Supplementary Online Content

King WC, Hinerman AS, Belle SH, Wahed AS, Courcoulas AP. Comparison of the performance of common measures of weight regain after bariatric surgery for association with clinical outcomes. *JAMA*. doi:10.1001/jama.2018.14433

eAppendix 1. Formulas for weight loss and weight regain measures

eAppendix 2. Sensitivity analysis with multiple imputation

eAppendix 3. Weight regain, as percentage of maximum weight lost, and associated clinician outcomes by time since post- Roux-en-Y gastric bypass weight nadir

eFigure 1. Flow of participants from recruitment through follow-up

eFigure 2. Cumulative proportion of participants who reached weight nadir by time since Roux-en-Y gastric bypass (N=1406)

eTable 1. Comparisons of pre-surgery characteristics between those excluded versus included from the analysis sample

eTable 2. Comparisons of weight loss between those excluded versus included from the analysis sample

eTable 3. Weight loss at weight nadir and last study assessment among adults who underwent Roux-en-Y gastric bypass (N=1406)

eTable 4. Sensitivity analysis: weight regain by time since weight nadir among adults who underwent Roux-en-Y gastric bypass with imputed data

eTable 5. Modeled weight regain by time since weight nadir among adults who underwent Roux-en-Y gastric bypass (N=1286)

eTable 6. Percentage of participants who underwent Roux-en-Y gastric bypass with declines in health outcomes by time since weight nadir (N=1286)

eTable 7. Associations between common weight regain measures and concurrent progression of hyperlipidemia and hypertension among adults who underwent Roux-en-Y gastric bypass (N=1286)

eTable 8. Primary analysis versus sensitivity analysis with imputed data: associations between common weight regain measures and concurrent delcines in health outcomes among adults who underwent Roux-en-Y gastric bypass

eTable 9. A comparison of model fits (as measured by Bayesian Information Criterion values) between models with continuous vs. dichotomous weight regain measures (N=1286)

This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix 1. Formulas for weight loss and weight regain measures

Weight loss from surgery was calculated in kilograms (kg), i.e., (pre-surgery weight – post-surgery weight); as reduction in BMI (kg/m^2), i.e., (pre-surgery BMI – post-surgery BMI); and as percentage of pre-surgery weight, i.e., [100*(pre-surgery weight – post-surgery weight)]/pre-surgery weight[1].

Weight regain definitions. Weight regain was calculated using five common equations: as increase in kg, i.e., (post-nadir weight – nadir weight)[2-5]; as increase in BMI (kg/m^2), i.e., (post-nadir BMI – nadir BMI)[6,7]; as percentage of pre-surgery weight, i.e., [100*(post-nadir weight – nadir weight)]/pre-surgery weight[8-14]; as percentage of weight nadir, i.e., [100*(post-nadir weight – nadir weight)]/nadir weight[15-20]; and as percentage of maximum weight lost, i.e., [100*(post-nadir weight – nadir weight)]/(pre-surgery weight – nadir weight)[21-23].

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eAppendix 2. Sensitivity analysis with multiple imputation

Variables measured at the pre-surgery assessment: sex (complete data, no imputation needed), race, smoking status, and diabetes status were imputed sequentially using the prior variables in this list as covariates in a logistic regression model via a full conditional specification of the distribution. Continuous longitudinal variables used to calculate weight and clinical outcomes (weight, glycated hemoglobin (HbA1c), low density lipoprotein (LDL), systolic blood pressure (SBP), diastolic blood pressure (DBP), SF-36 Mental Component Summary (MCS) score, and SF-36 Physical Component Summary (PCS) score) were imputed using a linear regression, while the longitudinal binary variables used to calculate clinical outcomes (diabetes, lipid, and hypertension medication) were imputed using a logistic regression, both in the order of assessment with prior variables sequentially appearing in these models. The order of these variables in the MI models were as follows: weight variable pre-surgery, 6 months, and so on, followed by DBP, HbA1c, LDL, diabetes medication, lipid medication, hypertension medication, SBP, SF-36 MCS score, and SF-36 PCS score, all in the order of assessment.
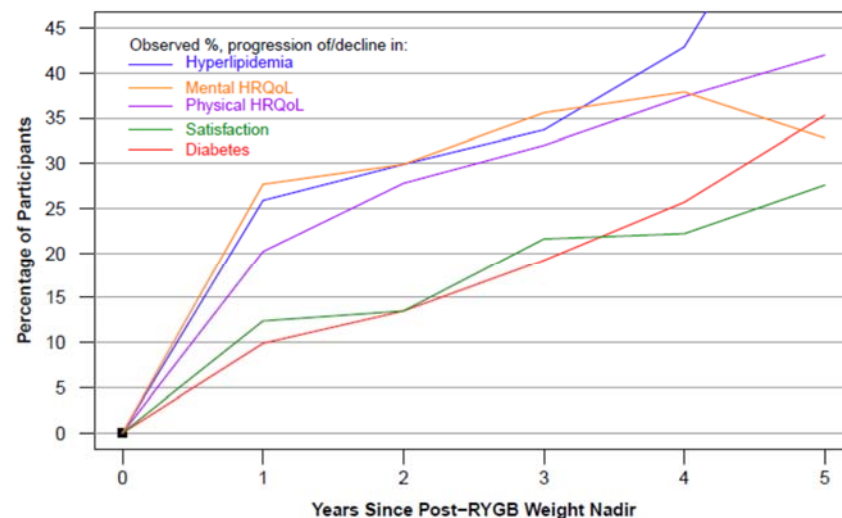
eAppendix 3. Weight regain, as percentage of maximum weight lost, and associated clinical outcomes by time since post-Roux-en-Y gastric bypass (RYGB) weight nadir

In a sample of 1406 adults, the median time to weight nadir (i.e. lowest weight) was 2.0 years (25th-75th%ile, 1.0-3.2) following RYGB. Median (25th-75th%ile) maximum weight loss was 37.4% (31.6-43.3) of pre-surgery weight. Panel A in the figure below shows the modeled mean and observed median (25th-75th%ile) of percentage of maximum weight lost that was regained, by year since post-RYGB weight nadir. The rate of weight regain was largest in the first year after weight nadir and decreased over time, but continued throughout follow-up. Panel B shows the percentage of adults with progression, or decline, of select clinical outcomes by year since weight nadir, which generally appeared to increase over time in a similar pattern. Modeled associations between weight regain and clinical outcomes is available in Table 3 and eTable 6.
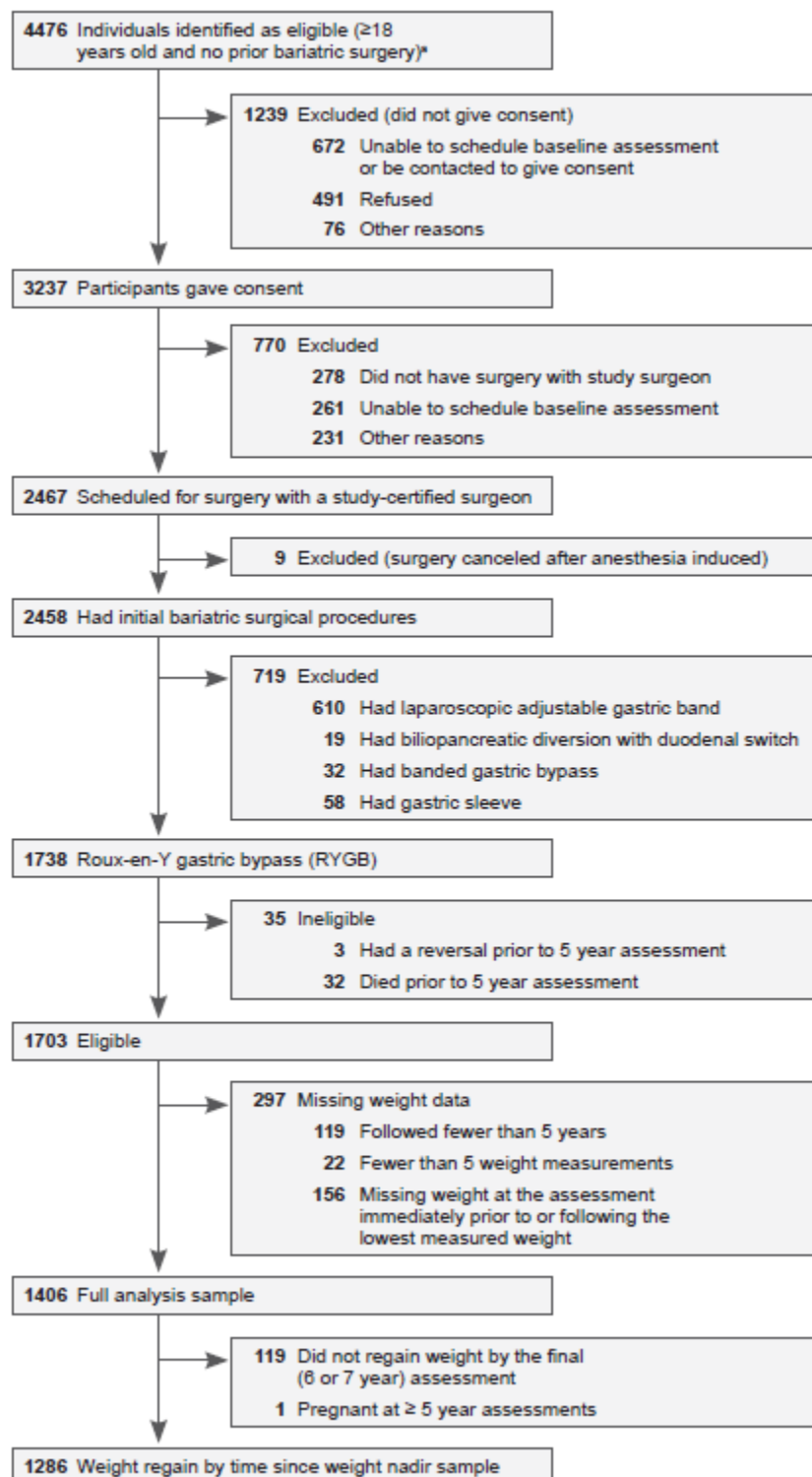
A. Weight regain, as percentage of maximum weight lost
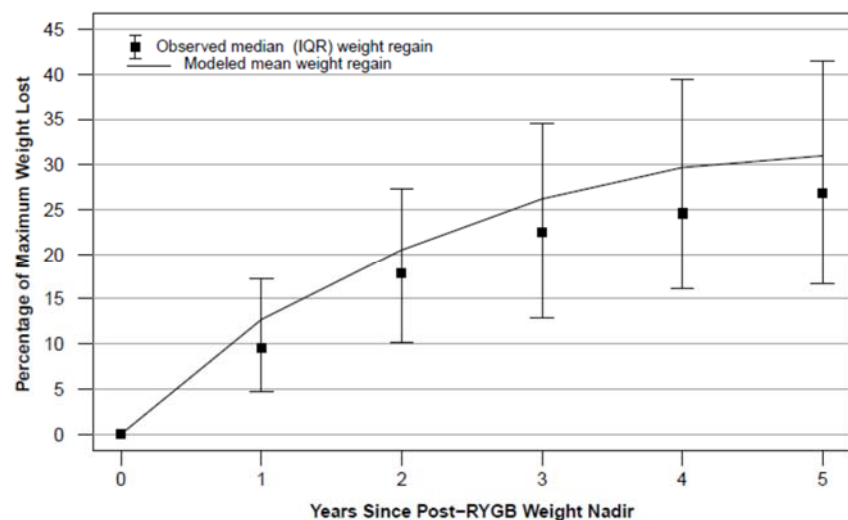
B. Clinician outcomes associated with weight regain

eFigure 1. Flow of participants from recruitment through follow-up

4476 Individuals identified as eligible (≥18 years old and no prior bariatric surgery)*

> **1239** Excluded (did not give consent)
> > **672** Unable to schedule baseline assessment or be contacted to give consent
> > **491** Refused
> > **76** Other reasons

3237 Participants gave consent

> **770** Excluded
> > **278** Did not have surgery with study surgeon
> > **261** Unable to schedule baseline assessment
> > **231** Other reasons

2467 Scheduled for surgery with a study-certified surgeon

> **9** Excluded (surgery canceled after anesthesia induced)

2458 Had initial bariatric surgical procedures

> **719** Excluded
> > **610** Had laparoscopic adjustable gastric band
> > **19** Had biliopancreatic diversion with duodenal switch
> > **32** Had banded gastric bypass
> > **58** Had gastric sleeve

1738 Roux-en-Y gastric bypass (RYGB)

> **35** Ineligible
> > **3** Had a reversal prior to 5 year assessment
> > **32** Died prior to 5 year assessment

1703 Eligible

> **297** Missing weight data
> > **119** Followed fewer than 5 years
> > **22** Fewer than 5 weight measurements
> > **156** Missing weight at the assessment immediately prior to or following the lowest measured weight

1406 Full analysis sample

> **119** Did not regain weight by the final (6 or 7 year) assessment
> **1** Pregnant at ≥ 5 year assessments

1286 Weight regain by time since weight nadir sample

*The number of patients screened to identify those thought to be eligible was not recorded.

eFigure 2. Cumulative percentage of participants who reached maximum weight loss by time since Roux-en-Y gastric bypass (n=1406)
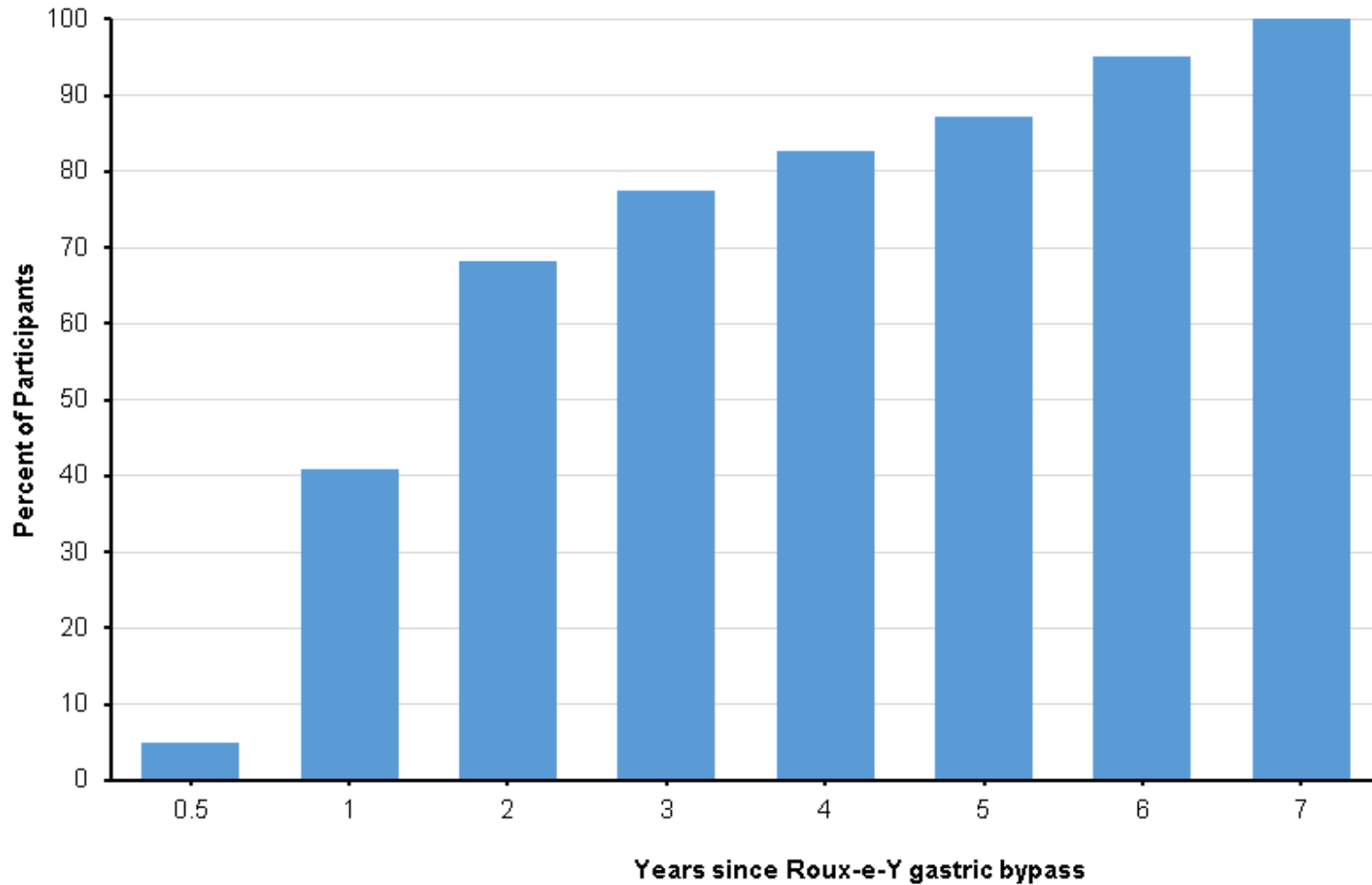
	n(%) by time maximum weight loss occurred						
71 (5.0)	505 (35.9)	384 (27.3)	129 (9.2)	73 (5.2)	64 (4.6)	111 (7.9)[a]	69 (4.9)[a]

[a]If the lowest weight was identified in the final year of study data collection (i.e., year 6 or 7) it was considered weight nadir. Year 6 was the final assessment for n=50 who reached weight nadir at year 6. Thus, 8.4% of participants (n=119) reached weight nadir in the final year of follow-up.

eTable 1. Comparisons of pre-surgery characteristics between eligible participants who were excluded versus included from the analysis sample

	Excluded (N=297[a]) no. (%)[b]		Included (N=1406[a]) no. (%)[b]		P[c]
Age, years					<0.001
Median (25th -75th %-ile)	39	(33, 47)	47	(38, 55)	
Female	231	(77.8)	1129	(80.3)	0.33
White race	242	(81.5)	1193	(84.9)	0.15
Hispanic/Latino ethnicity, No./total (%)	22/296	(7.4)	61/1406	(4.3)	0.02
Married or living as married	158	(53.2)	818	(58.2)	0.11
Education	(n=266)		(n=1306)		0.46
High school or less	65	(24.4)	305	(23.4)	
Some college	118	(44.4)	559	(42.8)	
College degree	83	(31.2)	442	(33.8)	
Unemployed	16	(5.4)	50	(3.6)	0.14
Household income, US $	(n=259)		(n=1308)		0.17
Less than 25,000	53	(20.5)	243	(19.1)	
25,000-49,999	75	(29.0)	357	(28.1)	
50,000-74,999	67	(25.9)	300	(23.6)	
75,000-99,999	39	(15.1)	194	(15.3)	
>100,000	25	(9.7)	176	(13.9)	
Current or recent smoker, No./total (%)	60/295	(20.3)	183/1404	(13.0)	0.001
Body mass index, kg/m^2					0.07
Median (25th -75th %-ile)	47.6	(43.1, 52.0)	46.3	(42.3, 51.8)	
Diabetes	89/282	(31.6)	480/1333	(36.0)	0.16
Hyperlipidemia	63/244	(25.8)	438/1132	(38.7)	<0.001
Hypertension	184/287	(64.1)	950/1361	(69.8)	0.059
SF-36 Physical component score[d]	(n=257)		(n=1287)		<0.001
Median (25th -75th %-ile)	38.5	(30.0, 46.4)	35.1	(26.7, 43.9)	<0.001
SF-36 Mental component score[d]	(n=257)		(n=1287)		0.91
Median (25th -75th %-ile)	51.7	(42.8, 57.6)	51.6	(42.8, 57.2)	

Abbreviations: SF-36, Short-Form 36-item Health Survey
[a]Denominators shift between variables due to missing data.
[b]Data are reported as No. (%) unless otherwise indicated.
[c]The Pearson chi square test or Fisher's exact test for categorical variables, the Cochran-Armitage test for ordinal variables, and the Wilcoxon rank sum test for continuous variables
[d]Norm-based methods transform the SF-36 scores to a mean of 50 and standard deviations of 10 in the general U.S. population (range 0-100). Lower scores imply more disability/worse function.

eTable 2. Comparison of weight loss between eligible participants who were excluded versus included from the analysis sample

	Time since Roux-en-Y gastric bypass								P value[b]
	6 month	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	
	Observed Median (IQR)								.65
Excluded[a]	(n=231)	(n=216)	(n=160)	(n=163)	(n=158)	(n=127)	(n=137)	(n=103)	
(N=297)	27.3 (23.4-31.7)	34.34 (29.5-39.9)	35.3 (28.3-42.4)	32.0 (22.7-39.1)	28.7 (21.5-36.8)	28.1 (21.1-36.1)	28.5 (22.1-37.5)	25.2 (19.3-33.7)	
Included	(n=1378)	(n=1383)	(n=1384)	(n=1355)	(n=1346)	(n=1349)	(n=1329)	(n=881)	
(N=1406)	27.0 (23.0-30.8)	34.0 (28.4-39.2)	34.0 (27.5-40.1)	31.5 (24.9-38.3)	29.6 (22.7-36.9)	28.9 (21.7-36.0)	29.2 (21.8-36.4)	28.0 (20.4-35.5)	

Abbreviations: IQR, interquartile range
[a]Participants were excluded from the analysis sample if they had inadequate weight assessments (i.e. fewer than 5 post-surgery weight assessments, no weight assessment ≥ year 5 or missing the weight prior to or following the lowest measured weight).
[b]From a linear mixed model via maximum likelihood with a person-level random intercept, with sample designation as a discrete fixed effect and time since surgery as a continuous fixed effect, controlling for pre-surgery factors related to missing follow-up data (i.e., site, age, smoking).

eTable 3. Weight loss at post-surgery weight nadir and last study assessment[a] among adults who underwent Roux-en-Y gastric bypass (N=1406)

	Timing		Last assessment, by year since surgery[c]		
	Weight Nadir[a]	Last Assessment[b]	Year 5	Year 6	Year 7
			n=54	n=475	n=876
Weight loss, Median (25th -75th %-ile)					
Weight, kg	48.1 (39.9-59.0)	35.8 (26.8-47.6)	36.5 (28.6-47.6)	36.7 (27.2-47.6)	35.8 (26.3-47.2)
Body mass index, kg/m^2	17.4 (14.3-21.0)	12.9 (9.5-16.9)	13.1 (9.0-17.1)	12.9 (9.7-17.0)	12.9 (9.3-16.8)
Percentage of pre-surgery weight	37.4 (31.6-43.3)	28.0 (20.6-35.6)	28.9 (18.1-34.3)	27.9 (20.8-35.9)	28.0 (20.3-35.5)
Weight loss thresholds, No. (%)					
≥10% of pre-surgery weight	1405 (99.9)	1345 (95.7)	52 (96.3)	457 (96.2)	836 (95.4)
≥25% of pre-surgery weight	1304 (92.8)	857 (61.0)	34 (63.0)	288 (60.6)	535 (61.1)

[a]Participants post-surgery weight nadir occurred a median of 2.0 years (25th-75th %-ile: 1.0-3.2) post-surgery.
[b]Participants last assessment occurred a median (25th-75th %-ile)= 6.6 (5.9-7.0) years. One participant who was pregnant during all non-missing weight assessments in years 5-7 is excluded from the last assessment column.
[c]Values stratified by the timing of participants' last assessment (i.e. year 5, 6 or 7 post-surgery).

eTable 4. Modeled weight regain by time since post-surgery weight nadir among adults who underwent Roux-en-Y gastric bypass (N=1286)

	Years since weight nadir									
	1 Year		**2 Years**		**3 Years**		**4 Years**		**5 Years**	
Weight regain, Modeled mean (95% CI) [a]										
Weight, kg	6.3	(5.9-6.5)	9.8	(9.5-9.9)	12.4	(12.2-12.6)	14.2	(13.9-14.4)	15.0	(14.5-15.5)
BMI, kg/m²	2.2	(2.1-2.3)	3.5	(3.4-3.6)	4.4	(4.3-4.5)	5.0	(4.9-5.1)	5.3	(5.2-5.5)
% of pre-surgery weight	4.6	(4.4-4.8)	7.2	(7.1-7.4)	9.2	(9.0-9.4)	10.5	(10.3-10.7)	11.1	(10.8-11.4)
% of weight nadir	7.7	(7.3-8.0)	11.9	(11.6-12.1)	15.1	(14.8-15.3)	17.2	(16.9-17.5)	18.3	(17.7-18.8)
% of max weight lost	12.6	(12.0-13.2)	20.4	(20.1-20.9)	26.1	(25.8-26.7)	29.6	(29.2-30.2)	30.9	(30.0-31.9)
Clinically important weight Regain, Modeled % (95% CI)										
≥10 kg	17.0	(14.4-17.5)	37.3	(35.5-38.4)	54.1	(52.2-55.5)	62.6	(60.9-64.1)	63.1	(59.8-65.7)
≥5 kg/m² BMI points	7.6	(6.0-8.1)	20.3	(18.8-21.2)	34.5	(32.7-36.0)	44.0	(42.3-45.8)	46.5	(43.4-49.9)
≥10% of pre-surgery weight	8.1	(6.6-8.9)	22.3	(20.9-23.5)	37.8	(36.2-39.6)	47.8	(46.3-49.9)	50.0	(47.2-53.3)
≥10% of nadir weight	24.2	(21.6-25.3)	49.0	(47.5-50.8)	66.2	(64.8-68.0)	73.7	(72.8-75.4)	73.7	(71.6-76.5)
≥15% of nadir weight	10.5	(8.7-11.1)	26.7	(25.1-27.7)	42.5	(40.9-44.2)	51.6	(50.3-53.4)	52.6	(49.8-55.8)
≥10% of max weight lost	49.5	(47.4-51.8)	73.9	(72.8-75.6)	84.7	(83.9-86.4)	87.9	(87.2-89.3)	86.3	(84.5-88.6)
≥20% of max weight lost	19.7	(17.5-20.7)	40.9	(39.5-42.4)	57.5	(56.3-59.7)	65.9	(64.9-68.0)	66.8	(64.4-70.4)
≥25% of max weight lost	12.5	(10.6-13.2)	28.6	(27.0-29.5)	43.5	(41.5-45.2)	52.5	(50.8-54.3)	54.1	(51.0-57.3)

Abbreviations: BMI, body mass index; max, maximum.
[a]Based on linear mixed models using maximum likelihood with a person-level random intercept, and time since post-surgery weight nadir (entered as linear and quadratic terms) as a continuous fixed effects, controlling for pre-surgery factors related to missing follow-up data (i.e., site, pre-surgery age and pre-surgery smoking status). The quadratic term for time since weight nadir was significant ($P<0.01$) in all models.

eTable 5. Sensitivity analysis: weight regain by time since weight nadir among adults who underwent Roux-en-Y gastric bypass with imputed data[a]

	Years since weight nadir									
	1 Year		**2 Years**		**3 Years**		**4 Years**		**5 Years**	
Timing, median (25th -75th %-ile)										
Years since initial surgery	3.0	(2.1-4.1)	3.9	(3.0-4.4)	4.8	(4.0-5.2)	5.4	(5.0-6.0)	6.1	(5.8-7.0)
Weight regain, median (25th -75th %-ile)										
Weight, kg	5.0	(2.3-8.6)	8.9	(5.0-14.0)	11.4	(6.4-17.4)	12.4	(7.5-19.6)	13.1	(7.8-20.2)
BMI, kg/m²	1.8	(0.9-3.1)	3.2	(1.8-4.9)	4.1	(2.3-6.2)	4.4	(2.7-7.0)	4.6	(2.8-7.1)
% of pre-surgery weight	3.9	(1.8-6.6)	6.8	(3.9-10.2)	8.4	(5.0-12.9)	9.4	(5.9-14.5)	10.0	(6.2-14.7)
% of nadir weight	6.2	(2.9-10.5)	10.7	(6.4-16.9)	13.7	(7.8-20.8)	15.1	(9.1-23.3)	15.3	(9.5-23.7)
% of max weight lost	10.3	(5.0-18.1)	18.6	(10.5-28.7)	24.0	(13.9-35.9)	26.1	(16.8-40.5)	27.9	(17.1-42.8)
Clinically important weight regain[b], No. (%)										
≥10 kg	297	(19.1)	610	(42.5)	747	(55.2)	743	(60.5)	601	(63.5)
≥ 5 BMI points	135	(8.7)	342	(23.9)	506	(37.4)	521	(42.4)	432	(45.6)
≥10% of pre-surgery weight	152	(9.8)	382	(26.7)	552	(40.8)	575	(46.8)	478	(50.5)
≥10% of nadir weight	426	(27.5)	773	(53.9)	897	(66.3)	878	(71.5)	697	(73.6)
≥15% of nadir weight	195	(12.6)	458	(31.9)	592	(43.8)	619	(50.4)	495	(52.3)
≥10% of max weight lost	791	(51.0)	1102	(76.9)	1141	(84.3)	1079	(87.8)	826	(87.3)
≥20% of max weight lost	326	(21.0)	658	(45.9)	804	(59.4)	806	(65.7)	652	(68.9)
≥25% of max weight lost	207	(13.4)	469	(32.7)	639	(47.2)	640	(52.1)	541	(57.1)

Abbreviations: BMI, body mass index; max, maximum.
[a]See eAppendix 2 for a description of the imputation process. Of 1703 participants, a minimum of 137 and maximum of 158 participants who reached weight nadir during the final year of data collection in the 20 imputed datasets were excluded.

eTable 6. Percentage of participants who underwent Roux-en-Y gastric bypass[a] with declines in health by time since post-surgery weight nadir (N=1286[a])

	Time since weight nadir[b]				
	Year 1	2 Years	3 Years	4 Years	5 Years
			n, no.(%)		
Progression of disease:					
Diabetes (n=689)[c]	n=555	n=518	n=458	n=304	n=153
	55 (9.9)	70 (13.5)	88 (19.2)	78 (25.7)	54 (35.3)
Hyperlipidemia (n=539)[d]	n=414	n=388	n=341	n=224	n=114
	107 (25.9)	116 (29.9)	115 (33.7)	96 (42.9)	78 (68.4)
Hypertension (n=956)[e]	n=822	n=758	n=694	n=469	n=263
	380 (46.2)	408 (53.8)	408 (58.8)	288 (61.4)	188 (71.5)
Clinically important decline:					
Physical HRQoL (n=903)[f]	n=712	n=663	n=590	n=364	n=174
	144 (20.2)	184 (27.8)	189 (32.0)	136 (37.4)	73 (42.0)
Mental HRQoL (n=903)[g]	n=712	n=663	n=590	n=364	n=174
	197 (27.7)	198 (29.9)	210 (35.6)	138 (37.9)	57 (32.8)
Satisfaction with surgery[h] (n=272)	n =218	n =200	n =139	n =36	n =29
	27 (12.4)	27 (13.5)	30 (21.6)	8 (22.2)	8 (27.6)

Abbreviations: HRQoL, health-related quality of life

[a]Participants who reached weight nadir during the final year of data collection (n=119) or did not complete the required measure(s) for an outcome at the time of maximum weight loss and at least one later assessment (diabetes n=597, hyperlipidemia n=747, hypertension n=330, physical and mental HRQoL n=383; satisfaction n=1014) were excluded from this table because change from weight nadir could not be determined. 615 of 1014 participants missing satisfaction experienced weight nadir prior to the addition of this item to the study protocol in 2010. Participants were excluded from specific time points if the data was not collected (i.e., diabetes, hyperlipidemia and hypertension were not collected at the year 6 assessment), if they were due for assessment after study data collection ended, if they were pregnant, or if they missed an assessment.

[b]Poisson mixed models with robust error variance were used to test associations with the continuous fixed effect of time since weight nadir. Both a linear and quadratic term were considered. In all models, the linear term was significant ($P<0.05$); the quadratic term for time was not ($P>0.05$).

[c]Diabetes: a change from not taking diabetes medication to taking diabetes medication, change from not taking insulin to taking insulin, or an increase of glycated hemoglobin (HbA1c) by at least 0.5% plus a post-weight nadir value of 5.7% or greater.

[d]Hyperlipidemia: a change from not taking lipid lowering medication to taking lipid lowering medication, an increase of low-density lipoprotein (LDL) by at least 10 mg/dL plus a post-weight nadir value of 100 mg/dL or greater.

[e]Hypertension: a change from not taking hypertension medication to taking hypertension medication, an increase of systolic blood pressure by at least 5 mm Hg plus a post-weight nadir value of 120 mm Hg or greater, or an increase of diastolic blood pressure (DBP) by at least 5 mm HG plus a post-weight nadir value of 80 mm Hg or greater.

[f]A decrease of ≥5 points on the Short-Form 36-item Health Survey Mental Component Score and Physical Component Score, respectively.

[f]An increase of at least 1 point to at least 3 (i.e., "somewhat satisfied" – "very dissatisfied").

eTable 7. Associations between common definitions of weight regain and concurrent progression of hyperlipidemia and hypertension, respectively, among adults who underwent Roux-en-Y gastric bypass (N=1286)

	Progression of hyperlipidemia[a] N=539				Progression of hypertension[b] N=956			
	RR[c]	(95% CI)	P value	BIC[d]	RR[c]	(95% CI)	P value	BIC[d]
Weight regain, continuous[e]								
Weight in kg, per 9.1 kg[b]	1.14	(1.00-1.29)	.045	2050.9	1.10	(1.05-1.16)	<.001	5631.9
BMI (kg/m²), per 3.2 kg/m²[b]	1.14	(1.00-1.28)	.043	2050.8	1.10	(1.05-1.16)	<.001	5632.1
% pre-surgery weight, per 6.9%[b]	1.13	(0.99-1.29)	.07	2051.7	1.12	(1.06-1.18)	<.001	5630.8
% nadir weight, per 11.0%[b]	1.12	(0.99-1.26)	.07	2051.5	1.09	(1.04-1.15)	<.001	5634.9
% max weight lost, per 18.9%[b]	1.11	(0.97-1.27)	.14	2052.8	1.13	(1.07-1.19)	<.001	5627.9
Clinically important weight regain[f]								
≥10 kg	1.30	(1.05-1.61)	.02	2049.4	1.18	(1.06-1.30)	0.002	5636.3
≥ 5 BMI points (kg/m²)	1.22	(0.97-1.55)	.09	2052.4	1.17	(1.05-1.30)	0.004	5637.8
≥10% of pre-surgery weight	1.23	(0.98-1.54)	.08	2052.2	1.18	(1.06-1.31)	0.002	5636.8
≥10% of nadir weight	1.14	(0.92-1.42)	.22	2053.5	1.19	(1.07-1.32)	0.001	5635.2
≥15% of nadir weight	1.22	(0.98-1.53)	.07	2052.0	1.16	(1.04-1.28)	0.006	5638.4
≥10% of max weight lost	1.12	(0.88-1.43)	.34	2054.9	1.26	(1.11-1.43)	<.001	5631.8
≥20% of max weight lost	1.27	(1.02-1.57)	.03	2050.6	1.20	(1.08-1.33)	<.001	5634.1
≥25% of max weight lost	1.22	(0.98-1.51)	.07	2052.1	1.20	(1.08-1.33)	<.001	5634.1

Abbreviations: BIC=Bayesian Information Criterion; max=maximum.

[a]A change from not taking lipid lowering medication to taking lipid lowering medication, an increase of low-density lipoprotein (LDL) by at least 10 mg/dL plus a post-weight nadir value of 100 mg/dL or greater.

[b]A change from not taking hypertension medication to taking hypertension medication, an increase of systolic blood pressure (SBP) by at least 5 mm Hg plus a post-weight nadir value of 120 mm Hg or greater, or an increase of diastolic blood pressure (DBP) by at least 5 mm HG plus a post-weight nadir value of 80 mm Hg or greater.

[c]Adjusted for pre-surgery factors related to missing data (i.e., site, age and smoking status), LDL or SBP and DBP, at time of weight loss nadir, respectively, and time since weight nadir entered as a continuous fixed effect (only linear term retained).

[d]Given equivalent model complexities, a difference of more than 2 is considered good evidence that the model with the lower BIC has better fit.

[e]Relative risk is reported per median weight regain across post-nadir time points.

[f]As previously defined in the scientific literature.

eTable 8. Sensitivity analysis with imputed data versus primary analysis: Associations between common weight regain measures and concurrent declines in health outcomes among adults who underwent Roux-en-Y gastric bypass

	Progression of diabetes				Progression of hyperlipidemia				Progression of hypertension			
	Primary analysis		Sensitivity analysis		Primary analysis		Sensitivity analysis		Primary analysis		Sensitivity analysis	
	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)
Weight regain, continuous[b]												
Weight in kg, per 9.1 kg	1.40	(1.18-1.67)	1.40	(1.27-1.53)	**1.14**	**(1.00-1.29)**	1.22	(1.14-1.30)	1.10	(1.05-1.16)	1.13	(1.09-1.17)
BMI, per 3.2 kg/m²	1.41	(1.19-1.68)	1.41	(1.29-1.55)	**1.14**	**(1.00-1.28)**	1.22	(1.14-1.31)	1.10	(1.05-1.16)	1.13	(1.09-1.17)
% pre-surgery weight, per 6.9%	1.45	(1.22-1.73)	1.44	(1.31-1.59)	1.13	(0.99-1.29)	**1.24**	**(1.15-1.33)**	1.12	(1.06-1.18)	1.15	(1.10-1.19)
% nadir weight, per 11.0%	1.36	(1.15-1.60)	1.36	(1.24-1.48)	1.12	(0.99-1.26)	1.20	(1.13-1.28)	1.09	(1.04-1.15)	1.11	(1.07-1.15)
% max weight lost, per 18.9%	**1.51**	**(1.27-1.78)**	**1.46**	**(1.33-1.60)**	1.11	(0.97-1.27)	**1.24**	**(1.15-1.34)**	**1.13**	**(1.07-1.19)**	**1.16**	**(1.12-1.21)**
Clinically important weight regain												
≥10 kg	1.56	(1.15-2.11)	1.75	(1.44-2.13)	**1.30**	**(1.05-1.61)**	1.41	(1.22-1.62)	1.18	(1.06-1.30)	1.25	(1.15-1.36)
≥ 5 BMI points	1.66	(1.19-2.30)	1.81	(1.50-2.19)	1.22	(0.97-1.55)	1.43	(1.24-1.64)	1.17	(1.05-1.30)	1.25	(1.15-1.36)
≥10% of pre-surgery weight	1.63	(1.19-2.25)	1.76	(1.46-2.12)	1.23	(0.98-1.54)	1.42	(1.23-1.64)	1.18	(1.06-1.31)	1.25	(1.15-1.35)
≥10% of nadir weight	1.37	(1.02-1.84)	1.62	(1.33-1.96)	1.14	(0.92-1.42)	1.39	(1.20-1.60)	1.19	(1.07-1.32)	1.25	(1.15-1.36)
≥15% of nadir weight	1.41	(1.03-1.92)	1.64	(1.37-1.97)	1.22	(0.98-1.53)	1.36	(1.18-1.56)	1.16	(1.04-1.28)	1.23	(1.13-1.33)
≥10% of max weight lost	1.42	(1.02-1.98)	1.72	(1.34-2.21)	1.12	(0.88-1.43)	1.37	(1.16-1.61)	**1.26**	**(1.11-1.43)**	**1.35**	**(1.22-1.50)**
≥20% of max weight lost	**1.64**	**(1.22-2.19)**	**1.84**	**(1.52-2.24)**	1.27	(1.02-1.57)	**1.48**	**(1.29-1.71)**	1.20	(1.08-1.33)	1.28	(1.18-1.39)
≥25% of max weight lost	**1.64**	**(1.21-2.20)**	1.81	(1.50-2.17)	1.22	(0.98-1.51)	1.47	(1.27-1.70)	1.20	(1.08-1.33)	1.27	(1.17-1.37)

	Clinically important decline in physical HRQoL				Clinically important decline in mental HRQoL			
	Primary analysis		Sensitivity analysis		Primary analysis		Sensitivity analysis	
	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)	RR[a]	(95% CI)
Weight regain, continuous[b]								
Weight in kg, per 9.1 kg	1.21	(1.12-1.31)	1.25	(1.19-1.31)	1.08	(1.00-1.17)	1.11	(1.05-1.17)
BMI, per 3.2 kg/m²	1.21	(1.12-1.31)	1.25	(1.19-1.32)	1.09	(1.01-1.18)	1.12	(1.06-1.18)
% pre-surgery weight, per 6.9%	1.22	(1.12-1.32)	1.26	(1.20-1.33)	**1.11**	**(1.02-1.20)**	**1.13**	**(1.07-1.20)**
% nadir weight, per 11.0%	1.16	(1.07-1.25)	1.19	(1.14-1.25)	1.08	(1.00-1.17)	1.11	(1.05-1.17)
% max weight lost, per 18.9%	**1.28**	**(1.18-1.38)**	**1.31**	**(1.24-1.38)**	**1.11**	**(1.02-1.20)**	**1.13**	**(1.07-1.19)**
Clinically important weight regain								
≥10 kg	1.39	(1.19-1.63)	1.53	(1.37-1.72)	1.12	(0.96-1.30)	1.19	(1.07-1.34)
≥ 5 BMI points	1.40	(1.18-1.65)	1.53	(1.36-1.72)	**1.23**	**(1.04-1.45)**	**1.26**	**(1.12-1.42)**
≥10% of pre-surgery weight	1.45	(1.23-1.71)	1.53	(1.36-1.72)	1.17	(1.00-1.38)	1.24	(1.11-1.39)
≥10% of nadir weight	1.36	(1.15-1.59)	1.49	(1.32-1.68)	1.11	(0.95-1.29)	1.20	(1.07-1.34)
≥15% of nadir weight	1.36	(1.16-1.59)	1.45	(1.29-1.64)	1.19	(1.01-1.39)	1.23	(1.10-1.38)
≥10% of max weight lost	1.42	(1.17-1.72)	1.60	(1.38-1.87)	1.09	(0.92-1.29)	1.16	(1.02-1.32)
≥20% of max weight lost	**1.55**	**(1.33-1.82)**	**1.64**	**(1.47-1.85)**	**1.23**	**(1.06-1.43)**	1.25	(1.12-1.39)
≥25% of max weight lost	1.43	(1.22-1.68)	1.59	(1.42-1.79)	1.16	(0.99-1.36)	1.23	(1.11-1.37)

eTable 8 continued

Abbreviations: BMI=body mass index; HRQoL=health-related quality of life; max=maximum; RR= Relative Risk. (Continued on next page)
[a]Adjusted for either glycated hemoglobin, low-density lipoprotein, systolic and diastolic blood pressure, the Short-Form 36 Physical Component Summary score, or the Short-Form 36 Mental Component Summary score at time of weight nadir, and time since weight nadir entered as a continuous fixed effect. The primary analysis also adjusted for pre-surgery factors related to missing data (i.e., site, age and smoking status). The highest RR among each set of regain variables is in bold type.
[b]For continous variables, RR is reported per median weight regain across post-nadir time points.

eTable 9. A comparison of model fits, as measured by Bayesian Information Criterion (BIC) values, between models with continuous vs. dichotomous weight regain measures[a] (N=1286)

	Progression of diabetes[b] N=689				Progression of hyperlipidemia[a] N=539				Progression of hypertension[b] N=956			
Continuous vs. dichotomous	Cont	Dich	Diff	Better Fit[b]	Cont	Dich	Diff	Better Fit[b]	Cont	Dich	Diff	Better Fit[b]
Weight in kg vs. ≥10 kg	1543.2	1549.4	6.2	Cont	2050.9	2049.4	-1.5	-	5631.9	5636.3	4.4	Cont
BMI (kg/m²) vs. ≥ 5 BMI points	1543.2	1548.6	5.4	Cont	2050.8	2052.4	1.6	-	5632.1	5637.8	5.7	Cont
% pre-surgery weight vs. ≥10%	1541.9	1549.5	7.6	Cont	2051.7	2052.2	0.5	-	5630.8	5636.8	6.0	Cont
% nadir weight vs. ≥10%	1545.5	1553.2	7.7	Cont	2051.54	2053.52	1.98	-	5634.9	5635.2	0.3	-
% nadir weight vs. ≥15%	1545.5	1554.0	8.5	Cont	2051.5	2052.0	0.5	-	5634.9	5638.4	3.5	Cont
% max weight lost vs. ≥10%	1535.8	1554.0	18.2	Cont	2052.8	2054.9	2.1	Cont	5627.9	5631.8	3.9	Cont
% max weight lost vs. ≥20%	1535.8	1547.2	11.4	Cont	2052.8	2050.6	-2.2	Dich	5627.9	5634.1	6.2	Cont
% max weight lost vs. ≥25%	1535.8	1547.3	11.5	Cont	2052.8	2052.1	-0.7	-	5627.9	5634.1	6.2	Cont
Best vs. Best[c]	1535.8	1547.2	11.4	Cont	2050.8	2049.4	-1.3	-	5627.9	5631.8	3.9	Cont

	Clinically important decline in physical HRQoL[b] N=903				Clinically important decline in mental HRQoL[a] N=903				Clinically important decline in satisfaction[c] N=272			
	Cont	Dich	Diff	Better Fit[a]	Cont	Dich	Diff	Better Fit[b]	Cont	Dich	Diff	Better Fit[b]
Weight in kg vs. ≥10 kg	3541.9	3548.0	6.1	Cont	3739.2	3741.9	2.7	Cont	584.4	585.3	0.9	-
BMI (kg/m²) vs. ≥ 5 BMI points	3542.8	3550.2	7.4	Cont	3738.5	3737.3	-1.2	-	583.3	586.9	3.6	Cont
% pre-surgery weight vs. ≥10%	3544.1	3544.4	0.3	-	3737.7	3739.6	1.9	Cont	585.5	588.1	2.6	Cont
% nadir weight vs. ≥10%	3551.2	3552.0	0.8	-	3738.8	3741.0	2.2	Cont	586.9	586.5	-0.4	-
% nadir weight vs. ≥15%	3551.2	3550.3	-0.9	-	3738.8	3739.6	0.8	-	586.9	589.8	2.9	Cont
% max weight lost vs. ≥10%	3532.8	3550.4	17.6	Cont	3737.6	3742.2	4.6	Cont	582.9	582.9	0.0	Cont
% max weight lost vs. ≥20%	3532.8	3535.5	2.7	Cont	3737.6	3735.8	-1.8	-	582.9	579.4	-3.5	Dich
% max weight lost vs. ≥25%	3532.8	3546.5	13.7	Cont	3737.6	3739.9	2.3	Cont	582.9	575.9	-7.0	Dich
Best vs. Best[c]	3532.8	3535.5	2.7	Cont	3737.6	3735.8	-1.8	-	582.9	575.9	-7.0	Dich

Abbreviations: Cont=continuous; Dich=dichotomous; HRQoL=health-related quality of life; max=maximum.
[a] Relative risks with 95% confidence intervals and *p*-values from associations are presented in Table 3 and eTable 6.
[b] Given equivalent model complexities, a difference of more than 2 is considered good evidence that the model with the lower BIC has better fit. Weight regain measures are considered to perform similarly if the difference in BICs is ≤2.
[c] The best continuous measure vs. the best dichotomous measure. Within type of measures (i.e., continous or dichotomous), measures were considered to perform similarly if the difference in BICs was ≤2, or the model fit was better with one measure, while the magnitude of the association was larger with another. When measures within type tied for "best" using these criteria, the measure with the lowest BIC was selected for comparison across type (i.e. best continuous measure vs. the best dichotomous).