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Demographic, Clinical, and Behavioral Determinants of 7-Year Weight Change Trajectories in Roux-en-Y Gastric Bypass Patients.

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Original article

Demographic, clinical, and behavioral determinants of 7-year weight change trajectories in Roux-en-Y gastric bypass patients☆

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Abstract

Background:
Objectives: This study evaluated the weight trajectories of Roux-en-Y gastric bypass (RYGB) patients and identified the distinct clinical, behavioral, and demographic features of patients by trajectory.
Setting: Data from 2918 RYGB patients from a comprehensive medical center between January 2004 and November 2016 were included.
Methods: This retrospective, observational study used data for RYGB patients up to 7 years postsurgery. Group-based trajectory models were fitted for percentage weight change. Variables evaluated by trajectory included age, sex, diagnoses, medications, smoking, presurgical body mass index, preoperative weight loss, and early postoperative weight loss.
Results: Of 3215 possible patients, 2918 (90.8%) were included (mean age = 46.2 ± 11.2 yr, body mass index = 46.9 ± 7.9 kg/m^2 at the time of surgery). Three weight change trajectories were identified (above average, average, and below average). Mean percentage weight change at the nadir for the above average group was −42.85% ± 5.7% compared with −31.57% ± 5.0% in the average group and −22.74% ± 5.7% in the below average group. Compared with the above average group, the below average group was more likely to be male (odds ratio [OR] = 2.40, $P < .0001$) and have diabetes (noninsulin users, OR = 2.08, $P < .0001$), but less likely to have a smoking history (OR = .62, $P = .0007$) or take sleep medications (OR = .50, $P = .005$). Below average group patients had a lower BMI at the time of surgery (OR = .96, $P < .0001$). Lower initial weight loss postsurgery was associated with a greater chance of a poorer weight outcomes (OR = 1.64, $P < .0001$).
Conclusion: Select clinical, demographic, and behavioral factors may increase or decrease the chance for better weight loss after RYGB. (Surg Obes Relat Dis 2018;xxx:xxx–xxx.) © 2018 American Society for Bariatric Surgery. Published by Elsevier Inc. All rights reserved.

Keywords: Roux-en-Y Gastric bypass; Weight loss trajectories; Predictors

For many patients with obesity, weight loss surgery conveys durable benefits that span improvements in physical and mental health, longevity, and quality of life [1–

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6]. However, weight change trajectories after surgery are heterogeneous [1]. In 2013, Courcoulas et al. [1] modeled weight change trajectories of surgery patients through 3 years postoperatively and found that approximately 23% of Roux-en-Y gastric bypass (RYGB) patients did not achieve or sustain >25% total weight loss.

In the era of precision medicine [7], better understanding the demographic and clinical features of weight loss surgery patients who experience poorer outcomes would help to guide clinical care. To date, body mass index (BMI) at the time of surgery and age are consistently associated with weight change postoperatively [8–12]. Certain personality disorders or traits, eating pathology and psychiatric disorders, diabetes status, and preoperative weight loss may also relate to postoperative weight loss, though findings are less consistent regarding these relationships [8,9,13–17]. Wood and colleagues [16] found preoperative insulin use, history of smoking, and a high number of prescribed medications to relate to better long-term weight loss, while hyperlipidemia was associated with poorer outcomes. Finally, early postoperative weight loss (initial 3–6 mo) is associated with greater weight loss 2 years after RYGB [18].

This study's objective was to evaluate the determinants of weight change trajectories in a cohort of RYGB patients followed for 7 years postsurgery. Specifically, this study aimed to (1) replicate weight loss trajectory modeling conducted previously [1] but for a longer timeframe and (2) compare the demographic, behavioral, and clinical factors associated with the weight-change trajectories, including preoperative and early postoperative weight loss, diagnoses, and medication use.

Methods

Participants

De-identified electronic health record (EHR) data were obtained for patients who completed weight loss surgery from January 2004 to November 2016 at a large, rural, comprehensive medical center. Inclusion criteria were as follows: (1) completion of primary RYGB, and (2) weight data available in the EHR preoperatively and postoperatively (up to year 7). Patients who were <1 year postsurgery were excluded. The preoperative program for weight loss surgery involves a 6- to 12-month multidisciplinary curriculum with the goal of 10% weight loss [19]. Postoperatively, patients are scheduled for follow-up visits 1 and 2 weeks after surgery; 2, 5, 8, and 12 months; and yearly thereafter.

Outcome measures

The primary study outcome was the percentage of initial weight change [1], measured longitudinally through 7 years. Weights were collected from the EHR from all encounters across the health system.

Demographic variables included patients' age, sex, and race. Clinical variables collected at the time of surgery were diagnoses (i.e., mood disorders, osteoarthritis, diabetes, nondependent drug use, hypertension, sleep disorders, back or soft tissue disorders, fibrosis, and dyslipidemia as documented by International Classification of Disease code), use of certain medications and total medications prescribed, and surgical BMI.

Behavioral factors included history of smoking, presurgical weight loss (time of initial consult to day of surgery), and early postoperative weight change (percentage weight change from day of surgery through postsurgery month 6).

Statistical analyses

Descriptive statistics characterized the cohort at the time of surgery (mean and standard deviation for continuous variables and frequency for categorical variables).

To account for heterogeneity of postsurgery weight change patterns, group-based trajectory models (GBTM) [20] with time as a polynomial trend (6 mo postsurgery through up to 7 yr postsurgery) were fitted for the percentage weight change from baseline. Given a minimum of 1% sample inclusion per trajectory [1], Bayesian criterion determined the best model fit. Percentage weight change up to 7 years postsurgery was plotted from postoperative month 6 for each trajectory. To identify factors associated with group membership, preoperative factors and weight change within 6 months postsurgery were linked to the trajectories by simultaneously fitting a multinomial logistic regression within the GBTM.

Given the large number of baseline covariates, a selection procedure was implemented. From the initial GBTM, each patient was assigned the trajectory corresponding to the highest membership probability. A multinomial logistic regression model was fit using stepwise selection, erring on the side of including more variables in the model. Finally, the reduced set of baseline covariates was entered into the GBTM to fit the final model. Model results are reported using odds ratios (ORs) and 95% confidence intervals (CIs).

The trajectory assignment was repeated for the final model to permit characterizing the trajectory patterns. Analysis of variance was conducted to test the differences in continuous variables, and Pearson χ^2 tests were performed to test the independence of categorical variables in the 3 subgroups. Analyses were performed using SAS 9.4. Results were considered significant at $P < .05$. The health system's institutional review board approved this study.

Table 1
Number of Roux-en-Y gastric bypass patients with weight data at each postsurgery year (N = 2918).

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Postsurgery year	Frequency	Total eligible	Percent (N)	Weight change %*
1	2399	2918	82.2	−31.1 (8.1)
2	1738	2835	61.3	−31.2 (10.5)
3	1714	2519	68.0	−28.7 (10.8)
4	1455	2140	68.0	−26.9 (11.2)
5	1244	1778	70.0	−25.5 (11.6)
6	1049	1435	73.1	−24.6 (11.8)
7	586	1019	57.5	−24.5 (12.0)

* Weight change % from time of surgery.

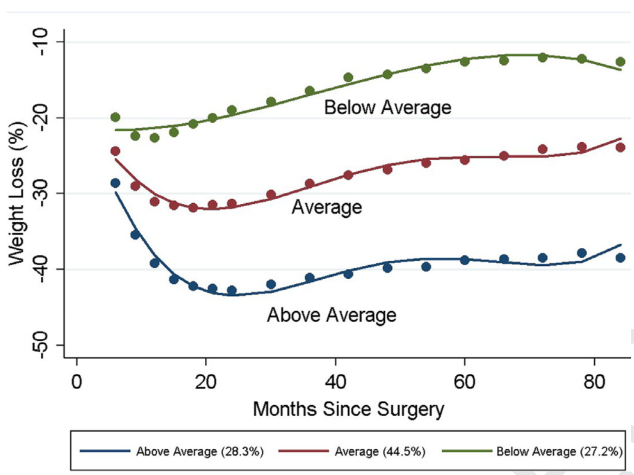

Fig. 1. Weight change trajectories in Roux-en-Y gastric bypass patients (N = 2918) up to 7 years postoperatively.

Results

Of 3215 possible eligible RYGB patients, 2918 patients (90.8%) had a weight in the EHR at postsurgery years 1 through 7. Data available for analyses at each postoperative year are in Table 1. At the time of surgery, patients were a mean age of 46.2 ± 11.2 years with a mean BMI of 46.9 ± 7.9 kg/m^2.

Weight change trajectories

Q7 Through evaluation of the BIC criterion and visual fit, 3 weight-change trajectories were best modeled with 2 quartic and 1 cubic polynomials (Fig. 1). Group 1 (n = 818, 28%) achieved a weight loss nadir of −42.85% ± 5.68% at 24 months postsurgery and −38.50% ± 7.37% weight loss at postsurgery year 7 (“above average” group). Group 2 (n = 1307, 45%, “average” group) achieved a weight loss nadir of −31.57% ± 5.00% at 15 months postsurgery and −24.06% ± 7.48% weight change at postsurgery year 7. Group 3 (n = 793, 27%, “below average” group) achieved a weight loss nadir of −22.74% ± 5.66% at 12 months postsurgery and −12.67% ± 8.41% weight loss at postsurgery year 7.

Mean percentage weight change for the above average group was −28.43% ± 5.69%; −24.38% ± 4.37% in the average group, and −20.13% ± 4.33% in the below average group.

Demographic characteristics

Characteristics by trajectory group are in Table 2. Compared with the above average group (Table 3), patients in the below average group were more likely to be male (OR = 2.40, CI = 1.63–3.51, $P < .001$).

Clinical characteristics

Compared with the above average group, the below average group (Table 3) had lower BMI at the time of surgery (OR = .91, CI = .90–.93, $P < .0001$). Below average group patients were less likely to take sleep medications (OR = .51, CI = .32–.81, $P = .005$) but more likely to have diabetes (noninsulin users, OR = 2.08, 1.46–2.96, $P < .0001$).

No significant differences between trajectory groups were identified regarding number of medications or diagnoses of fibrosis, osteoarthritis, iron deficiency, sleep disorders, back or soft tissue disorders, or psychiatric disorders at the time of surgery ($P > .05$, Table 3).

Behavioral factors

Below average group patients were less likely to smoke (OR = .62, CI = .47–.81, $P = .0007$). Mean preoperative and early postoperative weight changes by group are in Table 2. No significant relationship was found between preoperative weight change and postoperative weight trajectories ($P > .05$). Smaller weight loss in the first 6 months postsurgery was associated with greater chance of a poorer long-term weight outcome (OR = 1.64, CI = 1.57–1.70, $P < .0001$).

Discussion

This study identified 3 distinct weight loss trajectories up to 7 years after RYGB. Our modeling resulted in fewer trajectories compared with a previous study that identified 5 trajectories [1], which is likely due to differing study durations, the data used, and statistical approaches. While almost half of our RYGB patients sustained a successful amount of weight at postoperative year 7 (25–30%), the remaining half equally either sustained an above average amount (≥40%) or a below average amount (≤20%) after reaching their weight loss nadir.

Comparison of the demographic and clinical characteristics of the 2 most divergent weight loss outcomes (above average versus below average) led to the identification of several distinguishing characteristics. First, males were >2

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Table 2
Demographic, clinical, and behavioral factors of Roux-en-Y gastric bypass patients by weight change trajectory group (N = 2918)*.

	Below average (n = 793)	Average (n = 1307)	Above average (n = 818)	*P* value†
Male sex, n (%)	176 (22.2)	260 (19.9)	133 (16.3)	<.01
Smoking history, n (%)	391 (49.3)	646 (49.4)	470 (57.5)	<.001
Age at surgery, yr, mean (SD)	48.7 (11.0)	45.5(11.0)	43.2 (10.9)	< 0.0001
BMI at surgery, kg/m^2, mean (SD)	46.4 (7.9)	46.4 (7.8)	48.1 (7.9)	<.0001
Presurgical BMI change, kg/m^2, mean (SD)	−5.6 (5.1)	−4.8 (5.3)	−3.8 (5.7)	<.0001
Early postoperative weight change (0–6 mo %), mean (SD)	−20.1 (4.3)	−24.4 (4.4)	−28.4 (5.1)	<.0001
Nondependent drug/alcohol use N (%)	31 (3.9)	76 (5.8)	69 (8.4)	<.001
Diabetes	373 (47.0%)	480 (36.7%)	223 (27.3%)	<.001
Hypertension	443 (55.9%)	654 (50.0%)	344 (42.0%)	<.001
Dyslipidemia	362 (45.7%)	538 (41.2%)	285 (34.8%)	<.001
Fibrosis, n (%)	223 (28.1)	339 (25.9)	214 (26.3)	.52
Iron deficiency, n (%)	107 (13.5)	170 (13.0)	96 (11.7)	.54
Osteoarthrosis and allied disorders	170 (21.4%)	305 (23.3%)	204 (24.9%)	0.25
Disorders of the back	63 (7.9%)	136 (10.4%)	84 (10.3%)	.15
Soft tissue disorders	42 (5.3%)	71 (5.4%)	53 (6.5%)	.51
Depression	238 (30.0%)	351 (26.9%)	244 (29.8%)	.19
Sleep disorders	140 (17.7%)	224 (17.1%)	138 (16.9%)	.91
Any diabetes medication use	222 (28.0%)	244 (18.7%)	122 (14.9%)	<.001
Insulin use	145 (18.3%)	213 (16.3%)	92 (28.0%)	<.001
Bupropion	69 (8.7%)	108 (8.3%)	100 (12.2%)	<.01
Total medications (>12)	377 (47.5%)	588 (45.0%)	346 (42.3%)	.11

SD = standard deviation; BMI = body mass index.
* At time of surgery unless otherwise noted.
† Analysis of variance for continuous variables; χ^2 test for categoric variables.

Table 3
Demographic, clinical, and behavioral factors associated with weight trajectory membership (N = 2918).

	Below average versus above average OR (95% CI)	*P* value	Average versus above average OR (95% CI)	*P* value
Age, yr	1.00 (.99–1.02)	.81	1.01 (.99–1.02)	.26
Sex, male	2.40 (1.64–3.51)	<.0001	.71 (.57–.89)	.0003
Smoking history, yes	.62 (.47–.82)	.0007	.71 (.57–.89)	.003
BMI, kg/m^2 (time of surgery)	.91 (.90–.93)	<.0001	.94 (.93–.95)	<.0001
Early postoperative weight change (0–6 mo, %)*	1.64 (1.57–1.70)	<.0001	1.25 (1.21–1.28)	<.0001
Depressive disorder	.98 (.72–1.33)	.89	.80 (.63–1.03)	.08
Sleep medication	.50 (0.31–.80)	.005	.86 (.61–1.23)	.43
Diabetes, no insulin	2.08 (1.46–2.96)	<.0001	1.44 (1.08–1.94)	.02
Diabetes, insulin	1.23 (.81–1.88)	.33	1.28 (.90–1.81)	.17

OR = odds ratio; CI = confidence interval; BMI = body mass index.
Adjusted results from group-based trajectory modeling.
* Inverse relationship given that lower weight loss is associated with risk of below average group.

times as likely to have below average outcomes. Though we had fewer males than females in our cohort, similar findings were reported in male gastric banding patients over aged ≥50 years [12]. Unlike previous studies, we did not find older age to be a risk factor for poorer weight loss [8,10,16], which may relate to the long study timeframe. Future studies could evaluate sex and age in patients who undergo sleeve gastrectomy, a procedure that is rising in popularity.

Second, patients with a higher BMI at the time of surgery were more likely to experience better BMI change over the study period, which mirrors the findings of several previous studies [21,22]. Higher BMI may be associated with greater co-morbidity, which may provide greater motivation to adhere to the postoperative diet and lifestyle in the long term. However, other studies reported higher BMI to predict poorer weight loss, but these studies primarily used percentage excess weight loss to evaluate weight change, which is influenced by initial BMI [8,16,21].

Third, the use of certain medications was associated with weight change. Patients with diabetes who did not use insulin were >2 times as likely to experience below average weight loss. Notably, insulin use appeared to attenuate this risk. This finding adds to the mixed findings on diabetes and long-term weight change after RYGB [8,16]. Patients using sleep medications were 50% less likely to experience poor trajectories. Patients using sleep medications may be less likely to rise during the night, providing fewer opportunities for calorie consumption. Additionally, these patients could be more rested, providing greater motivation to engage in healthy eating and lifestyle behaviors.

Several behavioral factors were evaluated in regard to weight outcomes, including preoperative and early postoperative weight loss and smoking history. We did not find a relationship between preoperative weight change and postoperative weight outcomes. A previous prospective, randomized trial found patients in a preoperative program with the goal of 10% weight loss achieved greater percentage excess weight loss at 3 months postsurgery compared with controls with no preoperative weight loss expectation [23]. Physician-supervised preoperative weight loss is strongly recommended, if not required, as a prerequisite to surgery in many programs [24]; however, our findings do not support the clinical relevance of this recommendation as it relates to a patient's ability and readiness to implement behavior change. Additional prospective, randomized studies are needed to investigate the direction of the potential relationship between preoperative weight loss and long-term outcomes.

In our study, greater weight loss within the initial 6 postoperative months decreased the likelihood of poorer weight outcomes. Manning et al. [18] also found initial weight loss velocity after RYGB to predict better weight loss. Collectively, our findings suggest that clinically, this initial period of rapid weight loss may be a target for future interventions. While diet during the first 3 postoperative months is largely dictated by the staged dietary progression [25], patients can exert more choice regarding level of adherence to the recommended long-term diet during postoperative months 3 to 6. Future studies could evaluate the impact of additional behavioral support during this critical weight loss time on dietary adherence and long-term weight outcomes. Finally, patients with a history of smoking were less likely to have below average long-term weight loss (38%). A history of smoking may be protective in that patients may be able to apply the experience and skills gained to achieve smoking cessation to behavior change for long-term weight reduction.

Our study had several strengths, including the long timeframe for some patients, the inclusion of all available weight data from the EHR, and the wide range of demographic, behavioral, and clinical factors explored in relation to weight trajectories. Our study was limited, however, by the retrospective design, homogeneity of our cohort, fewer patients for inclusion at the later postoperative years, and the inclusion of only 1 procedure type (RYGB).

Conclusion

In summary, certain RYGB patients may be at risk for less robust long-weight loss. These patients, however, still lose clinically meaningful amounts of weight and may experience the other well-documented benefits of surgery, such as improvements in co-morbid conditions and quality of life [3–5,26]. Study findings can help to inform patient–provider discussions surrounding postoperative expectations after RYGB and better guide clinical care. Q8

Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

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