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ORIGINAL CONTRIBUTIONS

Weight Loss Prior to Bariatric Surgery and 30-Day Mortality, Readmission, Reoperation, and Intervention: an MBSAQIP Analysis of 349,016 Cases

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Abstract

Introduction Despite preoperative weight loss being a common prerequisite to metabolic and bariatric surgery, its relationship to 30-day postoperative outcomes is unclear. The aim of this study was to assess whether preoperative weight loss is associated with 30-day postoperative quality outcomes in adults undergoing metabolic and bariatric surgery.

Methods Retrospective cohort study assessing adults who underwent Roux-en-Y gastric bypass or sleeve gastrectomy in the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program Participant Use File, years 2015–2017. The relationship between preoperative weight loss and 30-day readmission, reoperation, mortality, intervention, and morbidity was assessed using multivariable logistic regression.

Results Preoperative weight loss, body mass index loss, and percent weight loss were not associated with 30-day postoperative overall readmission, reoperation, mortality, or intervention ($p > 0.01$). Preoperative percent weight loss was associated with increased incidence of superficial surgical site infections (OR = 1.023, 95% CI 1.009–1.036; $p = 0.001$) and urinary tract infections (OR = 1.044, 95% CI 1.030–1.059; $p < 0.001$).

Conclusion Weight loss prior to metabolic and bariatric surgery may not be necessary or safe for all patients. Unsafe weight loss prior to surgery may compromise nutrition status and lead to increased infection rates.

Keywords Preoperative weight loss · MBSAQIP · Bariatric surgery

Introduction

Medical weight management (MWM) is a medically supervised period of weight loss prior to metabolic and bariatric surgery [1]. This practice was inadvertently established in the 1991 National Institutes of Health guidelines when the panel members concluded that an experienced clinician should determine that individuals seeking metabolic and bariatric surgery should have a low probability of successful weight loss with nonsurgical weight loss methods before being classified as appropriate for metabolic and bariatric surgery [2]. This recommendation was interpreted in clinical practice to suggest that patients should have engaged in more conservative weight loss efforts, such as lifestyle modification and/or pharmacotherapy, prior to metabolic and bariatric surgery. However, little evidence existed at the time to support this practice. The requirements of MWM are often determined by third party payers or individual programs. The American Association of Clinical Endocrinologists, the Obesity Society, and the American Society for Metabolic and Bariatric Surgery (AACE/TOS/ASMBS) clinical guidelines have also recommended some forms of MWM prior to surgery; however, the specific evidence regarding the benefits, if any, of preoperative weight loss is mixed [3, 4].

Some have found weight loss to be associated with shorter operative time; however, others have found this difficult to

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replicate given differing measures of operative time [5, 6]. Several studies have found shorter length of stay and lower rates of complication with preoperative weight loss, but reviews of these findings concluded that variations in the methodology across studies precluded the authors from making strong statements on the relationship between preoperative weight loss and surgical complications [6]. Even with the limited evidence to support mandated preoperative weight loss in order to receive surgical treatment, it is nevertheless common practice for many programs and a requirement by insurance providers.

The present study aims to rectify this gap in knowledge by investigating whether preoperative weight loss is associated with 30-day postoperative quality outcomes among adults who have undergone metabolic and bariatric surgery. Based on previous smaller studies, we hypothesized weight loss prior to metabolic and bariatric surgery would be associated with fewer 30-day readmissions, reoperations, mortalities, and interventions.

Methods

This is a retrospective study utilizing the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP) Participant Use File (PUF). The MBSAQIP PUF is a Health Insurance Portability and Accountability Act-compliant database consisting of metabolic and bariatric surgery cases submitted by more than 700 MBSAQIP-participating centers in North America. The data are entered by certified clinical reviewers, whose training is specific to metabolic and bariatric surgery. Data entry and site survey to audit cases and data entry methodology is required for MBSAQIP comprehensive accreditation [7]. PUFs from 2015, 2016, and 2017 were used in the analysis. Data sets were merged with variables renamed to match other years. Variables not available for all 3 years were excluded from the study.

Inclusion criteria was comprised of Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG) cases. Further inclusion stipulated RYGB or SG as the initial metabolic and bariatric surgery, a laparoscopic approach, and patients were 18 years of age or older at time of surgery ($n = 470{,}148$). Cases missing a preoperative weight or highest preoperative weight within a year of surgery were excluded ($n = 34{,}213$; 7.3%). Due to low volume, current BMI recommendations, and possible anthropometric data entry error, cases with a BMI of less than 35 kg/m^2 or greater than 60 kg/m^2 ($n = 38{,}471$; 8.2%) were excluded as well as those with a preoperative BMI loss of greater than 10 kg/m^2 ($n = 3448$; 0.7%).

Due to varying weight measure units, preoperative weight and highest weight within a year of surgery were validated using corresponding BMI and reported height. Three different weight change predictor variables were created using the highest weight and BMI within 1 year prior to surgery and the immediate preoperative BMI and weight variables: weight loss, BMI loss, and percent weight loss.

Stata/SE 14.1 by StataCorp was used to conduct all analyses. Descriptive, independent *t* tests, and chi-square statistics were used to assess baseline variables. Multivariable logistic regression was used to evaluate the relationship between preoperative weight loss and postoperative readmission, reoperation, mortality, and intervention. Additional multivariable logistic regressions were used to assess preoperative weight loss's relationship to 30-day postoperative complications. All multivariable regression models were controlled for factors commonly associated with 30-day postoperative outcomes including demographics, baseline clinical variables [preoperative BMI, hypertension (HTN), obstructive sleep apnea (OSA), gastroesophageal reflux disease (GERD), diabetes mellitus (DM), hyperlipidemia (HLD), smoking status, chronic obstructive pulmonary disease (COPD), kidney disease requiring dialysis (ESRD)], and surgical factors/history [procedure, American Society of Anesthesiologists (ASA) class and history of percutaneous coronary intervention/percutaneous transluminal coronary angioplasty, pulmonary embolism, myocardial infarction, or venous stasis]. These variables are commonly used in MBSAQIP's risk-adjusted semiannual report to centers. Due to multiple comparisons, a Bonferroni correction alpha of 0.01 was used for both univariate and multivariable analyses to minimize the risk of type I error. The study was deemed exempt by the University of Pennsylvania's Institutional Review Board.

Results

The final analysis included 394,016 patients. Demographic and clinical characteristics are shown in Table 1. Seventy-two percent of patients underwent SG ($N = 282{,}463$). The majority of patients were female ($N = 315{,}698$, 80.1%), white ($N = 290{,}943$, 73.8%), with a mean ± standard deviation age of 44.8 ± 11.9 years. Many patients had HTN ($N = 247{,}292$, 62.8%), OSA ($N = 146{,}002$, 37.1%), GERD ($N = 124{,}187$, 31.5%), DM ($N = 100{,}516$, 25.5%), or HLD ($N = 94{,}374$, 24.0%). Few patients (≤ 2.1%) had a history of significant cardiac disease, events, or surgeries. ASA class for the sample was 2.8 ± 0.5. Mean preoperative weight and BMI were 124.1 kg ± 21.9 kg and 44.5 kg/m^2 ± 5.8 kg/m^2, respectively. Highest weight and BMI within 1 year of surgery were 129.2 kg ± 23.2 kg and 46.3 kg/m^2 ± 6.2 kg/m^2, respectively. For the created predictor variables, BMI loss was 1.8 kg/m^2 ± 1.7 kg/m^2, weight loss was 5.1 kg ± 5.0 kg, and percent weight loss was 3.8% ± 3.5%. Seventeen percent of the sample had no difference between highest preoperative weight and immediate preoperative weight.

Table 1 Baseline demographic and clinical characteristics

Variable	Roux-en-Y gastric bypass	Sleeve gastrectomy	Total	*p* value
	Mean (SD) or No. (%)			
	N = 111,553	*N* = 282,463	*N* = 394,016	
Sex				
Female	90,406 (81.0)	225,292 (79.8)	315,698 (80.1)	< 0.0001
Male	21,147 (19.0)	57,171 (20.2)	78,318 (19.9)	
Age, years	45.6 (11.8)	44.5 (12.0)	44.8 (11.9)	< 0.0001
Race				
White	85,367 (76.5)	205,576 (72.8)	290,943 (73.8)	
Non-White	17,159 (15.4)	55,467 (19.6)	72,626 (18.4)	
Missing/not reported	9027 (8.1)	21,420 (7.6)	30,447 (7.7)	< 0.0001
Body mass index, kg/m^2	45.1 (6.0)	44.3 (5.8)	44.5 (5.8)	< 0.0001
Weight, kg	125.4 (21.9)	123.6 (21.8)	124.1 (21.9)	< 0.0001
Hypertension	74,871 (67.1)	172,421 (61.0)	247,292 (62.8)	< 0.0001
Obstructive sleep apnea	46,773 (41.9)	99,229 (35.1)	146,002 (37.1)	< 0.0001
Gastroesophageal reflux disease	43,936 (39.3)	80,251 (28.4)	124,187 (31.5)	< 0.0001
Diabetes				
Non-insulin	22,732 (20.4)	44,937 (16.0)	67,669 (17.2)	< 0.0001
Insulin dependent	14,890 (13.3)	17,957 (6.4)	32,847 (8.3)	
Hyperlipidemia	31,970 (28.7)	62,404 (22.1)	94,374 (24.0)	< 0.0001
Current smoker within 1 year	9191 (8.2)	24,663 (8.7)	33,854 (8.6)	< 0.0001
Chronic obstructive pulmonary disease	2134 (1.9)	4370 (1.5)	6504 (1.7)	< 0.0001
Renal insufficiency	698 (0.6)	1763 (0.6)	2461 (0.6)	0.96
Kidney disease requiring dialysis	191 (0.2)	963 (0.3)	1154 (0.3)	< 0.0001
American Society of Anesthesiologists Class	2.9 (0.5)	2.8 (0.5)	2.8 (0.5)	< 0.0001
History				
Percutaneous coronary intervention/percutaneous transluminal coronary angioplasty	2680 (2.4)	5435 (1.9)	8115 (2.1)	< 0.0001
Myocardial infarction	1750 (1.6)	3386 (1.2)	5136 (1.3)	< 0.0001
Pulmonary embolism	1380 (1.2)	3069 (1.1)	4449 (1.1)	< 0.0001
Cardiac surgery	1244 (1.1)	3199 (1.1)	4443 (1.1)	0.64
Venous stasis	1181 (1.1)	2301 (0.8)	3482 (0.9)	< 0.0001
Weight change within 1 year				
Highest body mass index	47.0 (6.4)	46.1 (6.2)	46.3 (6.2)	< 0.0001
Highest weight	130.8 (23.3)	128.5 (23.2)	129.2 (23.2)	< 0.0001
Body mass index loss	2.0 (1.8)	1.8 (1.7)	1.8 (1.7)	< 0.0001
Weight loss, kg	5.5 (5.2)	4.9 (4.9)	5.1 (5.0)	< 0.0001
Percent weight loss	4.1 (3.6)	3.7 (3.4)	3.8 (3.5)	< 0.0001

p value reflects chi-squared or independent *t* tests, SD = Standard Deviation

When comparing the two procedures using independent *t* tests or chi-squared tests, a greater proportion of female and white patients underwent RYGB versus SG ($p < 0.0001$). Patients who underwent RYGB had greater prevalence of comorbidity in respect to HTN, OSA, GERD, DM, HLD, and COPD ($p < 0.0001$). Fewer patients who underwent SG had a history of percutaneous coronary intervention/percutaneous transluminal coronary angioplasty, myocardial infarction, pulmonary embolism, or venous stasis ($p < 0.0001$). RYGB patients had greater preoperative BMI, weight, and percent weight loss ($p < 0.0001$).

Shown in Table 2, weight loss, as measured in kilograms, BMI, or percent, was not associated with 30-day readmission, reoperation, mortality, or intervention ($p > 0.01$). While 30-day readmission did trend towards weight loss being associated with lower risk, it did not reach the specified level of significance ($p = 0.02$).

Table 3 shows the relationship between preoperative percent weight loss and 30-day postoperative complications.

Table 2 Relationship between preoperative weight loss and 30-day mortality, readmission, reoperation, and intervention outcomes

Variable	OR	95% CI		*p* value
		Lower	Upper	
30-day readmission				
Weight loss	0.996	0.992	0.999	0.02
BMI loss	0.990	0.980	0.999	0.03
Percent weight loss	0.995	0.990	1.000	0.04
30-day reoperation				
Weight loss	0.995	0.989	1.001	0.08
BMI loss	0.986	0.970	1.002	0.09
Percent weight loss	0.981	0.950	1.013	0.25
30-day mortality				
Weight loss	0.989	0.968	1.010	0.31
BMI loss	0.967	0.909	1.028	0.28
Percent weight loss	0.981	0.950	1.013	0.25
30-day intervention				
Weight loss	0.997	0.992	1.003	0.36
BMI loss	0.993	0.977	1.009	0.38
Percent weight loss	0.996	0.988	1.004	0.37

Multivariable regression controlling for procedure, sex, age, race, preoperative body mass index, hypertension, obstructive sleep apnea, gastroesophageal reflux disease, diabetes, hyperlipidemia, smoking status, chronic obstructive pulmonary disease, kidney disease requiring dialysis, American Society of Anesthesiologists Class, history of percutaneous coronary intervention/percutaneous transluminal coronary angioplasty, history of pulmonary embolism, history of myocardial infarction, and history of venous stasis. CI, confidence interval

Each additional percent body weight loss was associated with a 2.3% increase in superficial SSIs (OR = 1.023, 95% CI 1.009–1.036; $p = 0.001$). Each additional percentage point weight loss prior to surgery was associated with a 4.4% increased observed rate of urinary tract infection (OR = 1.044, 95% CI 1.030–1.059; $p < 0.001$). Weight loss was unrelated to other types of SSIs, wound disruption, sepsis, and venous thrombosis requiring therapy, pulmonary embolism, or pneumonia. Among the five most frequent reasons for readmission, reoperation, and intervention, preoperative weight loss was associated with a lower rate of 30-day readmission for abdominal pain (OR = 0.981, 95% CI 0.968–0.994; $p = 0.005$) but unrelated to the other most common reasons for readmission. Preoperative weight loss was also unrelated to the most likely reasons for reoperation or intervention ($p > 0.01$).

Conclusion

The present study found weight loss in the year prior to laparoscopic RYGB or SG was not associated with readmission, reoperation, mortality, or intervention. Specifically, weight loss was associated with lower rates of readmission for abdominal pain, but increased rates of superficial SSI and urinary tract infection. These results reject the presented hypothesis and differ from some previous studies suggesting universally lower rates of postoperative complications. However, the most recent publication on the subject from Eng et al. found similar outcomes to the present study with a limited relationship between preoperative weight loss and postoperative outcomes [8].

In 2008, the AACE/TOS/ASMBS Clinical Practice Guidelines reviewed the studies which, to that point in time, had investigated the relationship between preoperative weight loss and postoperative complications—of which appeared to demonstrate reduced liver size and increased postoperative weight loss [4]. Since that time, additional studies have investigated this relationship and several authors have written reviews of this literature with mixed conclusions. Despite the lack of consensus, the 2013 AACE/TOS/ASMBS Bariatric Surgery Clinical Practice Guidelines did not change the 2008 recommendations of encouraging preoperative weight loss. Most recently, ASMBS released a position statement concluding, "The discriminatory, arbitrary and scientifically unfounded practice of insurance mandated preoperative weight loss, contributes to patient attrition, causes unnecessary delay of lifesaving treatment, leads to the progression of life-threatening co-morbid conditions, is unethical, and should be abandoned." [9]

Patients with preoperative weight loss were less likely to experience readmission for abdominal pain within this sample which may speak to the technical aspect of the surgeries [10]. Previous studies have described the relationship between preoperative weight loss and operative time or technical experience for the surgeon [6]. Weight loss reduces liver size which may lead to shorter operative time, less disruption of the abdominal wall, and subsequently less pain for the patient, potentially explaining the observed trend demonstrated here [11, 12]. Although it did not reach a level of significance, SSI observations align with Winfield and colleagues' findings showing a negative correlation between BMI and organ/space SSIs in clean-contaminated abdominal operations [13].

At odds with the suggested benefits of weight loss in respect to abdominal pain and readmission, increased weight loss was associated with increased rates of superficial SSIs and urinary tract infections. This relationship may be related to malnutrition and the surgical obesity paradox considering previous studies have linked impaired nutrition status to SSIs [14]. Concurrent malnutrition and obesity is well-documented in the nutrition field and in patients presenting for metabolic and bariatric surgery [15, 16]. Current dogma among programs is a recommendation to lose weight prior to surgery, which seems to make logical sense, but is not without nutrition risk. Many programs simply impose a weight loss recommendation or requirement, but provide limited instruction on how to achieve such weight loss. As a result, patients who have

Table 3 Relationship between preoperative percent weight loss and postoperative complications

Variable	OR	95% CI		*p* value
		Lower	Upper	
SSI				
Superficial	1.023	1.009	1.036	0.001
Deep	1.033	0.998	1.068	0.06
Organ/space	0.979	0.960	0.999	0.04
Wound disruption	1.026	0.986	1.067	0.20
Sepsis	1.010	0.983	1.038	0.46
Venous thrombosis requiring therapy	0.998	0.977	1.020	0.89
Pulmonary embolism	1.007	0.980	1.035	0.61
Urinary tract infection	1.044	1.030	1.059	<0.001
Pneumonia	0.979	0.959	0.999	0.04
Most likely reason for readmission				
Nausea and vomiting, fluid, electrolyte depletion	1.003	0.995	1.012	0.43
Abdominal pain	0.981	0.968	0.994	0.005
Bleeding	1.015	0.994	1.037	0.16
Anastomotic/staple line leak	0.988	0.965	1.011	0.29
Other	0.995	0.984	1.007	0.41
Most likely reason for intervention				
Nausea and vomiting, fluid, electrolyte depletion	0.999	0.982	1.017	0.92
Other	0.994	0.975	1.013	0.52
Stricture/stomal obstruction	1.017	0.997	1.037	0.11
Anastomotic/staple line leak	0.993	0.966	1.021	0.61
Bleeding	1.000	0.972	1.029	0.99
Most likely reason for reoperation				
Bleeding	1.014	0.996	1.034	0.13
Other	0.984	0.964	1.004	0.11
Intestinal obstruction	1.008	0.985	1.031	0.50
Anastomotic/staple line leak	0.974	0.950	0.999	0.04
Gallstone disease	1.001	0.970	1.034	0.93

Multivariable regression controlling for procedure, sex, age, race, preoperative body mass index, hypertension, obstructive sleep apnea, gastroesophageal reflux disease, diabetes, hyperlipidemia, smoking status, chronic obstructive pulmonary disease, kidney disease requiring dialysis, American Society of Anesthesiologists Class, history of percutaneous coronary intervention/percutaneous transluminal coronary angioplasty, history of pulmonary embolism, history of myocardial infarction, and history of venous stasis. CI, confidence interval

been able to lose weight in the past through restrictive, "crash" or "fad," diets employ such techniques to "drop weight," rather than using dietitian-supervised nutritional management during this time. Therefore, the means by which weight loss is achieved may be overly restrictive without nutritional management, leading to a more immunocompromised state compared to a dietitian-supervised, more nutritionally balanced caloric reduction [17, 18].

Although the present study suggests there may be additional risks and benefits to preoperative weight loss from a statistical significance standpoint, the clinical translation of these findings needs to be taken into account. The overall complication rates and specific reported here are well below reported previous acceptable rates [19]. Using an example based on the current study, producing 5% weight loss through intensive intervention, a loss typically taking 3 to 6 months to achieve, is associated with a 9.5% reduced risk of 30-day readmission for abdominal pain. This modest potential benefit has to be weighed against the risks of delaying surgery and the health benefits that come with it. In the same scenario of 5% weight loss, risk of a superficial SSI rises by 11.5% and urinary tract infection by 22%. This potential modest increased risks and benefits need to be considered with regard to the implications of delaying surgery and its associated health benefits. There is likely little potential benefit to extending time to surgery to produce preoperative weight loss, considering Eng and colleagues found no association between time to surgery and immediate postoperative complications or long-term weight loss [8].

Requiring weight loss prior to surgery has also been viewed as a potential barrier to receiving treatment, an important factor that should be taken into account when determining whether weight loss is a recommended part of the care plan. Jamal et al. randomized patients to complete a 13-week nutrition counseling program prior to surgery and found greater attrition in the group that received counseling versus no counseling (28 vs 19%, $p < 0.05$) [20]. Love and colleagues found insurance-mandated dietary requirements prior to surgery were independently predictive of preoperative drop-out in a sample of 1475 patients [21].

The primary strength of this study is the size of the sample. This is the largest study to date to evaluate preoperative weight loss in relation to 30-day postoperative outcomes. The MBSAQIP PUF also collects data on all metabolic and bariatric surgery cases within accredited centers by certified clinical reviewers. Limitations of this study are primarily related to the limitations of the database, specifically related to the variables themselves. Limited nutrition variables, no information on urinary catheters, and only 30-day outcomes were available. Additionally, only two variables were available to determine preoperative weight change: highest weight or BMI within 1 year of surgery and weight or BMI prior to surgery. These variables do not capture how quickly, how close to surgery, and with what method the weight loss occurred; it also does not described weight gain prior to surgery. For example, if a patient had maintained or gained weight in the year prior to surgery and was as their highest weight at the time of surgery, these two variables would be the same value, leading to a weight change of zero. This accounted for 17% of the sample. Likewise, there is no variable designating whether weight loss was recommended or required by the program. Furthermore, the MBSAQIP PUF relies on accurate data entry by certified clinical reviewers. For example, weight is entered into the database as a continuous variable where the clinical reviewer would then designate the measurement unit as kilograms or pounds. BMI is entered separately. When validating the weight values using BMI and weight, it is apparent that incorrect weight measurement units were designated for a significant minority of cases. This was rectified in the current study by validating the correct unit using these variables, however emphasizes the possibility of data entry error in this type of database.

The present results suggest weight loss prior to metabolic and bariatric surgery is unrelated to overall 30-day readmission, mortality, reoperation, or intervention. Weight loss was associated with a modest reduction in readmission for abdominal pain risk; however, weight loss was also associated with increased rates of superficial SSIs and urinary tract infections. Future studies should evaluate the relationship between weight loss and postoperative abdominal pain through intra-operative outcomes. The findings described here include both risk and benefits and do not support the use of weight loss prior to surgery as a prerequisite to receiving surgical treatment.

Compliance with Ethical Standards

Conflict of Interest Kelly C. Allison reports grants from Novo Nordisk and personal fees from Weight Watchers International.

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