Research Article
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Pre-operative weight, BMI and the incidence of obesity co-morbidities vary by sex in bariatric surgery patients: analysis of 166,601 women and men with obesity

Abstract

Background: Variations in pre-operative characteristics by sex in bariatric surgery cannot be easily extrapolated from current literature. Objective: to identify pre-operative differences between males and females across the spectrum of bariatric procedures, weight and co-morbidities.

Methods: Data from 166,601 pre-operative Surgical Review Corporation Bariatric Longitudinal Database (BOLD) patients undergoing bariatric surgery were divided into females (n=130,612) and males (n=35, 989). Statistics: Chi-square and Analysis of Variance (ANOVA).

Results: Males displayed higher pre-operative age, BMI, weight, and rates of cardiopulmonary obesity co-morbidities, diabetes, gout, dyslipidemia, abdominal hernia, liver disease, alcohol, tobacco and substance abuse. Females suffered more from asthma, GERD, cholelithiasis, stress urinary incontinence, abdominal panniculitis, somatic obesity co-morbidities and mental health conditions ($p<0.0001$).

Conclusions: Pre-operative weight, BMI, and weight-related medical problems vary by sex among patients undergoing bariatric surgery. With this advance knowledge, surgeons managing obese patients can anticipate co-morbidities by sex and adjust pre- and post-surgical preparations accordingly.

Keywords: pre-operative weight,surgical patients, abdominal panniculitis, somatic obesity

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Abbreviations: BMI, body mass index; LRYGB, laparoscopic roux-en-Y gastric bypass; GERD, gastro esophageal reflux disease

Introduction

In the United States, 60% of adults have a chronic medical condition and 40% have two or more.[1] The obesity epidemic exacerbates this situation, as nearly 38% of adults have body mass index (BMI) >30.[2] All surgeons of every specialty now must operate on patients with morbid obesity, where every clinical insight helps. Compared with the general population, cardiovascular disease, heart failure, cardiac arrhythmias. hypertension, diabetes, dyslipidemia, and depression are increased in patients with obesity.[3] Surgical patients with obesity also carry increased risks of difficult intubation, surgical site infection, and adverse events peri-operatively.[4] Understanding the complex pathophysiologies of morbid obesity may facilitate anticipatory surgical planning. Previous reports described variations by sex in weight, BMI, age, race, and the penetration of cardiopulmonary, abdominal/hepatobiliary, endocrine/metabolic, somatic, and psychological/behavioral weight-related pathology among patients pre-operative for laparoscopic Roux-en-Y gastric bypass(LRYGB) and bilio-pancreatic diversion/duodenal switch (BPD/DS).[5,6] However, patients who choose these operations vary widely in clinical characteristics and variations by sex cannot be extrapolated directly to all obese patients. The objective of this study, then, was to identify pre-operative variations between women and men across the spectrum of weight, BMI, and bariatric procedures.

Materials and methods

With the approval of the Surgical Review Corporation (SRC) and the IRB of Our Lady of Lourdes Medical Center, Camden, New Jersey, pre-operative data from the SRC's Bariatric Outcomes Longitudinal Database (BOLD) on 166,601 patients with morbid obesity who underwent laparoscopic (LRYGB. n=83,059), or open (n=5389) Roux-en-Y gastric bypass, laparoscopic adjustable gastric band (LAGB. n=67,514), Sleeve gastrectomy (SLEEVE. n=8,966), or biliopancreatic diversion/duodenal switch (BPD/DS. n=1,673) was analyzed in two groups: females (n=130,612) and males (n=35, 989).[7] Dependent variables included weight, BMI, age, race, health insurance, employment status and the percent frequency of 31 weight-related co-morbidities.Statistical Analysis:Continuous variables: Analysis of Variance (ANOVA) with treatment in the models. Dicotomous variables:general linear model with treatment in the model and modified for binomial distribution.[8]

Results

Variation by sex in weight, BMI, age and demographics is seen in Table 1. Men were older, heavier, and more often unemployed than women ($p<0.0001$). Female/male African American (12%/7%) and Caucasian (74%/79%) varied ($p<0.0001$).Variation by sex in cardiovascular and pulmonary obesity co-morbidities is listed in Table 2. All cardiopulmonary problems except asthma were higher in men. Variation by sex in abdominal/hepatobiliary and somatic

obesity co-morbidities is displayed in Table 3. Abdominal hernia and liver disease were increased men>women. Females had higher gastroesophageal reflux disease (GERD), stress urinary incontinence, cholelithiasis, and abdominal panniculitis. Somatic problems affected more women than men. Men more frequently had impaired functional status. Variation by sex in endocrine/metabolic and psychological/behavioral obesity co-morbidities are tabulated in Table 4. Diabetes, dyslipidemia, gout, alcohol/tobacco/substance abuse were higher among men. Women suffered more depression, mental health diagnosis, and psychologic impairment. Overall, 18 obesity co-morbidities affected men significantly more frequently than women. In women, 12 weight-related medical conditions were higher.

Table 1 Variation by sex in weight, BMI, age and demographics

	Female	Male	Chi-Sq.
			Probability
Average Weight (kg)	124.1 (±22)	153.3 (±29)	<.0001
Average BMI	46.23 (±8)	48.13 (±8)	<.0001
	No. (%)	No. (%)	±
Age			
<30	15,286 (12)	2,833 (8)	<.0001
30-40	34,302 (26)	7,577 (21)	<.0001
40-50	36,553 (28)	10,358 (29)	<.0001
50-60	31,208 (24)	9,580 (27)	<.0001
60-70	12,345 (9)	5,130 (14)	<.0001
>70	918 (1)	511 (1)	<.0001
Race			
African American	15,695 (12)	2,531 (7)	<.0001
Caucasian	97,058 (74)	28,434 (79)	<.0001
Asian	276 (<1)	103 (<1)	<.0001
Hispanic	9,607 (7)	2,798 (8)	<.0001
Other	7,906 (6)	2,123 (6)	<.0001
Employment			
Full/Part-time	78,617 (60)	21,742 (60)	<.0001
Unemployed/ Disabled	25,181 (19)	8,561 (24)	<.0001

Table 2 Variation by sex in cardiovascular and pulmonary obesity co-morbidities

	Female	Male	Chi-Sq.
	No. (%)	No. (%)	Probability
Cardiovascular			
Hypertension	71,544 (55)	25,278 (70)	<.0001
Lower Extremity Edema	35,549 (27)	9,827 (27)	<.0001
Ischemic Heart Disease	3,918 (3)	3,162 (9)	<.0001
Angina	2,988 (2)	1,343 (4)	<.0001

Table Continued...

	Female	Male	Chi-Sq.
	No. (%)	No. (%)	Probability
Congestive Heart Failure	1,984 (2)	1,372 (4)	<.0001
Peripheral Vascular Disease	1,204 (1)	637 (2)	<.0001
Deep Vein Thrombosis/ Pulmonary Embolism	3,488 (3)	1,163 (3)	<.0001
Pulmonary			
Asthma	24,420 (19)	4,274 (12)	<.0001
Obstructive Sleep Apnea	51,526 (39)	22,284 (62)	<.0001
Obesity Hypoventilation Syndrome	2,039 (2)	909 (3)	<.0001
Pulmonary Hypertension	5,646 (4)	1,765 (5)	<.0001

Table 3 Variation by sex in abdominal/hepatobiliary obesity co-morbidities

	Female	Male	Chi-Sq.
	No. (%)	No. (%)	Probability
Abdominal/Hepatobiliary			
Abdominal Hernia	5,768 (4)	2,664 (7)	<.0001
Cholelithiasis	29,282 (22)	3,041 (8)	<.0001
Gastroesophageal Reflux Disease	62,603 (48)	14,344 (40)	<.0001
Abdominal Panniculitis	8,957 (7)	1,962 (5)	<.0001
Stress Incontinence	36,522 (28)	1,394 (4)	<.0001
Liver Disease	7,431 (6)	2,529 (7.)	<.0001
Musculoskeletal/Neurologic			
Pseudotumor Cerebri	2725 (2)	274 (1)	<.0001
Impaired Functional Status	3,610 (3)	1,332 (4)	<.0001
Fibromyalgia	5,130 (4)	219 (1)	<.0001
Back Pain	62,841 (48)	16,416 (46)	<.0001
Musculoskeletal Pain	56,128 (43)	150,63 (42)	<.0001

Table 4 Variation by sex in endocrine/metabolic, somatic, and psychological/ behavioral obesity co-morbidities

	Female	Male	Chi-Sq.
	No. (%)	No. (%)	Probability
Metabolic/Endocrine			
Diabetes	41,307 (31)	15,980 (44)	<.0001
Dyslipidemia	51,055 (39)	18,050 (50)	<.0001
Gout	3,020 (2)	2,771 (8)	<.0001
Psychological/Behavioral			
Depression	48,782 (37)	8,344 (23)	<.0001

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Table Continued...

	Female	Male	Chi-Sq.
	No. (%)	**No. (%)**	**Probability**
Mental Health Diagnosis	14,779 (11)	2,410 (7)	<.0001
Psychological Impairment	22,592 (17)	4,220 (12)	<.0001
Substance Abuse	460 (<1)	219 (1)	<.0001
Alcohol Use	38,620 (30)	12,416 (35)	<.0001
Tobacco Use	7,954 (6)	2,942 (8)	<.0001

Discussion

This investigation identifies statistically and clinically significant variations by sex in pre-operative weight, BMI, age, race, clinical characteristics and weight-related medical problems across the spectrum of bariatric surgery patients and procedures. Men with obesity are older, heavier, drink, smoke, and use drugs more frequently than women. All serious cardiopulmonary obesity co-morbidities, except asthma, are increased among men with obesity, versus women. Morbidly obese men experience higher rates of diabetes, gout, and dyslipidemia than do women. Abdominal hernia and liver disease are increased in men with obesity, the latter possibly related to increased alcohol consumption. Conversely, GERD, cholelithiasis, stress urinary incontinence, abdominal panniculitis, somatic complaints, and psychological derangements affect women more than men. This advance clinical knowledge empowers surgeons to anticipate obesity co-morbidities for both sexes, possibly facilitating increased pre-surgical preparation, evidence-based peri-operative management, and improved outcomes for surgical patients with severe obesity. Our review of the literature indicates that these variations by sex in every organ system among patients along the entire spectrum of obesity have not been reported previously and are an important finding of this investigation.

Increased age and BMI among men over women appear clinically significant, considering the dramatically increased cardiovascular and pulmonary problems, up to double the female rates, in men with obesity.Whether or not higher male tobacco/alcohol/substance abuse contributed to these serious derangements in men is not clear from the data, but such behavioral factors may be causative. Young and co-workers observed similar cardiovascular and pulmonary variation by sex in LAGB, LRYGB, and SLEEVE patients, as did Schwartz in the LRYGB sub-cohort of this study.[5,9] Conversely, in the super-obese BPD/DS BOLD sub-group, DVT/PE, peripheral vascular disease, angina, pulmonary hypertension and obesity hypoventilation syndrome did not vary by sex.[6] Stroh and co-workers, however, found increased sleep apnea in men, but no other gender variation.[10] In the present study, inclusion of pre-operative data from patients undergoing five different bariatric operations may have ameliorated some if these inconsistencies.

The higher incidence of diabetes among men with obesity observed in the full-spectrum bariatric population of this study confirms previous reports pre-operative to LRYGB.[5,10] Increased gout and dyslipidemia in men with obesity compared to women completes the weight-related metabolic derangements. These findings should be considered in caring for surgical patients with obesity.[11]

Every abdominal and hepatobiliary weight-related medical problem examined in this report varied significantly by sex. Cholelithiasis, GERD, abdominal panniculitis, and stress urinary incontinence affected women most. Abdominal hernia and liver disease were increased among men.One might speculate that increased alcohol/tobacco/substance abuse by men in this investigation contributed to elevated liver disease. Similarly, a cause-and-effect relationship between increased symptomatic female GERD and higher asthma might be considered. In spite of lower age and BMI, somatic and neurologic derangements still dominated women with obesity in this investigation.Female fibromyalgia and pseudotumor cerebri increased dramatically versus men, consistent with known female/male characteristics.[11] However, increased back and musculoskeletal pain in women who were younger than men and had lower BMI, suggests female musculoskeletal susceptibility to these conditions. Nevertheless, higher physically impaired functional status in men, the mechanism for which is not clear from the data, remains a significant finding in this study.

Depression, psychological impairment, and mental health diagnosis were increased significantly in women versus men. These findings are consistent with previous reports from the LRYGB and BPD/DS subsets of the BOLD population.[5,6] In planning, surgeons might consider psychological co-morbidities in women with obesity related to post-operative compliance with treatment. The principal accomplishment of this investigation is identifying variations between women and men with obesity across the range of weight, BMI and the characteristics of patients who chose five bariatric procedures. While some findings from previous publications were confirmed in the comprehensive bariatric population analyzed here, others from sub-sections of the obesity world were refuted.[5,6,9] Statistically and clinically significant variations between women and men with morbid obesity were identified in this investigation, therefore, can be extrapolated to all surgical patients with obesity. This advance knowledge provides new insights for surgeons who must operate on patients with morbid obesity.

What is the clinical value of the variation by sex identified in this study? The advance knowledge presented here can raise the clinical index of suspicion for surgeons treating these complex and fragile morbidly obese patients. For example, knowing that the men with obesity have highly increased cardiovascular and pulmonary diseases can lead to potentially life-saving pre-operative evaluation and optimization. Similarly, closer attention to increased pre-operative asthma in women with obesity could trigger pre-operative pulmonary preparation. Increased awareness of other organ system variations by sex also could guide peri-operative management. Whether or not surgical outcomes actually can be improved with this advance clinical knowledge will require further prospective evaluation. There were several limitations to this study. It is a retrospective analysis of prospectively collected data, and, as such, carries many typical confounders. In addition, the patients in this study represent a self-selected population of patients with obesity who chose bariatric surgery. Diagnosis of co-morbidities was clinical, rather than pathological, such as liver biopsy not required for BOLD, as an example.

Conclusion

Pre-operative weight, BMI, and weight-related medical problems vary by sex across the spectrum of bariatric surgery patients and procedures. Men are older, heavier, drink, smoke, and use drugs more frequently than women, and experience higher rates of diabetes, dyslipidemia, cardiopulmonary problems, and liver disease. Among women with obesity, asthma, GERD, cholelithiasis, stress urinary incontinence, abdominal panniculitis, somatic and mental health

obesity co-morbidities were increased.With this advance clinical knowledge, surgeons can anticipate obesity co-morbidities for both sexes, possibly optimizing pre-surgical preparation and post-surgical outcomes.

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Conflicts of interest

The author declares that there is no conflict of interest.

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