

Clinical characteristics vary between women and men in 67,524 patients with moderate obesity preoperative for laparoscopic adjustable gastric Band (LAGB)

Abstract

Background: As of 2018, LAGB represents <2% of weight loss operations, but with excellent long-term outcomes in selected patients. Thus, every clinical insight can help in selecting LAGB patients and planning surgery. While more women than men undergo bariatric surgery, differences between the sexes in obesity-related clinical conditions pre-operatively among patients seeking LAGB have not been investigated. The objective of this study was to identify variations in obesity-related co-morbidities among women and men who chose laparoscopic adjustable gastric band (LAGB).

Methods: Pre-operative data on 53,292 women and 14,222 men undergoing LAGB were examined retrospectively from the Surgical Review Corporation's Bariatric Outcomes Longitudinal Database (BOLD).

Results: Women were more frequently African American and on Medicaid while men were more frequently Caucasian insured with Medicare. Men were older, heavier, and used alcohol, tobacco, and illicit substances more frequently. Men had higher rates of cardiovascular and pulmonary disease, diabetes, gout, impaired functional status, abdominal hernia, and liver disease. Women had higher rates of asthma, cholelithiasis, urinary incontinence, panniculitis, and mental health.

Conclusion: Pre-operative characteristics of LAGB patients vary by sex. This clinical knowledge may aid physicians and surgeons in facilitating anticipatory management of patients with moderate obesity.

Keywords: obesity, adjustable gastric band, bariatric surgery, metabolic surgery, obesity co-morbidities, laparoscopy

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Abbreviations: PVD, peripheral vascular disease; HTN, hypertension; MHD, mental health diagnoses; IFS, impaired functional status

Introduction

As of 2018, LAGB represents <2% of weight loss operations, but continues to effect excellent long-term outcomes in selected patients.¹ For patients with moderate obesity, every clinical insight can help in selecting LAGB patients and planning surgery. While more women than men undergo bariatric surgery, differences between the sexes in obesity-related clinical conditions pre-operatively among patients seeking LAGB have not been investigated. We have reported previously that the pre-operative clinical characteristics of laparoscopic Roux-en-Y gastric bypass (LRYGB) patients, and of patients undergoing biliopancreatic diversion/duodenal switch (BPD/DS) differed significantly women versus men.²⁻⁴ However, whether or not such variations by sex are clinically important also in the moderately obese population of patients who choose LAGB is unknown. The objective of this study was to identify variations in demographics, age, BMI, and the incidence of obesity co-morbidities between women versus men with moderate obesity who were pre-operative for LAGB.

Methods

Pre-operative clinical data from 67,524 patients in the Surgical Review Corporation's Bariatric Outcomes Longitudinal Database (BOLD)⁵ who were about to undergo LAGB were examined retrospectively in two groups: women (53,292) and men (14,222). Weight, BMI, age, race, health insurance status, and the percent frequency of obesity co-morbidities were obtained from BOLD, including hypertension (HTN), angina, congestive heart failure (CHF), peripheral vascular disease (PVD), obstructive sleep apnea (OSA), obesity hypoventilation syndrome (OHS), asthma, ischemic heart disease (IHD), deep vein thrombosis/pulmonary embolism (DVT/PE), abdominal hernia, abdominal panniculitis, cholelithiasis, gastroesophageal reflux disease (GERD), liver disease, stress urinary incontinence (SUI), diabetes mellitus, gout, dyslipidemia, pseudotumor cerebri, back pain, lower extremity edema (LEE), musculoskeletal pain, mental health diagnoses (MHD), impaired functional status (IFS), depression, psychological impairment, alcohol use, substance abuse, tobacco use, and fibromyalgia.⁵

Statistical analysis: Continuous variables were analyzed using analysis of variance (ANOVA). Pair-wise comparisons were performed on the least squares means of the treatments calculated

from the ANOVA model to find differences in the treatment groups. Distribution of obesity co-morbidities was examined by a general linear model with treatment in the model and modified for binomial distribution to account for dichotomous variables.⁶

Results

Demographics in moderately obese women and men are listed in Table 1. Female/male age (45.2±12/48.2±12 years), weight (119±19/147±25 kilograms) (BMI (44.6±7/46.2±7) health insurance (Medicaid 3.1%/1.6%, Medicare 7.1%/9.9%) ($p<0.0001$) and race (African-American 12.4%/6.8%, Caucasian 73.5%/78.3%, Hispanic 5.8%/6.4%, Asian 0.2%/0.3%, Other 7.8%/8.1%; $p<0.001$) varied significantly. Cardiopulmonary co-morbidities in moderately obese women and men are displayed in Table 2. Cardiovascular co-morbidities angina, CHF, HTN, IHD, PVC ($p<0.0001$), and DVT/PE ($p<0.01$) were more prevalent in males. Only lower extremity edema was increased in women. ($p<0.01$). OSA and OHS were higher in males, while asthma was more frequent in females ($p<0.0001$). Psychological and Behavioral co-morbidities in moderately obese women and men are tabulated in Table 3. Male alcohol use, tobacco and substance abuse, and unemployment were greater than female ($p<0.0001$). Women suffered depression, psychological impairment, and mental

health diagnoses more often than men ($p<0.0001$). Abdominal and hepatobiliary co-morbidities in moderately obese women and men are detailed in Table 4. Abdominal hernia and liver disease were higher among men ($p<0.0001$). Females more frequently had GERD, abdominal panniculitis, cholelithiasis, and SUI ($p<0.0001$). Endocrine and metabolic co-morbidities in moderately obese women and men are demonstrated in Table 5. Diabetes, gout, and dyslipidemia were increased in men, while pseudotumor cerebri was higher in women ($p<0.0001$). Somatic co-morbidities in moderately obese women and men are presented in Table 6. Males more frequently had impairments in functional status, whereas females more often had fibromyalgia and back pain ($p<0.0001$). Musculoskeletal pain did not vary between males and females ($p=0.3708$). Overall, females carried 12 weight-related co-morbidities more frequently than did males: abdominal panniculitis, cholelithiasis, GERD, stress urinary incontinence, asthma, back pain, fibromyalgia, pseudotumor cerebri, mental health diagnosis, depression, psychological impairment ($p<0.0001$) and lower extremity edema ($p<0.01$). Seventeen obesity co-morbidities were increased in men: abdominal hernia, liver disease, OHS, OSA, angina, HTN, CHF, IHD, PVD, dyslipidemia, diabetes, gout, impaired functional status, alcohol use, tobacco use, substance abuse, and unemployment ($p<0.0001$) and DVT/PE ($p<0.01$).

Table 1 Demographics in women and men with moderate obesity

	Age	Weight (kg)	BMI	African American	Caucasian	Hispanic	Asian	Other	Medicaid	Medicare
Women	45.2±12	119±19	44.6±7	12.40%	73.50%	5.80%	0.20%	7.80%	3.10%	7.10%
Men	48.2±12	147±25	46.2±7	6.80%	78.30%	6.40%	0.30%	8.10%	1.60%	9.90%
p-value	<0.0001	<0.0001	<0.0001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0001	<0.0001

Table 2 Cardiopulmonary co-morbidities in women and men with moderate obesity

	Angina	CHF	HTN	Ischemic heart disease	Peripheral vascular disease	Lower extremity edema	DVT/ PE	Asthma	Obstructive sleep apnea	Obesity hypoventilation syndrome
Women	1.83%	1.15%	52.15%	2.83%	0.79%	23.32%	2.51%	16.42%	34.33%	1.37%
Men	3.35%	3.07%	67.09%	8.71%	1.51%	22.17%	2.94%	10.65%	56.65%	2.17%
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.01	<0.01	<0.0001	<0.0001	<0.0001

Table 3 Psychological/behavioral co-morbidities in women and men with moderate obesity

	Depression	Psychological impairment	Alcohol abuse	Substance abuse	Tobacco abuse	Mental health diagnosis	Unemployment
Women	34.29%	14.83%	29.74%	0.31%	5.99%	9.69%	16.55%
Men	20.63%	10.01%	34.58%	0.57%	8.09%	5.82%	21.64%
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table 4 Abdominal/hepatobiliary co-morbidities in women and men with moderate obesity

	GERD	Abdominal hernia	Abdominal panniculitis	Cholelithiasis	Stress urinary incontinence	Liver disease
Women	43.97%	3.95%	4.84%	19.44%	25.14%	3.91%
Men	36.66%	6.63%	3.36%	7.03%	3.45%	5.32%
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table 5 Endocrine/metabolic co-morbidities in women and men with moderate obesity

	Diabetes	Gout	Dyslipidemia	Pseudotumor cerebri
Women	26.30%	2.09%	37.25%	1.37%
Men	37.82%	6.75%	48.24%	0.64%
p-value	<0.0001	<0.0001	<0.0001	<0.0001

Table 6 Somatic co-morbidities in women and men with moderate obesity

	Back pain	Impaired functional status	Fibromyalgia	Musculoskeletal pain
Women	45.05%	1.92%	3.30%	38.80%
Men	42.74%	2.89%	0.55%	21.70%
p-value	<0.0001	<0.0001	<0.0001	0.3708

Discussion

The results of this study identify significant variation in the clinical characteristics of moderately obese women versus men who were pre-operative for LAGB. Women were more frequently African American and on Medicaid while men were more often Caucasian and on Medicare. Men were older, had higher BMI, used alcohol, drugs, and tobacco more frequently, and had higher rates of cardiovascular pathology (angina, CHF, hypertension, ischemic heart disease, PVD, DVT/PE), pulmonary dysfunction (obesity hypoventilation syndrome and obstructive sleep apnea), metabolic/endocrine conditions (diabetes, gout), abdominal hernia, liver disease, and impaired functional status. Among women, asthma, abdominal/hepatobiliary (cholelithiasis, stress urinary incontinence, abdominal panniculitis), and mental health issues/dysfunction were more frequent than in men. This advance clinical knowledge can complement clinical judgement of bariatric surgeons in selecting patients for LAGB and preparing them for surgery. In addition, since all surgeons of all specialties, not just bariatric surgeons, now must operate on morbidly obese patients, this advance clinical knowledge can increase clinical acumen in peri-operative patients with obesity and may facilitate anticipatory management. Understanding weight-related variation between women and men with moderate obesity thus may improve medical care and outcomes for these patients. Our review of the literature indicates that the statistically and clinically significant variations in baseline characteristics of moderately obese women versus men pre-surgical for LAGB have not been reported previously and are significant findings of this study. It is not surprising that males weighed more than females, but concurrent advanced male age may indicate that males choose bariatric surgery at a more progressive stage of obesity than females. Even though the gap in weight differences was small, these findings were still clinically significant. Advanced age in males with obesity is consistent with reports in the literature.⁷ Since men were also older and heavier than women in this study, that the male-dominated categories appeared more frequently in patients covered by Medicare, including cardiovascular and pulmonary disease, diabetes, gout, impaired functional status, abdominal hernia, liver disease, tobacco abuse, alcohol abuse, and drug abuse, is consistent with the data. Conversely, with higher Medicaid coverage among LAGB women, female-dominated categories appeared more frequently in Medicaid insured, including asthma, cholelithiasis, SUI, panniculitis, and mental health. Thus, the prevalence of sex related obesity co-morbidities directly correlates to their prevalence in patients

with Medicare versus Medicaid. Previously we reported variation between insurance carriers, with the highest obesity co-morbidities in Medicare and Medicaid, versus private insurance and Self-Pay.^{8,9} When organized by sex, more LAGB males were Caucasian, Hispanic, Asian, and Other. More females were African American. Caucasian men had the highest weight, BMI, and number of total co-morbidities. Previously we reported pre-operative variation by race in mixed sex populations undergoing open RYGB,¹⁰ and by health insurance before LRYGB8, open RYGB9, and biliopancreatic diversion/duodenal switch.⁴ While Caucasian and African American women and men and Medicare and Medicaid subscribers in these investigations carried the highest BMI and obesity co-morbidities, when LAGB patients were analyzed by sex, Caucasian and Medicare men appeared to be at higher risk for excess weight and weight-related medical problems.

Men with moderate obesity in this study had significantly greater rates of all cardiovascular co-morbidities including HTN, angina, CHF, IHD, LEE, PVD and DVT/PE. These results are consistent with the literature documenting increased male cardiovascular risks over females in the general population.¹¹⁻¹³ However, in the present investigation men with obesity not only had higher BMI than women, a health risk itself but also reported significantly more alcohol and tobacco abuse, both established risk factors for cardiopulmonary pathology.¹⁴ In addition to male sex, these factors may have contributed to the increased cardiovascular disease observed in men. Similar to the findings in our study, Weidner reported higher coronary artery disease in non-obese men than women, associated also with excessive alcohol consumption and smoking in these men.¹⁵ From this, one might speculate that in men with moderate obesity, behavioral misadventures contribute to their increased risk for coronary artery disease, angina, HTN, CHF, ischemic heart disease, and PVD.

Dyslipidemia is an independent risk factor for cardiovascular disease, and it is generally more frequent among men than women overall.¹⁶ This was confirmed in the present investigation of men and women with moderate obesity. Since male BMI in this study was higher than females, the results here support the concept of hyperlipidemia secondary to obesity as a direct risk factor for increased male risk for cardiopulmonary illnesses. Obese men had increased incidence of lower extremity edema in this study, which correlates with the literature stating that males overall have higher rates of venous insufficiency than women, and obesity further propagates its development.¹⁷ In this investigation, OSA and OHS affected men, at up to 1.65 times the female rate. These dramatic relative sex disparities contradict directly the findings of Beigh & Jain,¹³ who reported metabolic syndrome in 29% of women and 23% of men with moderate obesity. The pre-operative male/female variations in OSA and OHS rates in LAGB patients with mild to moderate obesity also are higher than those observed among patients undergoing LRYGB¹⁸ and BPD/DS4, in spite of the higher absolute OSA and OHS percentages in the heavier latter populations. Approximately 25% adults with a BMI between 25-28 have at least mild obstructive sleep apnea, 30% of which are men and 15% women, supporting the differences between the sexes.^{19,20} The results here and the supporting literature identify increased OSA in men as a sex-related propensity that is exacerbated in incidence and severity by higher BMI and, possibly, by increased male smoking and drinking. Exacerbated relative male-to-female disparity in OSA and OHS among LAGB patients with moderate obesity is a new finding of this study. Our results also identified higher rates of diabetes in men versus women with moderate obesity. Increased male weight and BMI, which directly correlate to the development of Type 2 Diabetes, may be contributing factors.²¹ Variation in biology, culture,

lifestyle, environment, and socioeconomic status impact males and females in development and clinical presentation of diabetes. Obese men nationwide have higher rates of diabetes than women, which is consistent with the findings of the present investigation.^{22,23}

The incidence of gout was increased significantly in LAGB men, compared with women. Gout is the most prevalent inflammatory arthritis in non-obese men and is associated with impaired quality of life.²⁰ A direct relationship between increasing BMI and the incidence of gout has not been characterized in the general US population.^{22,23} However, in the presence of obesity in the present investigation, both BMI and gout were increased significantly among LAGB men versus women. Pre-operative cholelithiasis was significantly greater in LAGB women than men studied here, consistent with historical trends and current data worldwide. Women are almost twice as likely to form gallstones as men, and most patients with gallstones in general are female and obese.²² In a study of over 11,000 patients, by Sun et al.,²⁴ reported a positive association between increasing BMI and the incidence of cholelithiasis in both women and men. However, women developed cholelithiasis at a lower BMI compared with men.²⁴ Sex and BMI are independent risk factors for cholelithiasis. Urinary incontinence affects more than 13 million women in the United States and profoundly impacts quality of life. Obesity is a strong risk factor for incontinence, consistent with the current results, one of multiple factors increasing the incidence among women.^{23,25} Women with incontinence in our study far outweighed the incidence in men, by nearly eight times. The weight-related problem of abdominal skin panniculitis was infrequent in this study population, but, nevertheless, affected a significant greater percentage of moderately obese women than it did men. Men had greater BMI, and abused tobacco, alcohol, and drugs more than women, all of which are well-known risk factors for infection. While fluctuations in female hormones which may contribute to obesity in women,²⁶ the literature does not support hormonal changes as contributors to panniculitis. This is an important element to recognize as female sex may be an independent risk factor for panniculitis.

Women evaluated here experienced significantly greater GERD than did men, in contrast to the non-obese population in which GERD is approximately even between the sexes.²⁷ Known risk factors for GERD are severe obesity, smoking, and alcohol abuse,²⁸ all of which were increased in men in this study. From these results, one could expect a higher male GERD prevalence. Higher estrogen levels may act to inhibit the lower esophageal sphincter in women.¹⁷ The mechanism underlying increased GERD among women versus men with moderate obesity is not clear from the data. Psychological co-morbidities in this study were diagnosed at higher rates among obese women for their male counterparts, consistent with prior publications. Mahoney and co-authors observed that women with obesity were more likely to report a history of anxiety and depression than men, and that they scored higher on psychiatric index testing preoperatively.²⁹ Obese women in this study experienced greater somatic co-morbidities than men, with the exception of impaired functional status. This is interesting to note, as men would be expected to have higher somatic co-morbidities due to their higher BMI and weight. This has not been previously reported.

Men undergoing LAGB abused tobacco, alcohol, and drugs more than women. These lifestyle choices are significant as they may contribute to their overall obesity, and the development of multiple other co-morbidities. Hart et. al, hypothesized that obesity alone may lead to steatohepatitis, and the presence of fatty liver due to alcohol

promotes obesity.¹⁵ This circular effect promotes dual detrimental effects on liver disease and obesity. This finding correlates with our data, in that increased alcohol abuse in men may be related to their higher weight and BMI. Increased alcohol abuse by LAGB men in this study also may have contributed to increased liver disease compared with women. Overall men consume alcohol more than women.³⁰ The combined effects of alcohol and obesity may synergistically induce hepatocellular injury, inflammation, fibrosis and the development of cancer.³¹ Even at moderate doses alcohol exacerbates the pathological effects of obesity on the liver, as the threshold for hepatotoxic alcohol effects in obese populations is lower than for normal weight individuals.^{28,32} These pathophysiologic interactions may be the mechanisms underlying increased male liver disease in this investigation. There were several limitations to this study. The data constraints of a retrospective investigation apply. Patients in this study represent a self-selected population who individually chose LAGB, and therefore our findings might not be applicable to all moderately obese surgical patients. Diagnosis of co-morbidities in BOLD was on a clinical diagnosis, rather than a pathological diagnosis. For example, liver biopsies were not required. Nevertheless, the significant clinical variation by sex reported here may be extrapolated to male and female patients with similar moderate obesity.

Conclusion

The pre-operative clinical characteristics of LAGB women and men varied significantly. Women were more frequently African American and on Medicaid while men were more often Caucasian and on Medicare. Before AGB, compared with women, men were older, had higher BMI, used alcohol, drugs, and tobacco more frequently, and had higher rates of cardiovascular pathology, obesity hypoventilation syndrome and obstructive sleep apnea, diabetes, gout, abdominal hernia, liver disease, and impaired functional status. Among women, asthma, cholelithiasis, stress urinary incontinence, abdominal panniculitis, and mental health issues/dysfunction were more frequent than for men. Although the LAGB patients in this study were self-selected, the significant variations by sex identified can be applied to other similar individuals with obesity. Since all surgeons now operate on patients with obesity, the advance clinical knowledge reported here can increase clinical acumen and may facilitate anticipatory management. Understanding variation in weight-related characteristics of men and women with moderate obesity may improve outcomes not only for surgery, but in medical management, as well.

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Conflicts of interest

The author declares that there is no conflict of interest.

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