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Seven-Year Weight Trajectories and Health Outcomes in the Longitudinal Assessment of Bariatric Surgery (LABS) Study

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IMPORTANCE More information is needed about the durability of weight loss and health improvements after bariatric surgical procedures.

OBJECTIVE To examine long-term weight change and health status following Roux-en-Y gastric bypass (RYGB) and laparoscopic adjustable gastric banding (LAGB).

DESIGN, SETTING, AND PARTICIPANTS The Longitudinal Assessment of Bariatric Surgery (LABS) study is a multicenter observational cohort study at 10 US hospitals in 6 geographically diverse clinical centers. Adults undergoing bariatric surgical procedures as part of clinical care between 2006 and 2009 were recruited and followed up until January 31, 2015. Participants completed presurgery, 6-month, and annual research assessments for up to 7 years.

MAIN OUTCOME AND MEASURES Percentage of weight change from baseline, diabetes, dyslipidemia, and hypertension, determined by physical measures, laboratory testing, and medication use.

RESULTS Of 2348 participants, 1738 underwent RYGB (74%) and 610 underwent LAGB (26%). For RYBG, the median age was 45 years (range, 19-75 years), the median body mass index (calculated as weight in kilograms divided by height in meters squared) was 47 (range, 34-81), 1389 participants (80%) were women, and 257 participants (15%) were nonwhite. For LAGB, the median age was 48 years (range, 18-78), the body mass index was 44 (range, 33-87), 465 participants (76%) were women, and 63 participants (10%) were nonwhite. Follow-up weights were obtained in 1300 of 1569 (83%) eligible for a year-7 visit. Seven years following RYGB, mean weight loss was 38.2 kg (95% CI, 36.9-39.5), or 28.4% (95% CI, 27.6-29.2) of baseline weight; between years 3 and 7 mean weight regain was 3.9% (95% CI, 3.4-4.4) of baseline weight. Seven years after LAGB, mean weight loss was 18.8 kg (95% CI, 16.3-21.3) or 14.9% (95% CI, 13.1-16.7), with 1.4% (95% CI, 0.4-2.4) regain. Six distinct weight change trajectory patterns for RYGB and 7 for LAGB were identified. Most participants followed trajectories in which weight regain from 3 to 7 years was small relative to year-3 weight loss, but patterns were variable. Compared with baseline, dyslipidemia prevalence was lower 7 years following both procedures; diabetes and hypertension prevalence were lower following RYGB only. Among those with diabetes at baseline (488 of 1723 with RYGB [28%]; 175 of 604 with LAGB [29%]), the proportion in remission at 1, 3, 5, and 7 years were 71.2% (95% CI, 67.0-75.4), 69.4% (95% CI, 65.0-73.8), 64.6% (95% CI, 60.0-69.2), and 60.2% (95% CI, 54.7-65.6), respectively, for RYGB and 30.7% (95% CI, 22.8-38.7), 29.3% (95% CI, 21.6-37.1), 29.2% (95% CI, 21.0-37.4), and 20.3% (95% CI, 9.7-30.9) for LAGB. The incidence of diabetes at all follow-up assessments was less than 1.5% for RYGB. Bariatric reoperations occurred in 14 RYGB and 160 LAGB participants.

CONCLUSIONS AND RELEVANCE Following bariatric surgery, different weight loss patterns were observed, but most participants maintained much of their weight loss with variable fluctuations over the long term. There was some decline in diabetes remission over time, but the incidence of new cases is low following RYGB.

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There are continued gaps in knowledge about the long-term (5 years and longer) results of bariatric surgery.[1] High-quality evidence, including randomized clinical trials, shows that bariatric surgical procedures result in greater weight loss than nonsurgical treatments and are more effective at inducing initial type 2 diabetes remission.[2,3] Yet, more information is needed about the longer-term durability of weight loss, comorbidity control, and complications after bariatric procedures. Most evaluations of bariatric surgical outcomes have been limited by inadequate and incomplete long-term follow-up. A systematic review reported that fewer than 3% of studies in this field report weight loss outcomes for more than 80% of the original cohort, which may lead to biased and potentially overestimated reports of the effectiveness of these procedures.[4] The most comprehensive and longest follow-up information comes from the Swedish Obese Subjects study, which began in 1987, so nearly all participants in the surgical group underwent procedures that are no longer performed today (eg, 68% vertical banded gastroplasty, 19% nonadjustable gastric banding). The average weight loss including all the surgical procedure groups was 16% over the long term.[5] In addition to questions about the long-term sustainability of weight loss, it is important to understand whether improvements in obesity-related comorbid conditions are durable over time and if there is emergence of incident conditions after surgical treatments. In the Swedish Obese Subjects study, recovery from diabetes was found in 72%, 38%, and 30% at 2, 10, and 15 years in the surgery group, respectively.[6] By 10 years, incident diabetes (7%), hypertriglyceridemia (17%), and hypertension (41%) emerged among those in the surgical group who did not have these medical problems prior to bariatric surgery.[7]

The Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) study, a large multicenter observational cohort study with prospective and standardized data collection, was designed to contribute data to the literature by evaluating the effectiveness of surgery, durability of effect, and longer-term complications in this carefully studied cohort. Three-year weight change and health outcomes were previously reported and showed variability of the response to surgical treatment with 5 distinct weight trajectories for both Roux-en-Y gastric bypass (RYGB) and laparoscopic adjustable gastric banding (LAGB).[8] This 7-year follow-up report from the LABS-2 cohort addresses the durability and variability of weight loss and the prevalence, remission, and incidence of several major comorbid conditions (diabetes, dyslipidemia, and hypertension) by surgical procedure with a focus on changes between years 3 to 7. These results will contribute to addressing questions about the longer-term results of weight and health outcomes after bariatric procedures.

Key Points

Question What are the 7-year weight and comorbid health changes following Roux-en-Y gastric bypass and laparoscopic adjustable gastric banding?

Findings In this multicenter longitudinal study, 7-year mean weight loss was 28.4% with weight regain after 3 years of 3.9% for Roux-en-Y gastric bypass and 14.9% with 1.4% weight regain for laparoscopic adjustable gastric banding. The prevalence of dyslipidemia was reduced 7 years following both procedures, and diabetes and hypertension prevalence were reduced following gastric bypass; remission of diabetes at 7 years was 60.2% for Roux-en-Y gastric bypass and 20.3% for laparoscopic adjustable gastric banding.

Meaning Most participants maintained much of their weight loss with variable fluctuations over the longer term, and comorbid health improvements were sustained after Roux-en-Y gastric bypass.

Methods

Design and Participants

The LABS Consortium is a multicenter observational cohort study at 10 US hospitals in 6 geographically diverse clinical centers. Adults undergoing first-time bariatric surgical procedures as part of routine clinical care by participating surgeons were recruited between 2006 and 2009 and followed up through January 31, 2015 (eFigure 1 in the Supplement). Research assessments were conducted within 30 days prior to the surgical procedure and approximately 6 months, 12 months, and annually following the surgical procedure for at least 6 years and up to 7 years through the study end date (January 31, 2015). The institutional review boards at each center approved the protocol, and all participants gave written informed consent to participate in the study.

Assessments and Outcome Measures

Research assessments were primarily conducted in person, with the exception of the 6-month and 6-year assessments, which were brief and completed by telephone or mail. Sociodemographic characteristics and race/ethnicity were self-reported.

Weight change was reported in kilograms and as the percentage of change from baseline. During in-person assessments, weight was measured on a standard scale (Tanita Body Composition Analyzer, model TBF-310). If this per-protocol weight was not obtained, weight measured by research or medical personnel on a nonstudy scale was used, and if neither was available, a participant's self-reported weight was used. Differences between in-person and self-reported weights when both were available in this cohort were small (1 kg or less).[9] Weights of women in their second or third trimester of pregnancy or up to 6 months post partum were excluded from analyses.

Comorbid conditions were not assessed at the brief visits conducted at 6 months and year 6 but were at all other times. Diabetes was defined as currently receiving diabetes medication or having a glycated hemoglobin A_{1c} measure of 6.5% or greater or, if hemoglobin A_{1c} level was not available, fasting plasma glucose value of 126 mg/dL (to convert glucose to millimoles per liter, multiply by 0.0555) or greater as measured by a central laboratory used for all the study sites. Women reporting having polycystic ovarian syndrome who did not meet laboratory criteria for diabetes and who were not receiving a diabetes medication other than metformin were considered to not have diabetes. High low-density lipoprotein cholesterol (LDL) level was defined as patients currently receiving a lipid-lowering medication or having an LDL level of 160 mg/dL or greater. Low high-density lipoprotein cholesterol (HDL) level was defined in patients as less than 40 mg/dL, and high triglycerides as a fasting triglyceride level of 200 mg/dL or greater (to convert LDL or HDL cholesterol to millimoles per liter, multiply by 0.0259; to convert triglycerides to millimoles per liter, multiply by 0.0113). Hypertension was defined as receiving an antihypertensive medication or having systolic blood pressure of 140 mm Hg or greater, or diastolic blood pressure of 90 mm Hg or greater from a single measurement.[10] In addition to prevalence, remission and incidence of comorbidities at follow-up were determined in reference to baseline status. Remission was defined as having had the comorbidity at baseline with absence of the comorbidity at follow-up. Incidence was the absence of the comorbidity at baseline and having the comorbidity at follow-up.

Vital status was determined through annual study follow-up, and a query of the National Death Index was performed through 2015.[11] Subsequent bariatric procedures within 7 years of the initial bariatric surgery were identified by LABS surgeons, medical record review, or participant self-report, using a standardized protocol.

Statistical Analysis

All analyses were stratified by surgical procedure. Participants who underwent a revision or reversal of their bariatric procedure were included in the analyses of their original bariatric procedure, consistent with intention to treat. The complete statistical methods are reported in eAppendix 1 in the Supplement.

Results

Study Participants and Retention

Of 2348 participants, 1738 underwent RYGB (74%), and 610 underwent an LAGB procedure (26%) as their first bariatric operation, all of whom had baseline weight recorded (eFigure 1 in the Supplement). Excluding weights measured during pregnancy, weights missing owing to a death, and weights expected after data collection ended, between 95.3% (2231 of 2340) at 6 months and 82.9% (1300 of 1569) at year 7 had a weight recorded. Data completeness for other variables is provided in eAppendix 2 in the Supplement.

Baseline characteristics of the LABS-2 cohort by surgical procedure are reported in eTable 1 in the Supplement. Among participants who underwent RYGB, the median age was 45 years (range, 19-75 years), and the median body mass index (calculated as weight in kilograms divided by height in meters squared) was 47 (range, 34-81); of 1738 patients, 1389 participants were female (80%), and 257 were nonwhite (15%). Among those who underwent LAGB, the median age was 48 years (range, 18-78 years), and the median body mass index was 44 (range, 33-87); of 610 patients, 465 were female (76%), and 63 were nonwhite (10%).

Mortality and Subsequent Bariatric Surgery

There were 59 deaths following RYGB and 15 following LAGB within 7 years of the surgery, corresponding to death rates of 3.7 (95% CI, 1.2-8.7) per 700 person-years and 2.7 (95% CI, 0.8-7.0) per 700 person-years, respectively (**Table**). Only 3 of these deaths occurred within 30 days after surgery, all after RYGB.

Fourteen participants underwent subsequent bariatric surgical procedures (11 revisions and 3 reversals) within 7 years of RYGB procedures, corresponding to a rate of 0.92 (95% CI, 0.0-5.1) per 700 person-years. Six of the 11 revisions and 2 of the 3 reversals occurred in the first year following the original surgical procedure. Following LAGB, 160 of 610 participants underwent subsequent bariatric surgical procedures (29 port revisions, 17 band replacements, 16 revisions other than a port or band, 63 reversals/band removals, and 73 new procedures), corresponding to a rate of 30.3 (95% CI, 20.5-43.3) per 700 person-years (Table). Port revisions occurred most commonly in the first year following surgery; reversals and conversions were most common during years 2 through 5.

Weight Change

Figure 1 shows both observed and modeled percentage of weight change by time point and initial surgical procedure. The corresponding data are reported in eTable 2 in the Supplement. The modeled mean percentage of weight loss 7 years following RYGB was 28.4% (95% CI, 27.6-29.2), or a loss of 38.2 kg (95% CI, 36.9-39.5). Between years 3 and 7, there was a mean regain of 3.9% (95% CI, 3.4-4.4) of baseline weight that followed a quadratic trend ($P < .01$), such that the rate of weight gain decreased during this time. For LAGB, the modeled mean percentage of weight loss was 14.9% (95% CI, 13.1-16.7) at year 7, corresponding to a loss of 18.8 kg (95% CI, 16.3-21.3). Mean year 3 to 7 regain was 1.4% (95% CI, 0.4-2.4) of baseline weight, but there was not a significant linear or quadratic trend.

Comorbid Conditions

Figure 2 shows the modeled percentages (95% CI) of comorbidity prevalence by time and initial surgical procedure. The prevalence of all 5 comorbid conditions was significantly lower 7 years post-RYGB vs baseline ($P < .001$ for all; 7 years vs baseline for diabetes, 11.6 vs 28.3; for high LDL cholesterol, 14.3 vs 33.3; for high triglycerides, 4.9 vs 23.7; for low HDL cholesterol, 5.8 vs 34.9; and for hypertension, 51.6 vs 67.6), whereas only low HDL cholesterol and high triglyceride level prevalence were significantly lower 7 years post-LAGB ($P < .001$ for both; 7 years vs baseline for low HDL cholesterol, 16.3 vs 33.0; high triglycerides, 9.7 vs 21.3).

The modeled percentages and 95% CI of comorbidity remission and incidence by time are shown in **Figure 3** and eFigure 2 in the Supplement, respectively. Observed and modeled prevalence, remission, and incidence data are also reported in eTable 3 and eTable 4 in the Supplement, respectively. Between years 3 to 7 following RYGB, there was a trend of increasing diabetes prevalence (8.9%; 95% CI, 7.5-10.2 vs 11.6%; 95% CI, 9.9-13.4; $P < .001$), explained by a decrease in remission (69.4%; 95% CI, 65.0-73.8 vs 60.2%; 95 CI, 54.7-65.6; $P < .01$), rather than an increase in incidence. There was also an increase in hypertension prevalence between years

Table. Deaths and Subsequent Bariatric Surgical Procedures Within 7 Years Following Initial Bariatric Surgery

Characteristic	No. of Participants	Rate (95% CI),[a] per 1000 Person-years	Rate (95% CI),[a] per 700 Person-years
Roux-en-Y gastric bypass (n = 1738)			
Deaths	59	5.32 (1.72-12.39)	3.72 (1.20-8.67)
Within 30 d of surgery	3	NA	NA
After 30 d of surgery	56	NA	NA
Subsequent bariatric surgery	14	1.31 (0.03-7.31)	0.92 (0.02-5.12)
Revision	11	NA	NA
Reversal	3	NA	NA
New procedure	0	NA	NA
Laparoscopic adjustable gastric band (n = 610)			
Deaths	15	3.92 (1.07-10.05)	2.74 (0.75-7.04)
Within 30 d of surgery	0	NA	NA
After 30 d of surgery	15	NA	NA
Subsequent bariatric surgery	160[b]	43.27 (31.55-57.98)	30.29 (20.45-43.32)
Port revision	29[c]	NA	NA
Band replacement	17	NA	NA
Revision other than port or band replacement	16	NA	NA
Reversal	63	NA	NA
New procedure	73[d]	NA	NA

Abbreviation: NA, not applicable.

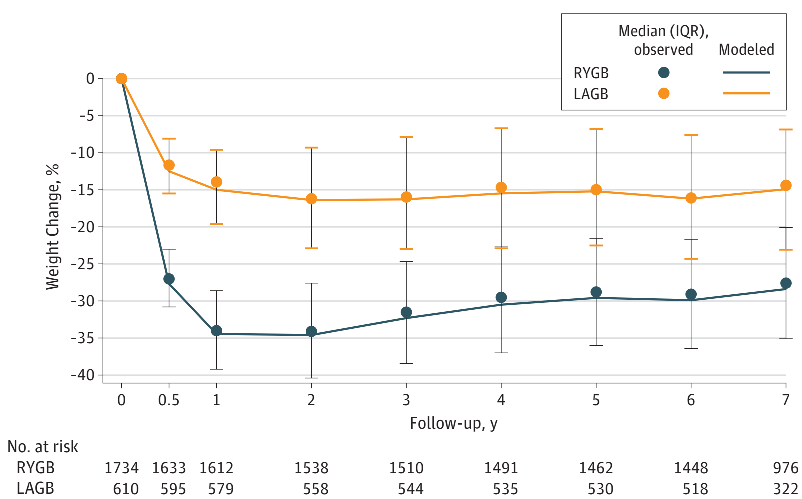
[a] The rates were estimated by dividing the number of participants with the specified event by the person-years of observation. Rates are reported per 1000 person-years, a standard unit, and per 700 person-years, which is equivalent to the percentage of participants expected to have the event when followed up for 7 years. Exact CIs for rates were constructed using the Poisson distribution.

[b] One hundred sixty participants underwent 204 surgeries in which 1 or more procedures were performed. Participants who underwent a reversal and a new procedure on different days are counted as having had 2 surgeries, a reversal and a new procedure. Participants who underwent a reversal and a new procedure on the same day are counted as having had 1 surgery, a new procedure only.

[c] Thirty-two port revisions occurred among 29 participants.

[d] Seventy-five new procedures occurred among 73 participants.

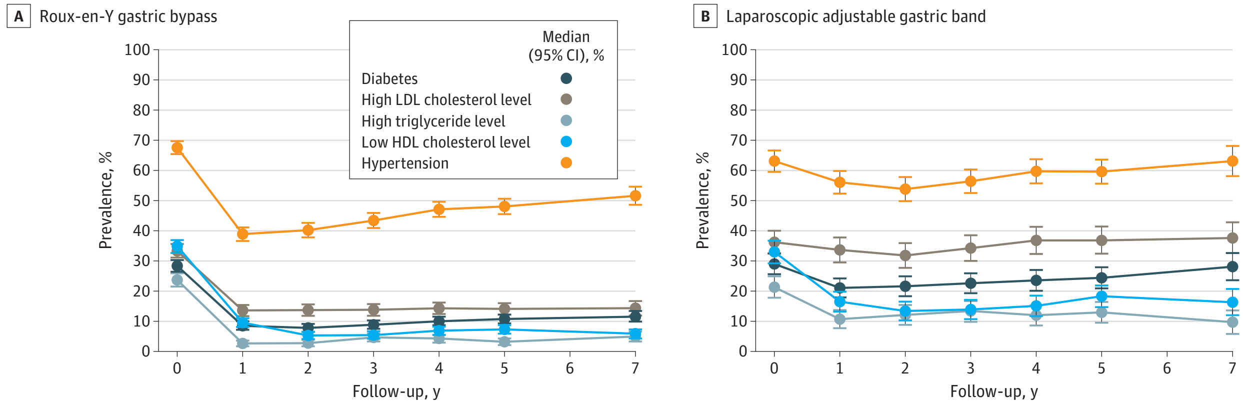
Figure 1. Observed and Modeled Percentage of Weight Change Following Bariatric Surgery



Lines indicate modeled weight change based on mixed models, adjusted for baseline factors independently related to missing follow-up data (ie, site, age, and smoking). Data markers, median values; bars, interquartile range (IQR) is 25th to 75th percentile of observed data. Negative value indicates weight loss from baseline. Data collection ended before the 7-year assessment of 498 Roux-en-Y gastric bypass (RYGB) and 202 laparoscopic adjustable gastric band (LAGB) participants.

3 to 7 (43.4%; 95% CI, 40.9-45.9 vs 51.6%; 95% CI, 48.6-54.6; $P < .01$); a result of both a decrease in remission (41.3%; 95% CI, 38.0-44.6 vs 33.4%; 95% CI, 29.9-37.0; $P < .01$) and an increase in incidence (12.7%; 95% CI, 9.3-16.1 vs 19.2%; 95% CI, 14.5-23.9; $P < .01$). There was not a significant trend in year 3 to 7 in prevalence or remission of high LDL cholesterol levels, although there was a significant increase in incidence (2.4%; 95% CI, 1.1-3.8 vs 4.4%; 95% CI, 2.1-6.7; $P = .04$). There was not a significant trend in prevalence, remission, or incidence of low HDL cholesterol or high triglyceride levels from years 3 to 7, with 1 exception. The prevalence of high triglycerides followed a quadric trend. However, values were similar at year 3 (4.6%; 95% CI, 3.3-6.0; $P = .02$) and year 7 (4.9%; 95% CI, 3.3-6.6; $P = .02$) (eTable 4 in the Supplement).

Figure 2. Prevalence of Comorbid Conditions Following Bariatric Surgery

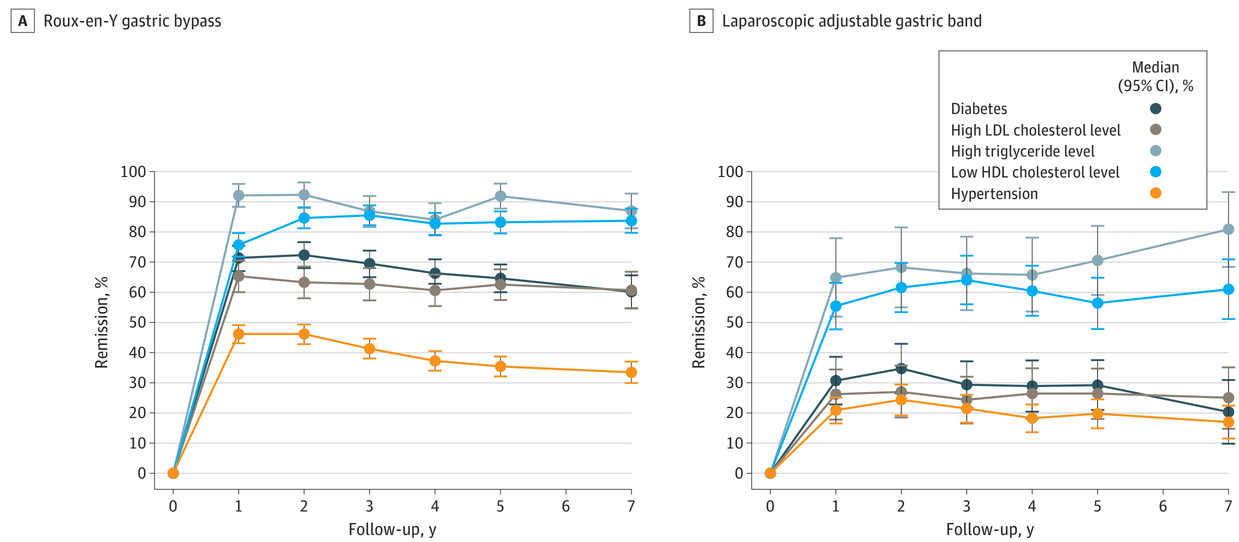


No. at risk

	A 0	A 1	A 2	A 3	A 4	A 5	A 7	B 0	B 1	B 2	B 3	B 4	B 5	B 7
Diabetes	1646	1122	942	933	964	999	681	569	410	348	363	344	359	205
High LDL cholesterol level	1406	866	710	724	732	775	509	582	316	280	285	277	290	169
High triglyceride level	1426	922	768	785	779	793	537	489	339	312	312	297	304	180
Low HDL cholesterol level	1671	1190	1016	1001	985	1034	692	582	445	390	389	363	370	212
Hypertension	1682	1415	1169	1109	1122	1162	783	585	502	435	437	411	424	238

Lines indicate modeled prevalence, bars, and 95% CI based on mixed models, adjusted for baseline factors independently related to missing follow-up data (ie, site, age, and smoking). Comorbidities were not assessed at 6 months or year 6. Data collection ended before the 7-year assessment of 498 Roux-en-Y gastric bypass and 202 laparoscopic adjustable gastric band participants. HDL indicates high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol.

Figure 3. Remission of Comorbid Conditions Following Bariatric Surgery

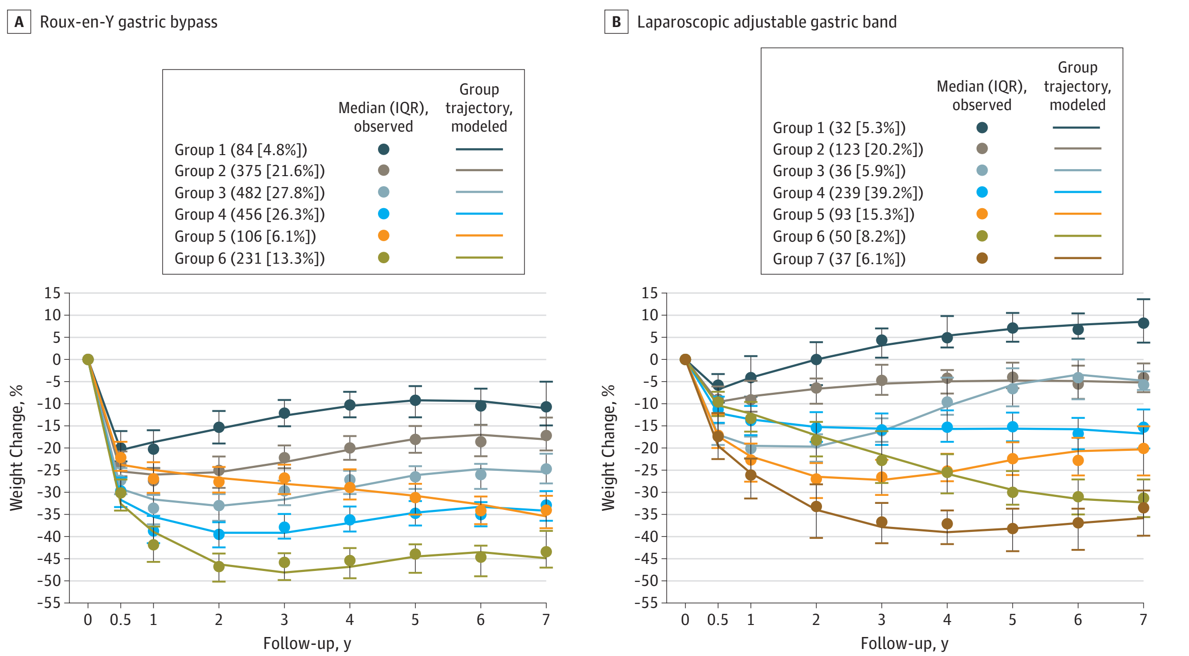


No. at risk

	A 1	A 2	A 3	A 4	A 5	A 7	B 1	B 2	B 3	B 4	B 5	B 7
Diabetes	379	327	320	342	345	219	120	100	98	95	94	50
High LDL cholesterol level	292	246	253	253	260	167	110	103	97	91	94	53
High triglyceride level	201	166	162	161	164	120	57	52	58	57	52	32
Low HDL cholesterol level	437	353	342	341	354	241	148	119	113	113	110	66
Hypertension	960	786	741	751	782	520	302	258	256	245	252	140

Lines indicate modeled remission, bars, and 95% CI based on mixed models, adjusted for baseline factors independently related to missing follow-up data (ie, site, age, and smoking). Remission was defined as the percentage of participants who did not have the comorbidity at the indicated follow-up among participants who had the comorbidity at baseline. Comorbidities were not assessed at 6 months or year 6. Data collection ended before the 7-year assessment of 30% of Longitudinal Assessment of Bariatric Surgery study participants. HDL indicates high-density lipoprotein cholesterol; LDL, low-density lipoprotein cholesterol.

Figure 4. Percentage of Weight Change Trajectory Groups Following Bariatric Surgery



Lines indicate modeled group trajectories; data markers and median values; bars, interquartile range (IQR) of observed data. Negative value indicates weight loss from baseline.

Between years 3 to 7 following LAGB, prevalence of diabetes increased (22.6%; 95% CI, 19.3-25.9 for year 3 vs 28.1%; 95% CI, 23.6-32.5 for year 7; *P* = .01). There appeared to be a similar trend in hypertension prevalence (56.4%; 95% CI, 52.5-60.3 for year 3 vs 63.1%; 95% CI, 58.1-68.1 for year 7; *P* = .05), whereas prevalence of high LDL cholesterol, low HDL cholesterol, and high triglycerides levels showed no such trend (eTable 4 in the Supplement). There were no statistically significant 3- to 7-year trends in remission or incidence of comorbidities following LAGB, with 1 exception. The proportion of participants with remission of high triglyceride levels increased over time from 66.2% (95% CI, 54.1-78.4) to 80.8% (95% CI, 68.4-93.2) (*P* = .04).

Weight Trajectory Groups

To further delineate the substantial variability in weight change across follow-up, 7-year trajectories of percentage of weight change were examined. Six distinct groups for RYGB and 7 groups for LAGB were identified (**Figure 4**). For both procedures, between years 3 and 7, there were trajectory groups with continued weight loss (ie, RYGB group 5 and LAGB group 6), similar percentage of weight change (ie, RYGB group 1 and LAGB groups 2, 4, and 7), and weight regain (ie, RYGB groups 2, 3, 4, and 6 and LAGB groups 1, 3, and 5). However, each groups' initial weight loss (ie, percentage of weight change from baseline to year 3) and the magnitude of weight change that followed differed (eTable 5 in the Supplement). For example, among RYGB trajectory groups with weight regain, mean 3-year weight loss ranged from 22% to 44% of baseline weight, followed by mean year 3 to 7 regain ranging from 3% to 6% of baseline weight.

The proportion of participants who had subsequent bariatric procedures within each weight trajectory group is shown in eTable 5 in the Supplement. Although there were few subsequent bariatric procedures following RYGB, 7 of 14 participants who had a revision or a reversal were in trajectory group 3, with the greatest weight gain during years 3 to 7. For LAGB, 34% (11 of 32) of participants in group 1, with the worst 7-year weight change, underwent a reversal/removal of their band. Seventeen percent (6 of 36) of group 3, with the most weight regain during years 3 to 7, also underwent a reversal/removal. Finally, 28% (14 of 50) of group 6, with the best 3- to 7-year weight loss, underwent an additional/new bariatric procedure after their initial LAGB procedure.

Among participants who underwent RYGB, the following factors at baseline were associated with more favorable weight trajectory groups: female sex, younger age, white race, smoking, higher body mass index, not having diabetes, not having low HDL cholesterol level, and not having hypertension (eTable 6A in the Supplement). Female sex, not having low HDL cholesterol levels, and not having hypertension at baseline were also associated with more favorable LAGB weight trajectory groups, as was Hispanic ethnicity (eTable 6B in the Supplement). Observed remission (percentage) and adjusted relative risk for remission of comorbidities by RYGB weight trajectory group membership and follow-up assessment are reported in eTable 7 in the Supplement. Chance of remission of diabetes, high triglycerides, low HDL cholesterol levels and hypertension, but not high LDL cholesterol, was significantly higher in more favorable vs less favorable RYGB weight trajectory groups; the magnitude of these associations changed over time as trajectory groups diverged. For example, compared with group 1, which had the worst 7-year percentage of weight change but no significant change from years 3 to 7, the adjusted relative risk of remission of hypertension was 1.07 (95% CI, 0.59-1.96) for group 5 at year 3 and 2.27 (95% CI, 1.13-4.53) at year 7 after continued weight loss.

Discussion

In this report, we address several knowledge gaps about long-term weight change and health outcomes after bariatric surgery using data from a multisite study with prospective standardized assessment and follow-up. There are distinct and variable patterns of weight change in response to different surgical treatments, yet most people maintain much of their initial weight loss, with small and variable fluctuations, up to 7 years after the surgical procedure. There are high rates of comorbid disease remission after RYGB, most of which is evident by the first 2 years after surgery, followed by some decline in remission from years 3 to 7, especially for diabetes and hypertension. Following LAGB, only low HDL cholesterol and high triglyceride level prevalence estimates are lower 7 years after the surgical procedure. Incident cases of diabetes are relatively uncommon following both procedures, especially after RYGB, and incident hypertension occurs commonly following both procedures. Finally, undergoing a subsequent bariatric procedure is uncommon following RYGB (<1% within 7 years). However, nearly one-third of patients have some type of surgical revision or reversal within 7 years of LAGB.

These results, in a large and geographically diverse population of US adults with complete follow-up weight data for more than 80% of participants, show the durability of surgical weight loss in the majority; 75% of RYGB participants maintained at least 20% weight loss, and 50% of LAGB participants maintained at least 16% weight loss through 7 years. For LAGB, this overall weight loss included participants who underwent a device removal and those who underwent a revision to a new bariatric procedure. The long-term weight loss following RYGB in this study was similar to the Swedish Obese Subjects study results at 10-year follow up, which reported 73% of the small number of people undergoing RYGB maintained 20% or greater weight loss.[5] The results from LABS are also similar to a 2016 study[12] of mostly male US veterans, showing a mean 4-year weight loss of 27% after RYGB, with more than 70% maintaining 20% or greater weight loss at 10 years. Finally, the 7-year weight change reported here for the RYGB group is identical to the 6-year weight losses reported in the Utah Obesity Study, a single-site cohort study of RYGB.[13]

In the current study, there is durability of the initial improvements in most of the comorbid conditions studied, especially after RYGB. Despite some decline in initial improvements in diabetes, high triglycerides, and hypertension following RYGB, all 5 comorbid conditions were less common throughout 7 years of follow-up compared with before RYGB, whereas only the prevalence of high triglycerides and low HDL cholesterol levels were lower 7 years after LAGB. The remission of most comorbid conditions (all but high LDL cholesterol levels) following RYGB were significantly related to more successful weight change trajectories, suggesting a link between long-term weight change and comorbidity status. In this article, the proportion achieving remission for diabetes at 6 and 7 years following RYGB in LABS was again nearly identical to that in the Utah Obesity Study,[13] while the proportion achieving remission of the components of dyslipidemia were each slightly higher, highlighting the remarkably consistent metabolic effects of RYGB between studies. There was little incident disease, especially diabetes, after RYGB, similar to previous studies.[7,13] These results from a large multicenter, cohort provide important confirmatory data from a carefully studied cohort. In addition, this study sheds some light on patterns and characteristics of weight loss variability and shows the impact of this variability on comorbidity resolution following RYGB.

This study identified distinct trajectories of initial (1- to 3-year) weight change followed by varied patterns of weight fluctuation over the longer-term (3- to 7-year) follow-up. These initial and later patterns of weight change were variable for RYGB and even more so for LAGB and were also associated with comorbidity resolution for RYGB. Overall, it appears from the initial weight change patterns that the longer-term outcomes in weight may be determined by the magnitude and direction/slope of the initial loss. A similar pattern was observed by Lent and colleagues[14] who showed 4 distinct patterns of 5-year weight change, with most maintaining at least 25% weight loss at 5 years and 1 group with early suboptimal weight loss after RYGB surgery. The initial early weight trajectories for nonsurgical treatments have also been shown to predict longer-term weight outcomes.[15] Together with the results reported here, these findings point to the need for enhanced and early (years 1-2) postoperative efforts to optimize short-term weight loss trajectory directions that may potentially influence the ability to stay on an optimal weight loss path over the longer term. Although this study identified several baseline characteristics (eg, female sex, younger age, and not having diabetes) associated with following more favorable weight trajectories, our results emphasize the importance of further work to identify and characterize specific subtypes of obesity that may be more or less responsive to surgical or other nonsurgical treatments. These future efforts should look at combinations of clinically relevant variables identified here, include variables other than those studied here, and include metabolomic/genomic data as well. This may lead to better prediction of outcomes from bariatric surgery and optimizing more individually tailored treatment strategies.[16]

Strengths and Limitations

A limitation of this study is that it was nonrandomized, so comparisons cannot be directly made between surgical procedures as there may be inherent differences between these treatment groups. The sleeve gastrectomy was an uncommon procedure at the time of recruitment for this study, so it was not evaluated. In addition, there was no nonsurgical control group so changes cannot necessarily be attributed to the surgery. This study has many important strengths, including the fact that it is a large, multicenter study, which enhances the generalizability of the results, and the large number of RYGB cases, still a common current procedure. The data collection was standardized, prospective, and comprehensive. There is excellent completeness of follow-up (especially for weight where there is more than 80% completeness through 7 years) and sufficient statistical power for the main outcomes of weight change and prevalence of comorbid conditions.

Conclusion

We found that following bariatric surgery, weight loss patterns over time were distinct and variable, but most participants maintained much of their weight loss, particularly those who underwent RYGB. Although there is some decline in diabetes remission over time, most with diabetes who undergo RYGB are in remission 7 years following surgery, and diabetes incidence is low. This study confirms that weight loss and most health improvements in diabetes and lipids following RYGB are durable over the long term. Finally, the variability in both short- and longer-term weight loss patterns may be an important area for further study with implications for both predicting and optimizing individual patients' results.

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