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ORIGINAL CONTRIBUTIONS

Predictors of Excess Weight Loss in Obese Patients After Gastric Bypass: a 60-Month Follow-up

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Abstract
Background The objective of this study was to analyze the factors associated with change in body mass index (BMI) and with percentage of excess weight loss (%EWL) in patients undergoing Roux-en-Y gastric bypass (RYGB). The following factors were analyzed: sex, age, surgical access (laparotomy vs. laparoscopy), preoperative BMI, waist circumference (WC), type 2 diabetes mellitus (T2DM), high blood pressure, and dyslipidemia.
Methods Retrospective cohort study using a convenience sample of 2070 patients of both sexes, aged 18 to 65 years, undergoing RYGB between 2000 and 2013. The outcomes of interest were BMI and %EWL at 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, and 60 months after RYGB.
Results After 36, 48, and 60 months, approximately 50 % of patients had BMI >30 kg/m^2. As for %EWL, 60-month results were poor for 17 % of patients (%EWL <50 %), good for 40 % of patients (%EWL 50–75 %), very good for 24 % of patients (%EWL from >75–90 %), and excellent for 19 % of patients (%EWL >90 %). The four most significant predictors of BMI change 60 months after RYGB (in descending order of magnitude) were preoperative BMI, preoperative WC, surgical access, and age; and of %EWL, surgical access, preoperative BMI, preoperative WC, and age.
Conclusions After 60 months of follow-up, the most relevant predictors of weight loss after RYGB were lower preoperative BMI and WC, videolaparoscopy as surgical access, and younger age. Further studies must be carried out to elucidate the impact of these factors on RYGB outcomes.

Keywords Gastric bypass · Predicting factor · Weight loss · Obesity

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Introduction

Several studies have tried to identify predictors of weight loss following Roux-en-Y gastric bypass (RYGB). Factors such as preoperative body mass index (BMI), type 2 diabetes mellitus (T2DM), dyslipidemia, hypertension, and waist circumference (WC), among others [1–12], all have been linked to RYGB results. There is evidence supporting an inverse correlation between preoperative BMI and postoperative weight loss [8, 9, 13, 14]. Other studies suggest that younger patients tend to regain less weight after gastric bypass than older patients [15], that increasing age is associated with lower percentage of excess weight loss (%EWL) after gastric bypass [8, 16], and that %EWL is lower after gastric bypass in patients older than 60 years of age [17, 18]. Conversely, other studies suggest that age above 50 [19] and 60 years [20] does not influence outcome after bariatric surgery.

One limitation of most studies carried out so far to evaluate post-RYGB weight loss is the length of follow-up—usually 1 or 2 years, and thus limited to the period during which weight loss is more pronounced. Nevertheless, because the goal of RYGB is sustained weight loss, longer follow-ups should be considered. The few studies reporting long-term assessments (at least 36 months) have shown that at least some of the benefits of RYGB are lost or mitigated over time [21–25].

Therefore, the objective of the present study was to analyze the behavior of BMI and %EWL over 60 months in patients undergoing RYGB, considering the effect of sex, age, surgical access (laparotomy vs. laparoscopy), preoperative BMI, WC, T2DM, hypertension, and dyslipidemia.

Materials and Methods

We conducted a retrospective cohort study using a convenience sample [26] of patients aged 18 to 65 years submitted to non-banded RYGB between 2000 and 2013 at the Center of Obesity and Metabolic Syndrome (COM) at a university hospital in Brazil (Hospital São Lucas, Pontifícia Universidade Católica do Rio Grande do Sul, PUCRS). The COM provides public and private healthcare services. In all cases, RYGB was performed with a 5-cm-long gastric pouch next to the lesser gastric curve, 150-cm alimentary limb, and 100-cm biliary limb.

Exclusion criteria for the present retrospective study were pregnancy, severe psychopathy, and major depression recorded at any time point between 0 and 60 months after RYGB. Patients undergoing revisional surgery (that is, revision of a prior bariatric procedure) during the study period were also excluded.

The following preoperative data were obtained from the patient charts: age, sex, proposed surgical access (laparotomy or laparoscopy), diagnosis of type 2 diabetes (T2DM), dyslipidemia, and hypertension, WC (cm), height (m), and weight (kg). Preoperative BMI was calculated based on height and weight measured at the patient's preoperative evaluation.

Diabetes was defined as fasting blood glucose >126 or >200 mg/dL 2 h after a 75-g oral glucose tolerance test [27]. Hypertension was defined as systolic blood pressure >140 mmHg and diastolic blood pressure >90 mmHg [28]. Dyslipidemia was diagnosed in the presence of total cholesterol >200 mg/dL, high-density lipoprotein (HDL) cholesterol <40 mg/dL for men and <50 mg/dL for women, low-density lipoprotein (LDL) cholesterol >129 mg/dL, and triglycerides >150 mg/dL [29].

The outcomes of interest were BMI and %EWL at 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, and 60 months after RYGB. %EWL was estimated as described by Deitel et al. [30] and Bray et al. [31] using the formula (preoperative weight [kg]−current weight [kg])/(preoperative weight [kg]−ideal weight to produce BMI 25 kg/m^2)×100. At 60 months, %EWL was categorized as poor (<50 %), good (50 to 75 %), very good (>75 to 90 %), and excellent (>90 %).

Univariate Analysis, Mixed Linear Models, and Statistical Analysis

To estimate the association of variables (age, sex, surgical access, T2DM, dyslipidemia, hypertension, preoperative BMI, and WC) with postoperative BMI and %EWL, two univariate models were analyzed. For that, the minimum BMI and the maximum %EWL measured between 6 and 60 months were considered for each patient. The first 6 months were excluded from this analysis because pronounced weight loss is expected in this period, which could be a source of bias. For univariate analysis, patients were divided into four BMI and %EWL quartiles, with group 1 representing the best results (lowest BMI or highest %EWL).

Variables showing significance in the univariate models were submitted to multivariate analysis. Nevertheless, because data were missing for some time points, 60-month BMI and %EWL were estimated using a linear mixed model (LMM), which allows analysis of observed data without the need to impute the missing data [32]. That allowed us to calculate the difference (Δ) in 60-month BMI and %EWL for each variable of interest.

Quantitative data were expressed as means and standard deviations, followed by the minimum and maximum values. Categorical variables were expressed as percentages. The association between variables and lowest BMI or %EWL between 6 and 60 months was assessed using linear regression analysis and chi-square test for linear trend. Significance level was set at alpha (α)=0.05. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20.

Results

At least one BMI and one %EWL measurement were available between 0 and 60 months postoperatively for 2070 patients. These patients were included in the study. Table 1 shows the baseline characteristics of the sample.

Figures 1 and 2 show the number of BMI and %EWL observations available at each time point (0, 6, 12, 18, 24, 30, 36, 42, 48, 54, and 60 months). The attrition rate at these time points was as follows: 0 % at month 0, 37 % at month 6, 44 % at month 12, 58 % at month 18, 62 % at month 24, 75 % at month 30, 81 % at month 36, 85 % at month 48, 92 % at month 54, and 78 % at month 60.

Median follow-up was 24 months (interquartile range 9–42 months), with minimum of 0 and maximum of 60 months. After 36, 48, and 60 months, approximately 50 % of patients

Table 1 Baseline characteristics of patients undergoing Roux-en-Y gastric bypass

Variable	n=2070
Age (years)	
Mean±SD	37.7±10.5
Minimum; maximum	18; 65
Male sex (%)	24.8
Videolaparoscopy (%)	37.5
BMI (kg/m^2)	
Mean±SD	47.1±7.8
Minimum; maximum	35.0; 91.5
BMI class (%)	
35 to 40 kg/m^2	16.2
>40 to 50 kg/m^2	54.6
>50 kg/m^2	29.1
Waist circumference (cm)	
Mean±SD	130.6±15.7
Minimum; maximum	94; 196
Type 2 diabetes mellitus (%)	21.6
Hypertension (%)	58.0
Dyslipidemia (%)	48.1

BMI body mass index, *SD* standard deviation

had BMI >30 kg/m^2. As for %EWL, 60-month results were poor for 17 % of patients (%EWL <50 %), good for 40 % of patients (%EWL 50–75 %), very good for 24 % of patients (%EWL >75–90 %), and excellent for 19 % of patients (%EWL >90 %).

The original sample provided a margin of error lower than 2 percentage points to estimate surgical success rate with a 95 % confidence interval. Considering the missing observations, a 5 % error margin was reached.

Univariate Analysis

Table 2 shows the distribution of 1758 patients according to minimum BMI 6 to 60 months after RYGP. Because of the broad range of minimum BMIs in the sample, four quartiles were used to categorize patients. Younger age and female sex were more frequent in group 1, with the most pronounced BMI reduction. Conversely, preoperative BMI, WC, T2DM, and high blood pressure were higher or more frequent in the least successful group (group 4). The same associations were observed for %EWL (Table 3).

Linear Mixed Models

Sex, age, T2DM, hypertension, surgical access, and preoperative BM and WC were included in this analysis. However, because a high colinearity was detected between preoperative BMI and WC, two LMMs were developed to test the role of the variables under study as predictors of BMI and %EWL at 60 months. Model 1 included preoperative BMI, sex, age, T2DM, high blood pressure, and surgical access. In model 2, preoperative BMI was replaced with preoperative WC. Age, preoperative BMI, and preoperative WC were analyzed as categories (61. vs. 22 years, 55 vs. 40 kg/m^2, and 160 vs. 115 cm, respectively).

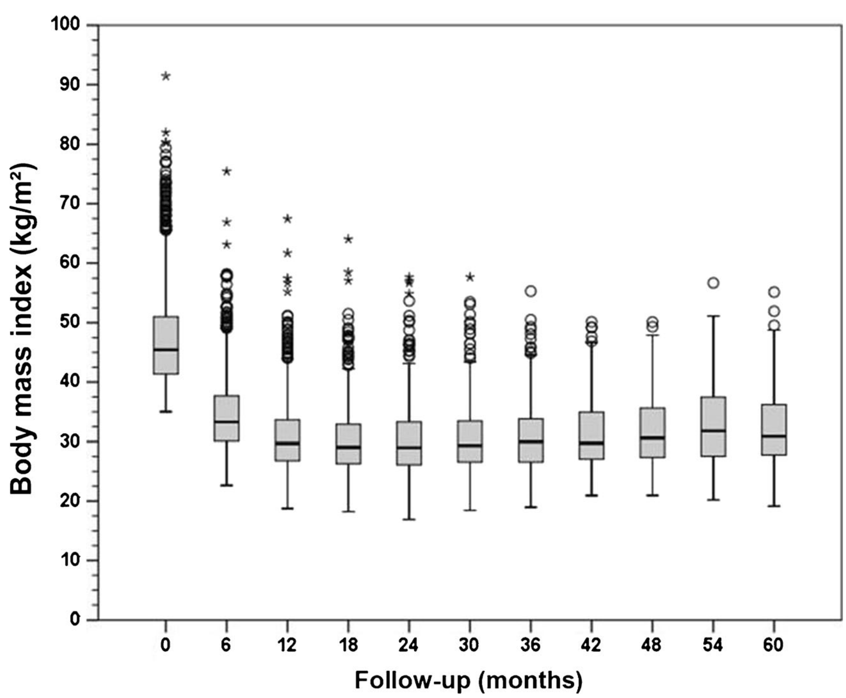

Fig. 1 BMI of patients submitted to Roux-en-Y gastric bypass at baseline (month 0, n=2070) and at 6 (n=1300), 12 (n=1159), 18 (n=870), 24 (n=782), 30 (n=512), 36 (n=471), 42 (n=392), 48 (n=312), 54 (n=173), and 60 (n=458)months

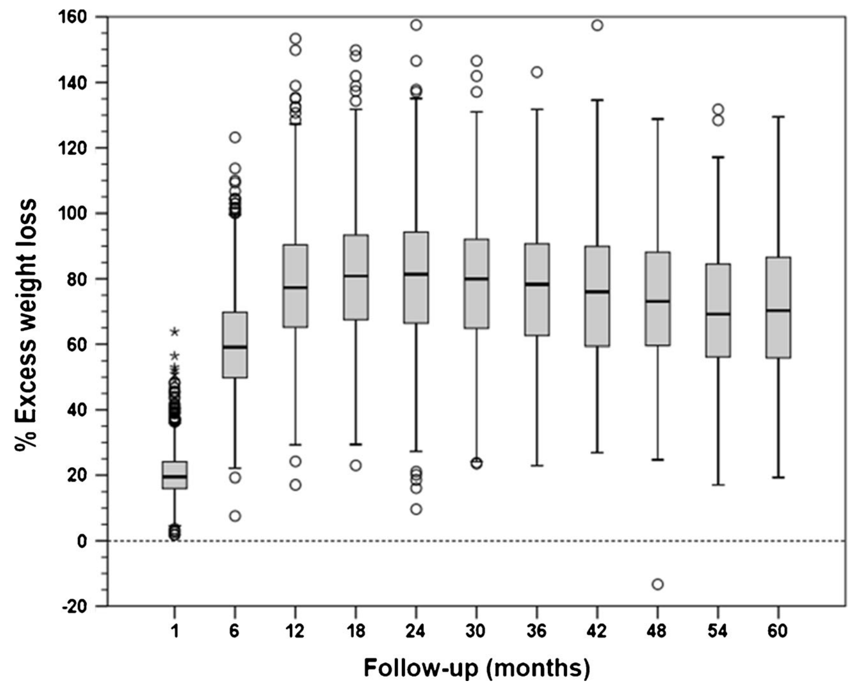

Fig. 2 %EWL of patients submitted to Roux-en-Y gastric bypass at baseline (month zero, *n*=2070) and at 6 (*n*=1300), 12 (*n*=1159), 18 (*n*=870), 24 (*n*=782), 30 (*n*=512), 36 (*n*=471), 42 (*n*=392), 48 (*n*=312), 54 (*n*=173), and 60 (*n*=458)months

Tables 4 and 5 show the results of the LMMs. In model 1 (Table 4), including preoperative BMI as predictor, there was no statistical difference in 60-month BMI (Δ) between sex and hypertension categories. Regarding %EWL, 60-month BMI was statistically different for all the variables except sex. The largest impact on 60-month BMI was observed for preoperative BMI, followed by age, and T2DM, in descending order. In terms of %EWL, the largest impact was observed for preoperative BMI, surgical access, and age.

Table 2 Univariate analysis comparing the characteristics of patients undergoing Roux-en-Y gastric bypass according to the lowest BMI measured between the 6th and the 60th month after surgery (*n*=1758)

Variables	Minimum BMI quartile 1 Range 16.9–25.9 *n*=440	2 Range 26.0–28.7 *n*=439	3 Range 28.8–326 *n*=440	4 Range 32.7–64.0 *n*=439	*p**
Age (years)					
Mean±SD	35.9±10.4	37.8±10.6	38.7±10.9	39.3±10.4	<0.001
Min; Max	18; 62	18; 64	18; 65	18; 65	
Male (%)	15.9	22.1	30.5	28.5	<0.001
Videolaparoscopy (%)	42.6	39.9	34.6	23.0	<0.001
Preoperative BMI (kg/m^2)					
Mean±SD	42.0±4.4	44.3±5.4	47.2±5.9	55.2±8.2	<0.001
Min; Max	35.0; 63.2	35.4; 65.1	35.1; 82.0	35.8; 91.5	
Preoperative WC (cm)					
Mean±SD	122±12	127±14	132±14	143±15	<0.001
Min; Max	96; 184	94; 183	97; 196	103; 190	
T2DM (%)	12.3	23.4	22.2	31.7	<0.001
High blood pressure (%)	48.1	54.5	61.5	73.0	<0.001
Dyslipidemia (%)	42.7	52.3	49.5	42.6	0.005

BMI body mass index, *Min*; *Max*: lowest and highest BMI in quartile, *SD* standard deviation, *T2DM* type 2 diabetes mellitus

*Statistical significance detected by linear trend test

Table 3 Univariate analysis comparing the characteristics of patients undergoing Roux-en-Y gastric bypass according to maximum %EWL measured between the 6th and the 60th month after surgery (n=1758)

Variable	Maximum %EWL quartile 1 Range 95.4–157.5 n=441	2 Range 82.1–95.3 n=436	3 Range 67.5–82.0 n=441	4 Range 17.1–67.5 n=440	p*
Age (years)					
Mean±SD	36.5±10.6	36.9±10.2	38.8±10.9	40.0±10.5	<0.001
Min; Max	18; 62	18; 64	18; 65	18; 65	
Male (%)	15.6	24.1	25.9	31.4	<0.001
Videolaparoscopy (%)	42.2	34.4	32.9	30.5	0.002
Preoperative BMI (kg/m^2)					
Mean±SD	42.4±4.9	46.2±6.5	48.4±7.5	51.7±9.0	<0.001
Min; Max	35.0; 65.1	35.4; 82.0	35.5; 80.3	35.1; 91.5	
Preoperative WC (cm)					
Mean±SD	123±13	129±15	133±15	138±16	<0.001
Min; Max	96; 184	94; 187	97; 196	97; 190	
T2DM (%)	12.0	20.9	23.6	32.0	<0.001
High blood pressure (%)	47.8	54.1	64.4	68.4	<0.001
Dyslipidemia (%)	41.0	49.5	48.1	46.1	0.063

BMI body mass index, *EWL* excess weight loss, *Min*; *Max* lowest and highest BMI in quartile, *SD* standard deviation, *T2DM* type 2 diabetes mellitus, *WC* waist circumference

*Statistical significance detected by linear trend test

Table 5 shows model 2 (including preoperative WC as predictor). No statistical significance was observed for the comparison of 60-month BMI between hypertension categories. The factors with the greatest effect on BMI were preoperative WC, surgical access, and T2DM. As for %EWL, the variables with the greatest effect were surgical access, WC, and age.

Considering both models, the factors with the greatest effect on 60-month BMI were preoperative BMI and WC followed by surgical access, age, T2DM, hypertension, and sex. The factors with the greatest effect on %EWL were surgical access followed by preoperative BMI and WC, age, T2DM, hypertension, and sex.

Discussion

The purpose of bariatric surgery is to promote significant and sustained weight loss. Nevertheless, between 5 and 20 % of patients undergoing bariatric surgery do not achieve the

Table 4 Linear mixed model (including preoperative BMI) estimating the impact of selected factors to predict BMI and %EWL 60 months after Roux-en-Y gastric bypass (n=2070)

Factor	BMI Δ at 60 m	BMI p	% excess weight loss Δ at 60 m	% excess weight loss p
Male	0.27	0.181	−3.72	0.073
Age 61 years[a]	2.62	0.004	−12.81	0.001
Preoperative BMI 55 kg/m^{2}[b]	4.43	<0.001	−17.43	<0.001
T2DM	2.27	<0.001	−10.61	<0.001
High blood pressure	0.72	0.012	−5.04	<0.002
Videolaparoscopy[c]	−2.55	<0.001	14.27	<0.001

Δ (delta) refers to the difference between groups

%EWL percentage of excess weight loss, *BMI* body mass index, *T2DM* type 2 diabetes mellitus

[a] vs. 22 years

[b] vs. 40 kg/m^2

[c] vs. laparotomy

Table 5 Linear mixed model (including preoperative WC) estimating the impact of selected factors to predict BMI and %EWL 60 months after Roux-en-Y gastric bypass (n=2070)

Factor	BMI		% excess weight loss	
	Δ at 60 m	p	Δ at 60 m	p
Male	−0.29	0.001	−1.13	0.003
High blood pressure	1.03	0.020	−5.42	<0.001
Age 61 years[a]	2.15	0.001	−11.56	0.005
Preoperative WC 160 cm[b]	4.19	<0.001	−14.04	0.002
T2DM	2.25	<0.001	−10.21	<0.001
Videolaparoscopy[c]	−3.21	<0.001	17.82	<0.001

Δ (delta) refers to the difference between groups

%EWL percentage of excess weight loss, *BMI* body mass index, *T2DM* type 2 diabetes mellitus, *WC* waist circumference

[a] vs. 22 years

[b] vs. 115 cm

[c] vs. laparotomy

desired weight loss (%EWL <50 %) or are unable to maintain it even if they are submitted to a well-standardized procedure, with regular follow-up, follow a balanced diet, and stay physically active [4, 8, 14, 21, 33, 34]. Some preoperative factors have been associated with an unsatisfactory outcome, including sex [2, 8, 35, 36] and some comorbidities [2, 5, 8–10]. Nevertheless, there is no consensus in the literature regarding which factors can actually predict success after bariatric surgery, despite a similarity in the characteristics of the samples in terms of age, sex, preoperative BMI, T2DM, high blood pressure, and dyslipidemia [1, 2, 5, 6, 37].

Our findings regarding BMI variation are similar to those of Scozzari et al., who reported that the improvement in BMI observed in the first year after surgery declined after 60 months [6]. It should be noted that most studies only report BMI results for the first year after the surgery [5, 37], with only a few reporting a longer follow-up [21–25]. It is expected, however, that longer follow-ups are required to determine true predictors of surgical success, since many patients regain weight with its associated health issues after the first year.

In the present sample, the observed %EWL was also in agreement with the literature [6, 23, 24, 38]. Our patients experienced pronounced %EWL until 6 months after the surgery, with the greatest weight loss occurring between 6 and 24 months. That was followed by stabilization and weight regain after 24 months. In both univariate analyses and LMMs, higher preoperative BMI translated into more difficulty to achieving optimal weight (BMI=25 kg/m^2) after RYGB, even in the presence of significant weight loss. Nevertheless, it is more difficult for heavier patients to achieve the same %EWL over the same period of time when compared to individuals with lower baseline weight. This association between higher baseline BMI and lower %EWL has been reported in the literature [3, 8, 9, 13, 39].

Preoperative WC was one of the most significant predictors of 60-month BMI. A previous 1-year follow-up study [5] has also found a significant association between preoperative WC and %EWL. This variable deserves further investigation in additional long-term studies.

Age was significantly correlated with BMI and %EWL in univariate analysis and LMMs throughout the 60 months of our study. Other authors have reported an association between young age and greater weight loss [8, 15, 40]. Analyzing a sample of 489 patients, Scozzari et al. [6] reported that individuals in the highest age quartile lost less weight after RYGB than younger patients. BMI decrease was less pronounced in patients aged ≥52 years vs. those younger than 52 years old 1 to 2 years after surgery. Contreras et al. observed greater BMI reduction and higher %EWL in patients younger than 45 years vs. those over 45 years. Again, it should be noted that follow-up was only 1 year long and their sample included only two age groups [1].

Male sex was associated limited success after RYGB, as also reported in by Junior et al. [4] in a 4-year follow-up. However, determining an effect of sex might be complicated by the fact that the majority of studies include samples that are made up mostly of women [41–43].

Videolaparoscopy was correlated in the present study with a more satisfactory outcome as compared with laparotomy. However, in Brazil, the public healthcare system (SUS) covers laparotomy but not videolaparoscopy, which is only covered by private health insurance plans [44]. Thus, the fact that all laparotomies were performed in public healthcare patients and all videolaparoscopies in private insurance patients might be reflecting specific characteristics of these subsamples, which were not, however, analyzed in our study.

T2DM was related to worse prognosis, which is in agreement with the literature [4, 5, 12]. In a 4-year follow-up study, Junior et al. [4] found that patients with T2DM had lower weight loss at 18 months after RYGB. According to these authors, the medication to control hyperglycemia that is often taken by T2DM patients increases circulating insulin levels or sensitivity to this hormone, promoting lipogenesis, differentiation of adipocytes, and muscle synthesis, and hindering weight loss [45–47].

Hypertension had a significant impact on RYGB outcomes in both groups, a trend that has been found in other studies [2, 4, 5]. Dyslipidemia was the least significant predictor of 60-month BMI. Conversely, Junior et al. [4] report dyslipidemia, together with T2DM, as a major factor preventing weight loss between the first and the third year after bariatric surgery.

Some limitations of this study must be mentioned. First of all, we employed “real world data” collected from patient charts, which may have influenced the quality of the data. Also, 60-month follow-up data were not available for all patients. Nevertheless, the fact that the COM follows a careful protocol with frequent follow-up visits and also the large number of patients in our sample served to minimize these issues. In addition, with the use of rigorous statistical analysis, we were able to estimate 60-month BMI and %EWL and to identify predictors of RYGB outcomes. The present findings will thus be useful for both clinical practice and future prospective studies. In clinical practice, a specific follow-up routine may be proposed based on the present results for certain patient groups, especially those who are less prone to weight loss.

Conclusion

After 60 months of follow-up, the most relevant predictors of weight loss after RYGB were lower preoperative BMI and WC, videolaparoscopy as surgical access, and younger age. Further studies may help to better elucidate the role of these predicting factors.

Compliance with Ethical Standards

Financial Disclosure The authors have no financial relationships relevant to this article to disclose.

Conflict of Interest The authors declare that they have no competing interests.

Ethical Approval This study was approved by the Research Ethics Committee at Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS) (no. 465.360) and is in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent is not required from retrospective studies using secondary data.

References

1. Contreras JE, Santander C, Bravo J. Correlation between age and weight loss after bariatric surgery. Obes Surg. 2013;1–4.
2. Campos GM, Rabl C, Mulligan K, Posselt A, Rogers SJ, Westphalen AC, et al. Factors associated with weight loss after gastric bypass. Arch Surg. 2008;143(9):877–83. discussion 84.
3. Hatoum IJ, Stein HK, Merrifield BF, Kaplan LM. Capacity for physical activity predicts weight loss after Roux-en-Y gastric bypass. Obesity. 2009;17(1):92–9.
4. Junior WS, do Amaral JL, Nonino-Borges CB. Factors related to weight loss up to 4 years after bariatric surgery. Obes Surg. 2011;21(11):1724–30.
5. Coupaye M, Sabate JM, Castel B, Jouet P, Clerici C, Msika S, et al. Predictive factors of weight loss 1 year after laparoscopic gastric bypass in obese patients. Obes Surg. 2010;20(12):1671–7.
6. Scozzari G, Passera R, Benvenga R, Toppino M, Morino M. Age as a long-term prognostic factor in bariatric surgery. Ann Surg. 2012;256(5):724–8. discussion 8–9.
7. Langer FB, Prager G, Poglitsch M, Kefurt R, Shakeri-Leidenmuhler S, Ludvik B, et al. Weight loss and weight regain-5-year follow-up for circular- vs. linear-stapled gastrojejunostomy in laparoscopic Roux-en-Y gastric bypass. Obes Surg. 2013;23(6): 776–81.
8. Ma Y, Pagoto SL, Olendzki BC, Hafner AR, Perugini RA, Mason R, et al. Predictors of weight status following laparoscopic gastric bypass. Obes Surg. 2006;16(9):1227–311.
9. Melton GB, Steele KE, Schweitzer MA, Lidor AO, Magnuson TH. Suboptimal weight loss after gastric bypass surgery: correlation of demographics, comorbidities, and insurance status with outcomes. J Gastrointest Surg. 2008;12(2):250–5.
10. Carbonell AM, Wolfe LG, Meador JG, Sugerman HJ, Kellum JM, Maher JW. Does diabetes affect weight loss after gastric bypass? Surg Obes Relat Dis. 2008;4(3):441–4.
11. Jamal MK, DeMaria EJ, Johnson JM, Carmody BJ, Wolfe LG, Kellum JM, et al. Impact of major co-morbidities on mortality and complications after gastric bypass. Surg Obes Relat Dis. 2005;1(6):511–6.
12. Still CD, Wood GC, Chu X, Manney C, Strodel W, Petrick A, et al. Clinical factors associated with weight loss outcomes after Roux-en-Y gastric bypass surgery. Obesity (Silver Spring). 2014;22(3): 888–94.
13. Lutfi R, Torquati A, Sekhar N, Richards W. Predictors of success after laparoscopic gastric bypass: a multivariate analysis of socioeconomic factors. Surg Endosc. 2006;20(6):864–7.
14. Livhits M, Mercado C, Yermilov I, Parikh JA, Dutson E, Mehran A, et al. Preoperative predictors of weight loss following bariatric surgery: systematic review. Obes Surg. 2012;22(1):70–89.
15. Barhouch AS, Zardo M, Padoin AV, Colossi FG, Casagrande DS, Chatkin R, et al. Excess weight loss variation in late postoperative period of gastric bypass. Obes Surg. 2010;20(11): 1479–83.
16. Dunkle-Blatter SE, St Jean MR, Whitehead C, Strodel III W, Bennotti PN, Still C, et al. Outcomes among elderly bariatric patients at a high-volume center. Surg Obes Relat Dis. 2007;3(2):163–9.
17. Sugerman HJ, DeMaria EJ, Kellum JM, Sugerman EL, Meador JG, Wolfe LG. Effects of bariatric surgery in older patients. Ann Surg. 2004;240(2):243.
18. St Peter SD, Craft RO, Tiede JL, Swain JM. Impact of advanced age on weight loss and health benefits after laparoscopic gastric bypass. Arch Surg. 2005;140(2):165.
19. Singhal R, Kitchen M, Bridgwater S, Super P. Age≥50 does not influence outcome in laparoscopic gastric banding. Obes Surg. 2009;19(4):418–21.
20. Wool D, Bellatorre N, Wren S, Eisenberg D. Male patients above age 60 have as good outcomes as male patients 50–59 years old at 1-year follow-up after bariatric surgery. Obes Surg. 2009;19(1):18–21.
21. Christou NV, Look D, MacLean LD. Weight gain after short-and long-limb gastric bypass in patients followed for longer than 10 years. Ann Surg. 2006;244(5):734–40.
22. Sjöström L, Lindroos AK, Peltonen M, Torgerson J, Bouchard C, Carlsson B, et al. Lifestyle, diabetes, and cardiovascular risk factors 10 years after bariatric surgery. N Engl J Med. 2004;351(26):2683–93.
23. Lopez PP, Patel NA, Koche LS. Outpatient complications encountered following Roux-en-Y gastric bypass. Med Clin North Am. 2007;91(3):471–83. xii.
24. Magro DO, Geloneze B, Delfini R, Pareja BC, Callejas F, Pareja JC. Long-term weight regain after gastric bypass: a 5-year prospective study. Obes Surg. 2008;18(6):648–51.
25. Shah M, Simha V, Garg A. Long-term impact of bariatric surgery on body weight, comorbidities, and nutritional status. J Clin Endocrinol Metab. 2006;91(11):4223–31.
26. Hulley SB, Cummings SR, Browner WS, Grady D, Hearst N, Newman TB. Designing clinical research. 2nd ed. Philadelphia: Lippincott Williams & Wilkins; 2001.

27. World Health Organization [Internet]. Diabetes programme. 2014 [cited 2015 Jan 23]. Available from: http://www.who.int/diabetes/en/.
28. American Heart Association [Internet]. Understanding blood pressure readings. 2014 [cited 2015 Jan 23]. Available from: http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/High-Blood-Pressure-or-Hypertension_UCM_002020_SubHomePage.jsp.
29. American Heart Association [Internet]. What do my cholesterol levels mean? 2012 [cited 2015 Jan 23]. Available from: http://www.heart.org/idc/groups/heart-public/@wcm/@hcm/documents/downloadable/ucm_300301.pdf.
30. Deitel M, Gawdat K, Melissas J. Reporting weight loss 2007. Obes Surg. 2007;17(5):565–8.
31. Bray GA, Bouchard C, Church TS, Cefalu WT, Greenway FL, Gupta AK, et al. Is it time to change the way we report and discuss weight loss? Obesity. 2009;17(4):619–21.
32. Biering K, Hjollund NH, Frydenberg M. Using multiple imputation to deal with missing data and attrition in longitudinal studies with repeated measures of patient-reported outcomes. Clin Epidemiol. 2015;7:91–106.
33. Salem L, Jensen CC, Flum DR. Are bariatric surgical outcomes worth their cost? A systematic review. J Am Coll Surg. 2005;200(2):270–8.
34. Wittgrove AC, Clark GW. Laparoscopic gastric bypass, Roux en-Y-500 patients: technique and results, with 3–60 month follow-up. Obes Surg. 2000;10(3):233–9.
35. Stefanidis D, Kuwada TS, Gersin KS. The importance of the length of the limbs for gastric bypass patients—an evidence-based review. Obes Surg. 2011;21(1):119–24.
36. Dallal RM, Quebbemann BB, Hunt LH, Braitman LE. Analysis of weight loss after bariatric surgery using mixed-effects linear modeling. Obes Surg. 2009;19(6):732–7.
37. Mônaco DV, Marhi VAL, Aranha N, Brandalise NA. Impacto da cirurgia bariátrica "tipo capella modificado" sobre a perda ponderal em pacientes com obesidade mórbida. Rev Ciênc Méd. 2012;15(4):289–98.
38. Dalcanale L, Oliveira CP, Faintuch J, Nogueira MA, Rondo P, Lima VM, et al. Long-term nutritional outcome after gastric bypass. Obes Surg. 2010;20(2):181–7.
39. Puzziferri N, Nakonezny PA, Livingston EH, Carmody TJ, Provost DA, Rush AJ. Variations of weight loss following gastric bypass and gastric band. Ann Surg. 2008;248(2):233–42.
40. Bobbioni-Harsch E, Huber O, Morel P, Chassot G, Lehmann T, Volery M, et al. Factors influencing energy intake and body weight loss after gastric bypass. Eur J Clin Nutr. 2002;56(6):551–6.
41. Alger-Mayer S, Rosati C, Polimeni J, Malone M. Preoperative binge eating status and gastric bypass surgery: a long-term outcome study. Obes Surg. 2009;19(2):139–45.
42. Alami RS, Morton JM, Schuster R, Lie J, Sanchez BR, Peters A, et al. Is there a benefit to preoperative weight loss in gastric bypass patients? A prospective randomized trial. Surg Obes Relat Dis. 2007;3(2):141–5.
43. Gould JC, Garren MJ, Boll V, Starling JR. Laparoscopic gastric bypass: risks vs. benefits up to two years following surgery in super-super obese patients. Surgery. 2006;140(4):524–31.
44. Sussenbach S, Padoin A, Silva E, Benzano D, Pufal M, Barhouch A, et al. Economic benefits of bariatric surgery. Obes Surg. 2012;22(2):266–70.
45. Flier J, Maratos-Flier E. Primer: energy homeostasis and body weight. Curr Biol. 2000;10(6):R215–7.
46. Kahn BB, Flier JS. Obesity and insulin resistance. J Clin Invest. 2000;106(4):473–81.
47. Turner R, Holman R, Cull C, Stratton I, Matthews D, Frighi V, et al. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet. 1998;352(9131):837–53.