss among those who underwent gastric bypass; these associations were attenuated and not statistically significant among those who underwent gastric banding (Table 4). Additional adjustment for eating behavior and difficulty limiting different dietary intake did not attenuate racial differences in weight loss for either surgery (Table 4) between African Americans and Caucasians.

Table 5 presents the change in QOL stratified by surgery type in the overall sample and the adjusted difference in this change between African American and Caucasian patients and between Hispanic and Caucasian patients. We found no significant differences across race and ethnicity.

Discussion

In our longitudinal study of over 450 patients followed for up to 2 years post-WLS, African Americans lost more than 5% less weight after gastric bypass and more than 4% weight loss after gastric banding than Caucasian patients, after accounting for relevant clinical, behavioral, and other demographic characteristics. Although not a focus of our study, we found that Hispanic patients also lost significantly less weight than Caucasian patients after gastric bypass. We found few new behavioral predictors of weight loss other than perceived difficulty in making different dietary changes at baseline was associated with less weight loss post-gastric bypass but not after gastric banding. In contrast to weight loss, improvements in QOL after WLS were comparable among Caucasian, African American, and Hispanic patients.

Our findings that African Americans lost less weight than Caucasian patients and that this weight difference is greater than the weight loss difference between Hispanics and Caucasian patients are consistent with previous studies [4–8]. Similarly, a prior study by Ng et al. also showed that racial differences are more pronounced after gastric bypass than gastric banding as in our study [7]. Few of these prior studies, however, have been able to account for potential demographic, clinical, and behavioral con-founders to the extent that

we did in our study [4–8, 22]. Nevertheless, adjusting for many of these factors did not explain observed racial differences in weight loss for African Americans. The few prior studies that have attempted to identify factors that might explain racial differences have been similarly unsuccessful. For example, a retrospective interview of patients 1 or more years post-WLS [4], did not identify any behavioral correlates of weight loss overall or factors that would explain racial differences in weight loss. Our data adds to this evidence base using a prospective study design. The consistency of our findings with other work raises questions about whether there are biological or physiological differences in how different groups respond to WLS.

The absolute weight loss differences across race we and others observed were modest given the overall weight loss achieved by most patients with WLS. This difference in weight loss did not translate to differences in the improvement of QOL after WLS across race and ethnicity in our study even though other work by our group and others suggest that African Americans report lower adverse impact of obesity on QOL relative to Caucasian adults at baseline [9, 10]. Whether racial differences in weight loss translate into meaningful reductions in clinical benefit—in terms of attenuated improvement and resolution in comorbidities, improvements in QOL and longevity, and on healthcare cost over the long-term—is uncertain; statistically significant findings do not necessarily indicate clinically significant ones. A few studies suggest that the small differences we observed may not translate to differences in metabolic outcomes in the short term [5, 7]. Nonetheless, longer term studies are warranted to examine whether racial differences in weight loss has implications on weight regain and long-term success.

Our findings must be interpreted in the context of the study's limitations. Our study recruited patients from two academic centers in Boston and our findings may not generalize to patients who undergo WLS in other settings. While we collected information on several behavioral and clinical factors, the measures used may not capture all domains related to that particular behavior. For example, we did not quantify actual calories ingested by patients although the TFEQ-18 we used has been validated in other studies [19]. Many of our measures (including follow-up weights on a proportion of participants) were self-reported and subject to misclassification and reporting bias. In addition, many of the instruments used were initially developed as self-administered measures and their validity when administered over the telephone is unclear. While we had over 450 patients in our study, we had very few patients of Hispanic ethnicity; our findings in Hispanic patients especially warrant validation in larger cohorts. Finally, we also noted differences in weight loss across other patient behaviors and characteristics which must be interpreted with caution as these comparisons were not pre-specified a priori and were included to adjust for potential confounding of our weight loss differences by race and ethnicity.

In summary, our study confirms the findings of previous studies suggesting that African American patients and to a lesser extent, Hispanic patients, lose less weight than Caucasian patients. Racial differences in weight loss could not be explained by baseline demographic, clinical, or behavioral characteristics assessed. The magnitude of these weight loss differences was modest and did not translate into differences in QOL changes after WLS.

Future studies should examine the implications of racial differences in post-bariatric surgery weight loss on clinical outcomes especially over the long term.

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Table 1

Baseline characteristics of patients overall and by race and ethnicity[a]

	Overall (*n* = 457)	Caucasian (*n* = 325)	African American (*n* = 80)	*p* value	Hispanic (*n* = 52)	*p* value
Gender				0.009		0.82
Male	24%	26%	13%		25%	
Female	76%	74%	88%		75%	
Age						
Mean	44.4 years	46.3 years	42.6 years	0.01	35.7 years	<0.001
Education				0.01		<0.001
HS diploma/GED	25%	21%	25%		48%	
2-Year college	35%	34%	48%		25%	
4-Year college or more	40%	45%	27%		27%	
Household income				<0.001		<0.001
$20,000 or less	15%	10%	21%		35%	
$20,001–40,000	15%	12%	26%		23%	
$40,001-$80,000	29%	26%	39%		29%	
Over $80,000	41%	52%	13%		13%	
Marital status				<0.001		0.02
Married	49%	58%	20%		38%	
Divorced/separated/widowed	20%	19%	28%		19%	
Never married	30%	23%	51%		42%	
BMI at baseline	46.8	46.3	48.5	0.02	47.9	0.15
Surgery type				0.008		0.07
Bypass	54%	50%	66%		63%	
Banding	46%	50%	34%		37%	
Comorbidities						
Diabetes	31%	30%	36%	0.27	31%	0.89
Hypertension	55%	55%	63%	0.25	44%	0.13
Asthma	24%	22%	25%	0.59	33%	0.10
Obstructive sleep apnea	46%	50%	36%	0.03	40%	0.22

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	Overall (*n* = 457)	Caucasian (*n* = 325)	African American (*n* = 80)	*p* value	Hispanic (*n* = 52)	*p* value
Cardiovascular disease	7%	8%	9%	0.90	0%	0.03
GI/GERD	50%	54%	38%	0.007	40%	0.06
Depression	53%	54%	40%	0.03	65%	0.11
Anxiety	38%	39%	28%	0.05	46%	0.33
Arthritis	31%	33%	28%	0.38	25%	0.27
Back pain	44%	41%	49%	0.19	54%	0.07
Anemia	15%	10%	37%	<0.001	15%	0.26
Other	9%	10%	10%	0.97	0%	0.02
Smoker				<0.001		0.01
Current	5%	4%	6%		8%	
Former	44%	50%	26%		29%	
Never	52%	46%	68%		63%	
Alcohol drinking				0.51		0.004
Not high risk drinker	84%	87%	84%		71%	
High risk drinker	16%	13%	16%		29%	
Eating behavior mean (% reporting levels scores above 50])[a]						
Emotional eating	53.0 (54%)	58.2 (61%)	39.0 (40%)	<0.001	42.7 (37%)	<0.001
Uncontrollable eating	41.7 (36%)	44.7 (41%)	32.6 (23%)	<0.001	36.4 (27%)	0.01
Cognitive restraint	49.0 (43%)	47.3 (38%)	55.3 (61%)	0.001	50.2 (48%)	0.29
METS expended/day						
Mean	35.9	35.3	36.7		38.2	
Difficulty decreasing portion sizes						
Mean score (0–10 scale)	5.9	6.1	5.0	<0.0001	5.8	0.26
Difficulty decreasing fat						
Mean (0–10 scale)	5.2	5.4	4.6	0.005	5.4	0.96
Difficulty decreasing carbohydrates						
Mean (0–10 scale)	5.7	5.8	5.0	0.007	6.0	0.68
Difficulty increasing protein						
Mean (0–10 scale)	2.7	2.5	3.2	0.07	2.6	0.80
SF36 (C-1CC scale)[b]						

	Overall (*n* = 457)	Caucasian (*n* = 325)	African American (*n* = 80)	*p* value	Hispanic (*n* = 52)	*p* value
Physical component score	38.5	38.2	39.8	0.23	38.0	0.90
Mental component score	50.7	50.8	51.7	0.49	48.6	0.16
IWQOL-lite (C-1CC scale)[b]						
Total	55.1	54.4	58.5	0.10	54.2	0.93
Physical functioning	48.0	48.2	48.0	0.95	46.7	0.66
Public distress	58.4	59.1	58.4	0.84	54.6	0.24
Self-esteem	49.7	47.6	58.6	0.001	49.7	0.58
Sex life	66.9	65.4	72.9	0.04	66.9	0.73
Work	67.4	66.8	71.4	0.12	65.1	0.64

SF-36 Short form-36, *IWQOL-lite* Impact of Weight on Quality of Life-lite

[a]Sample in the table represents patients with follow-up body weights assessed at either year 1 or year 2 after WLS; p-values refer to either comparisons between African Americans to Caucasians or Hispanic patients to Caucasians, respectively

[b]Higher scores indicate higher quality of life

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Table 2

Percent weight loss 1 or 2 years after bariatric surgery across different patient characteristics stratified by surgery type

	Bypass				Banding			
	% Δ Weight loss at year 1 (*n* = 245)	*p* value	% Δ Weight loss at year 2 (*n* = 211)	*p* value	% Δ Weight loss at value year 1 (*n* = 212)	*p* value	% Δ Weight loss at year 2 (*n* = 183)	*p* value
Overall	33.00 ± 8.84		32.43 ±10.16		16.07 ± 8.61		17.56 ± 10.55	
BMI at baseline		0.007		0.01		<0.001		<0.001
<40	33.29 ± 8.50		33.75 ± 9.35		19.73 ± 7.78		21.57 ± 8.96	
40–45	29.20 ± 6.75		30.34 ± 7.96		12.54 ± 8.29		8.73 ± 10.13	
>45	26.46 ± 6.24		23.78 ± 6.31		8.89 ± 4.74		8.52 ± 8.32	
Gender		0.06		0.03		0.93		0.80
Male	30.83 ± 10.12		29.33 ± 10.52		15.99 ± 8.93		17.23 ±11.09	
Female	33.50 ± 8.46		33.16 ±9.97		16.10 ± 8.49		17.68 ± 10.38	
Mean age		0.02		0.63		0.18		0.14
<40 years old	35.04 ± 9.05		33.18 ±9.93		16.54 ± 8.54		16.37 ± 12.12	
40–54 years old	32.29 ± 8.54		32.34 ± 10.51		16.95 ± 8.55		19.48 ±9.19	
55+ years old	30.81 ± 8.58		31.20 ± 9.75		14.37 ± 8.65		16.24 ± 10.32	
Race								
Caucasian (ref)	34.48 ± 8.65		34.17 ± 10.16		16.26 ± 8.64		17.63 ± 10.77	
African American	29.77 ± 7.38	<0.001	28.87 ± 8.79	0.002	13.31 ± 8.22	0.11	14.79 ± 10.92	0.25
Hispanic	31.79 ± 10.18	0.13	30.19 ± 10.41	0.07	17.58 ± 9.56	0.53	20.18 ±9.42	0.37
Other	30.04 ± 10.10	0.22	32.96 ± 10.63	0.81	17.25 ± 6.82	0.71	18.57 ± 7.80	0.80
Education		0.81		0.81		0.11		0.07
HS diploma/GED	33.62 ± 7.44		32.12 ±9.61		17.72 ± 9.90		20.76 ±11.93	
2-Year college	32.76 ± 8.86		33.17 ± 10.13		14.48 ± 8.11		15.69 ±9.68	
4-Year college or more	32.89 ± 9.80		32.30 ± 10.59		16.53 ± 8.24		17.46 ± 10.28	
Household income		0.41		0.76		0.18		0.38
$20,000 or less	31.40 ±9.51		31.33 ±9.68		15.76 ± 10.23		17.69 ± 10.51	
$20,001–40,000	34.00 ± 9.04		33.31 ± 10.86		15.03 ± 8.07		16.18 ± 12.36	
$40,001-$80,000	33.42 ± 8.14		32.46 ± 9.92		14.89 ± 8.47		16.57 ± 10.13	
Over $80,000	32.60 ± 8.78		33.13 ±9.74		17.79 ± 8.57		19.30 ± 9.23	

	Bypass				Banding			
	% Δ Weight loss at year 1 (*n* = 245)	*p* value	% Δ Weight loss at year 2 (*n* = 211)	*p* value	% Δ Weight loss at value year 1 (*n* = 212)	*p* value	% Δ Weight loss at year 2 (*n* = 183)	*p* value
Marital status		0.44		0.40		0.09		0.77
Married	32.73 ± 7.87		32.85 ± 32.85		18.24 ± 8.42		18.36 ± 9.93	
Divorced/separated	31.49 ± 8.17		32.25 ± 32.25		16.73 ± 8.54		17.57 ± 12.96	
Never married	33.57 ± 9.31		34.65 ± 34.65		14.82 ± 8.79		16.88 ± 10.98	
Comorbidities								
Arthritis	33.42 ± 8.82	0.62	33.92 ±11.58	0.19	15.69 ± 7.46	0.66	17.88 ± 8.69	0.77
Diabetes	29.88 ± 8.24	<0.001	29.54 ± 9.74	0.001	14.73 ± 7.99	0.18	16.14 ±9.59	0.26
Hypertension	32.39 ±9.15	0.16	31.75 ± 10.04	0.24	15.64 ± 7.79	0.44	17.55 ± 10.75	0.99
Asthma	33.34 ± 9.23	0.71	34.42 ± 10.93	0.10	16.55 ± 7.81	0.68	19.65 ± 9.99	0.18
Obstructive sleep	32.71 ± 9.05	0.60	32.97 ± 10.08	0.48	15.54 ± 8.72	0.36	16.69 ± 10.12	0.27
apnea GI/GERD	32.60 ± 8.85	0.46	32.52 ± 10.37	0.91	16.84 ± 8.88	0.14	17.81 ± 10.53	0.72
Depression	32.81 ± 8.89	0.72	33.27 ± 10.89	0.26	15.48 ± 7.87	0.30	16.07 ± 10.39	0.06
Anxiety	32.69 ± 9.85	0.66	34.19 ±11.00	0.08	14.74 ± 7.25	0.05	14.56 ± 9.32	0.003
Back pain	32.49 ± 9.34	0.37	32.63 ± 11.33	0.82	16.36 ± 7.46	0.67	16.62 ±9.11	0.37
Anemia	31.20 ± 7.71	0.21	32.10 ± 10.57	0.82	14.62 ± 9.64	0.30	18.00 ±11.23	0.82
Cardiovascular disease	29.36 ± 9.74	0.10	33.59 ± 8.04	0.65	13.17 ± 8.33	0.10	15.92 ± 10.10	0.49
Other	34.56 ± 10.53	0.38	37.26 ± 12.07	0.15	15.84 ±7.26	0.91	13.86 ± 10.66	0.17
Smoker		0.70		0.06		0.20		0.20
Current	33.95 ± 8.02		34.09 ± 9.34		14.95 ±11.00		9.31 ± 4.55	
Former	33.41 ± 9.02		34.19 ±9.93		14.98 ± 8.70		17.54 ± 10.27	
Never	32.56 ± 8.82		30.86 ± 10.27		17.11 ± 8.34		18.02 ± 10.91	
Alcohol drinking		0.31		0.93		0.49		0.16
Non-high risk drinker	32.76 ± 8.95		32.25 ± 10.26		16.01 ± 8.29		17.13 ± 10.55	
High risk drinker	34.41 ± 8.21		32.43 ± 9.76		17.14 ± 10.00		20.27 ± 10.73	
Disordered eating at baseline[a]								
Emotional eating		0.55		0.29		0.77		0.80
Score >50	32.64 ± 9.15		31.66 ± 9.48		15.90 ± 9.21		17.81 ± 10.66	
Score <50	33.32 ± 8.58		33.13 ± 10.73		16.25 ± 8.16		17.40 ± 10.56	
Uncontrollable eating		0.45		0.93		0.48		0.94

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	Bypass				Banding			
	% Δ Weight loss at year 1 (*n* = 245)	*p* value	% Δ Weight loss at year 2 (*n* = 211)	*p* value	% Δ Weight loss at value year 1 (*n* = 212)	*p* value	% Δ Weight loss at year 2 (*n* = 183)	*p* value
Score >50	32.68 ± 8.69		32.47 ± 9.87		15.67 ± 9.00		17.70 ± 10.49	
Score <50	33.62 ± 9.02		32.34 ±11.04		16.52 ± 8.16		17.58 ± 10.82	
Cognitive restraint		0.65		0.17		0.29		0.04
Score >50	33.22 ± 8.50		33.41 ± 9.85		15.58 ± 8.09		16.37 ± 10.60	
Score <50	32.71 ±9.13		31.49 ± 10.49		16.92 ± 9.68		19.70 ± 10.51	
Average # of METs burned in a day		0.32		0.76		0.64		0.76
1st Quartile (MET<33)	33.13 ± 8.97		33.14 ± 11.53		16.59 ± 8.15		16.96 ± 10.79	
2nd Quartile (MET33.01–34)	33.02 ± 7.08		31.00 ± 8.12		15.32 ± 9.03		18.54 ± 10.72	
3rd Quartile (MET34.0–36)	31.44 ± 9.56		32.23 ± 8.42		14.86 ± 7.30		16.53 ± 8.38	
4th Quartile (MET>36)	34.66 ±9.13		32.59 ± 11.11		16.78 ± 9.79		18.47 ± 11.76	
Difficulty decreasing portion size[b]		<0.001		0.009		<0.0001		0.002
High difficulty	25.18 ± 8.02		27.13 ± 10.77		12.17 ± 6.13		13.55 ± 8.30	
Low difficulty	33.24 ± 8.21		33.66 ± 9.06		18.31 ± 8.71		19.51 ± 11.67	
Difficulty decreasing fat[b]		0.05		0.003		0.07		0.14
High difficulty	28.07 ± 7.13		27.35 ±11.27		14.12 ± 6.41		15.86 ± 8.19	
Low difficulty	32.92 ± 8.46		33.83 ± 8.87		17.53 ± 8.83		18.44 ± 11.32	
Difficulty decreasing carbohydrates[b]		<0.001		<0.001		0.57		0.45
High difficulty	27.68 ± 8.29		28.17 ± 9.57		16.47 ± 6.91		16.91 ± 9.72	
Low difficulty	33.56 ± 8.17		34.61 ± 8.79		17.24 ± 9.08		18.33 ±11.20	
Difficulty increasing protein[b]		0.74		0.80		1.00		0.64
High difficulty	31.94 ± 7.19		33.73 ± 10.18		17.06 ± 9.46		18.91 ± 9.66	
Low difficulty	32.67 ± 8.57		33.07 ± 9.31		17.05 ± 8.55		17.75 ± 10.98	

Reporting mean ± SD

[a]Disordered eating is categorized as high when the TFEQ-18 disordered eating scores were between 51 and 100 with higher scores indicating more of that behavior

[b]Participants reporting a difficulty of 7 of higher (out of 10) are classified as having high difficulty

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Table 3

Association between race and percent weight loss among patient up to 2 years after undergoing gastric bypass and gastric banding with sequential adjustment for other potential correlates[a]

	Model 1, demographics		Model 2, model 1 + comorbidities		Model 3[b], model 2 + health behaviors	
		p value		*p* value		*p* value
Gastric bypass						
BMI at baseline	0.08 ± 0.07	0.29	0.08 ± 0.07	0.26	0.08 ± 0.07	0.26
Race/ethnicity Caucasian	Reference		Reference		Reference	
African American	–6.39 ± 1.48	<0.001	–6.33 ±1.46	<0.001	–5.93 ± 1.49	<0.001
Hispanic	–6.53 ± 2.37	0.001	–5.77 ± 2.36	0.01	–6.08 ± 2.39	0.01
Other	–4.54 ± 3.34	0.17	–4.24 ± 3.09	0.17	–4.36 ± 3.07	0.15
Sex						
Male	–3.74 ± 1.70	0.03	–3.64 ± 1.68	0.03	–3.27 ± 1.73	0.06
Female	Reference		Reference		Reference	
Age	–0.07 ± 0.06	0.25	–0.03 ± 0.058	0.56	–0.06 ± 0.06	0.34
Education						
High school or less	1.89 ± 1.47	0.20	1.71 ± 1.45	0.24	1.76 ± 1.48	0.23
Some college/2-year	Reference		Reference		Reference	
4-Year college or more	0.71 ± 1.42	0.62	0.73 ± 1.40	0.61	0.87 ± 1.42	0.54
Household income						
$20,000 or less	0.38 ± 2.08	0.86	0.63 ± 2.05	0.76	0.54 ±2.03	0.79
$20,001–40,000	2.87 ± 1.72	0.09	2.90 ± 1.70	0.09	2.90 ± 1.72	0.09
$40,001–80,000	1.66 ± 1.61	0.30	1.45 ± 1.61	0.37	1.52 ± 1.64	0.35
Over $80,000	Reference		Reference		Reference	
Marital status						
Not married	Reference		Reference		Reference	
Married	–2.68 ± 1.90	0.16	–2.54 ± 1.87	0.17	–2.46 ± 1.92	0.20
Separated/divorced	–1.13 ±1.75	0.52	–1.11 ± 1.73	0.52	–0.93 ±1.74	0.59
Comorbidities						
Diabetes	–		–1.95 ±0.90	0.03	–1.94 ±0.88	0.03

	Model 1, demographics		Model 2, model 1 + comorbidities		Model 3[b], model 2 + health behaviors	
Smoking						
Currently	–		–		1.85 ±2.16	0.39
Former	–		–		1.46 ± 1.23	0.23
Never	–		–		Reference	
Alcohol						
Not high risk drinker	–		–		Reference	
High risk drinker	–		–		–0.12 ± 1.68	0.94
Gastric banding						
BMI at baseline	–0.09 ±0.12	0.44	–0.09 ±0.12	0.44	–0.10 ±0.12	0.37
Sex						
Male	–1.14 ± 1.63	0.48	–1.51 ± 1.63	0.36	–1.70 ± 1.71	0.32
Female	Reference		Reference		Reference	
Age	–0.05 ± 0.07	0.46	–0.05 ± 0.07	0.50	–0.03 ± 0.07	0.71
Race/ethnicity Caucasian	Reference		Reference		Reference	
African American	–3.79 ± 1.96	0.05	–4.75 ± 1.95	0.02	–4.72 ± 1.96	0.02
Hispanic	2.43 ± 2.70	0.37	2.34 ± 2.70	0.38	1.61 ±2.62	0.54
Other	0.79 ± 2.75	0.77	1.05 ± 2.70	0.70	1.13 ±2.73	0.68
Education						
High school or less	3.06 ±2.11	0.15	2.17 ±2.12	0.31	2.39 ±2.10	0.26
Some college/2-year	Reference		Reference		Reference	
4-Year college or more	0.40 ± 1.45	0.78	0.19 ± 1.42	0.89	0.08 ± 1.44	0.96
Household income						
$20,000 or less	–6.38 ± 2.94	0.03	–6.14 ±2.96	0.04	–6.27 ± 2.98	0.04
$20,001–40,000	–4.14 ±2.05	0.04	–3.30 ± 2.05	0.11	–3.13 ±2.02	0.12
$40,001–80,000	–2.93 ± 1.82	0.11	–2.06 ± 1.87	0.27	–1.99 ± 1.85	0.28
Over $80,000	Reference		Reference		Reference	
Marital status						
Not married	Reference		Reference		Reference	
Married	2.09 ± 1.58	0.19	1.81 ± 1.49	0.23	1.93 ± 1.49	0.19
Separated/divorced	2.46 ± 2.03	0.23	2.53 ± 1.93	0.19	2.52 ± 1.91	0.19
Comorbidities						

	Model 1, demographics	Model 2, model 1 + comorbidities		Model 3[b], model 2 + health behaviors	
Anxiety	–	–3.07 ± 0.95	0.001	−3.16 ±0.98	0.001
Smoking					
Currently	–	–		–1.86 ±4.11	0.65
Former	–	–		–0.80 ± 1.32	0.55
Never	–	–		Reference	
Alcohol					
Not high risk drinker	–	–		Reference	
High risk drinker	–	–		2.63 ± 1.65	0.11

[a]The estimate indicates the percent additional change in weight loss associated with that factor relative to the reference group. All models were adjusted by site along with the variables specified in the tables in addition to whether body weight at follow-up was measured or self-reported

[b]In addition to alcohol and smoking, physical activity, QOL, and having a psychiatric diagnosis or poor mental functioning were also examined but not significantly associated with weight loss and not included in model 3

Table 4

Race, baseline dietary behavior and perception, and weight change after gastric bypass and gastric banding surgery[a]

	Effect of dietary behavior/perception	African Americans vs. Caucasians[b]		Hispanics vs. Caucasians[c]	
			p value		*p* value
Gastric bypass patients					
Unadjusted for dietary behavior/perception		−6.33 ± 1.46	<0.001	−5.77 ± 2.36	0.01
Difficulty limiting (0–10)					
Limiting portion sizes	−0.67 ± 0.24	−7.14 ± 1.46	<0.001	−6.11 ±2.40	0.01
Limiting fat	−0.70 ± 0.23	−6.94 ± 1.45	<0.001	−5.94 ± 2.30	0.01
Limiting carbohydrates	−0.46 ± 0.22	−6.66 ± 1.45	<0.001	−5.91 ± 2.36	0.01
Increasing protein	−0.38 ±0.18	−6.00 ± 1.45	<0.001	−5.55 ±2.44	0.02
TFEQ-18 disordered eating (0–100)					
Emotional eating	−0.02 ± 0.02	7.11 ± 1.62	<0.001	−6.36 ±2.41	0.001
Uncontrollable eating	−0.03 ± 0.03	−6.75 ± 1.52	<0.001	−6.07 ± 2.40	0.01
Cognitive restraint	0.02 ± 0.03	−6.40 ± 1.47	<0.001	−5.75 ±2.42	0.02
Gastric banding patients					
Unadjusted for dietary behavior/perception		−4.75 ± 1.95	0.02	2.34 ± 2.70	0.38
Difficulty limiting (0–10)					
Limiting portion sizes	−0.60 ± 0.30	−5.15 ± 1.93	0.01	2.24 ±2.61	0.39
Limiting fat	−0.38 ±0.33	−4.86 ± 1.90	0.01	2.43 ± 2.72	0.37
Limiting carbohydrates	−0.17 ±0.32	−4.82 ± 1.93	0.01	2.47 ± 2.72	0.36
Increasing protein	−0.25 ± 0.26	−4.49 ± 1.92	0.02	2.35 ± 2.69	0.38
TFEQ-18 disordered eating (0–100)					
Emotional eating	0.01 ± 0.02	−4.76 ± 1.95	0.01	2.37 ±2.68	0.38
Uncontrollable eating	0.02 ± 0.03	−4.67 ± 1.99	0.02	2.57 ± 2.74	0.35
Cognitive restraint	−0.03 ± 0.04	−4.63 ± 1.99	0.02	2.40 ± 2.70	0.37

[a]The estimates indicate the percent additional change in weight loss associated with that factor relative to the reference group; for example, a 1-point increase in difficulty limiting dietary portion size at baseline is associated with a lower weight loss of 0.62%. Models were adjusted for significant correlates and relevant confounders as denoted in Table 3a-c

[b]Estimates reflect the difference in weight loss in African Americans relative to Caucasians with additional adjustment for factors in first column

[c]Estimates reflect the difference in weight loss in Hispanics relative to Caucasians with additional adjustment for factors in first column

Table 5

Change in IWQOL-lite scores at 1 and 2 years after WLS relative to baseline by surgery type

	Mean Δ QOL at year 1	Mean Δ QOL at year 2	Adjusted differences compared to Caucasian patients[a]			
			AA		Hispanic	
	Mean ± SD	Mean ± SD	Estimate ± SE	*p* value	Estimate ± SE	*p* value
Gastric bypass						
Total	37.42 ± 17.49	37.33 ± 18.09	1.26±2.19	0.56	1.02±3.25	0.75
Physical functioning	47.62 ±21.60	46.50 ±22.05	−0.35±2.30	0.88	2.90±3.41	0.40
Public distrust	36.40 ± 24.03	36.77 ± 24.74	1.11±2.66	0.68	5.27±3.24	0.10
Self-esteem	34.99 ±25.52	34.38 ±26.66	2.62±3.71	0.48	0.96±5.22	0.85
Sex life	25.26 ±28.28	25.67 ±26.03	0.85±2.85	0.77	0.01±3.77	1.00
Work	27.44 ± 20.00	26.76 ± 20.84	−1.22±2.13	0.57	−4.68±3.29	0.15
Gastric banding						
Total	21.03 ± 14.76	23.85 ± 17.57	−1.38±2.83	0.63	3.71±4.72	0.43
Physical functioning	28.40 ± 18.38	31.18 ± 21.57	−2.17±3.66	0.55	2.69±4.04	0.51
Public distrust	18.18 ±20.19	22.17 ±21.10	−3.17±4.02	0.43	6.98±6.76	0.30
Self-esteem	19.50 ±20.24	21.72 ±22.37	1.02±3.06	0.74	5.45±6.14	0.38
Sex life	12.35 ±20.12	14.13 ±24.61	−1.27±3.33	0.70	2.37±5.61	0.67
Work	14.12 ± 18.56	18.74 ±21.64	0.40±3.05	0.90	−4.77±4.77	0.32

[a]All models were adjusted by site along with age, sex, education, income, marital status, surgery type and baseline QOL