SLEEVE VS GASTRIC BYPASS FOR WEIGHT LOSS IN DIABETICS

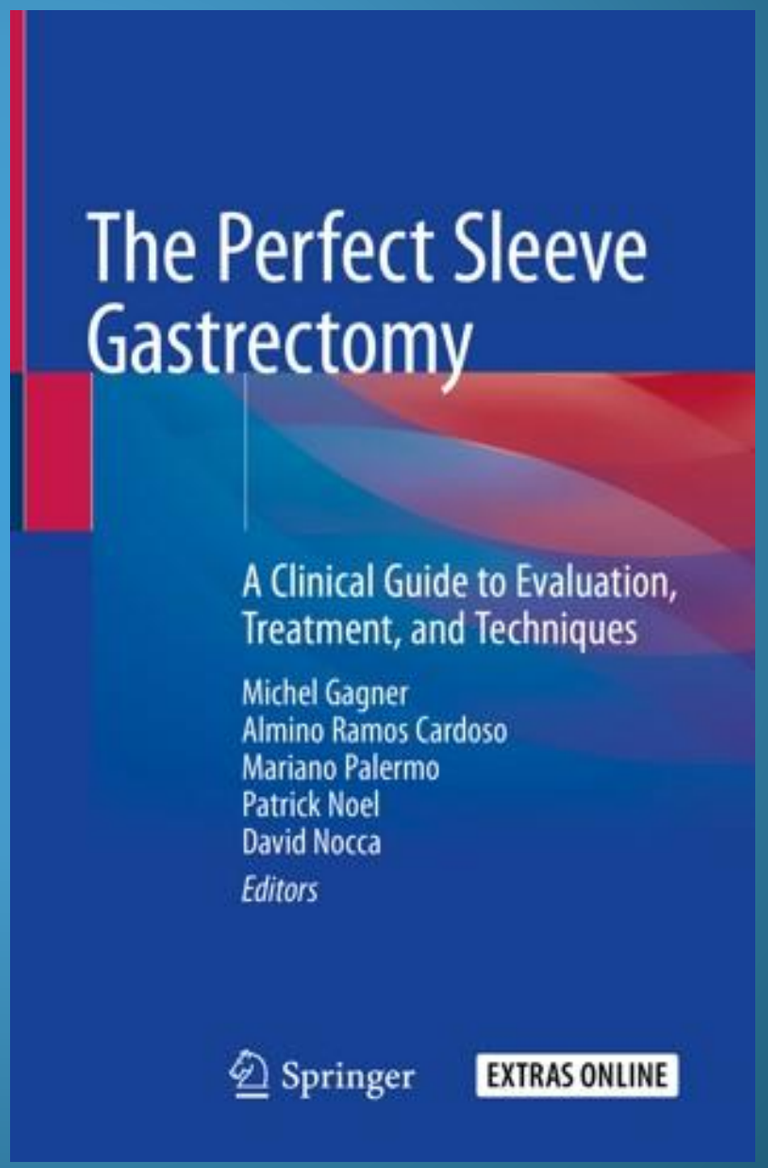
International Society of Surgery (ISS)
Société Internationale de Chirurgie (SIC)
Est. 1902

Michel Gagner, MD, FRCSC, FACS, FASMBS, FSSO

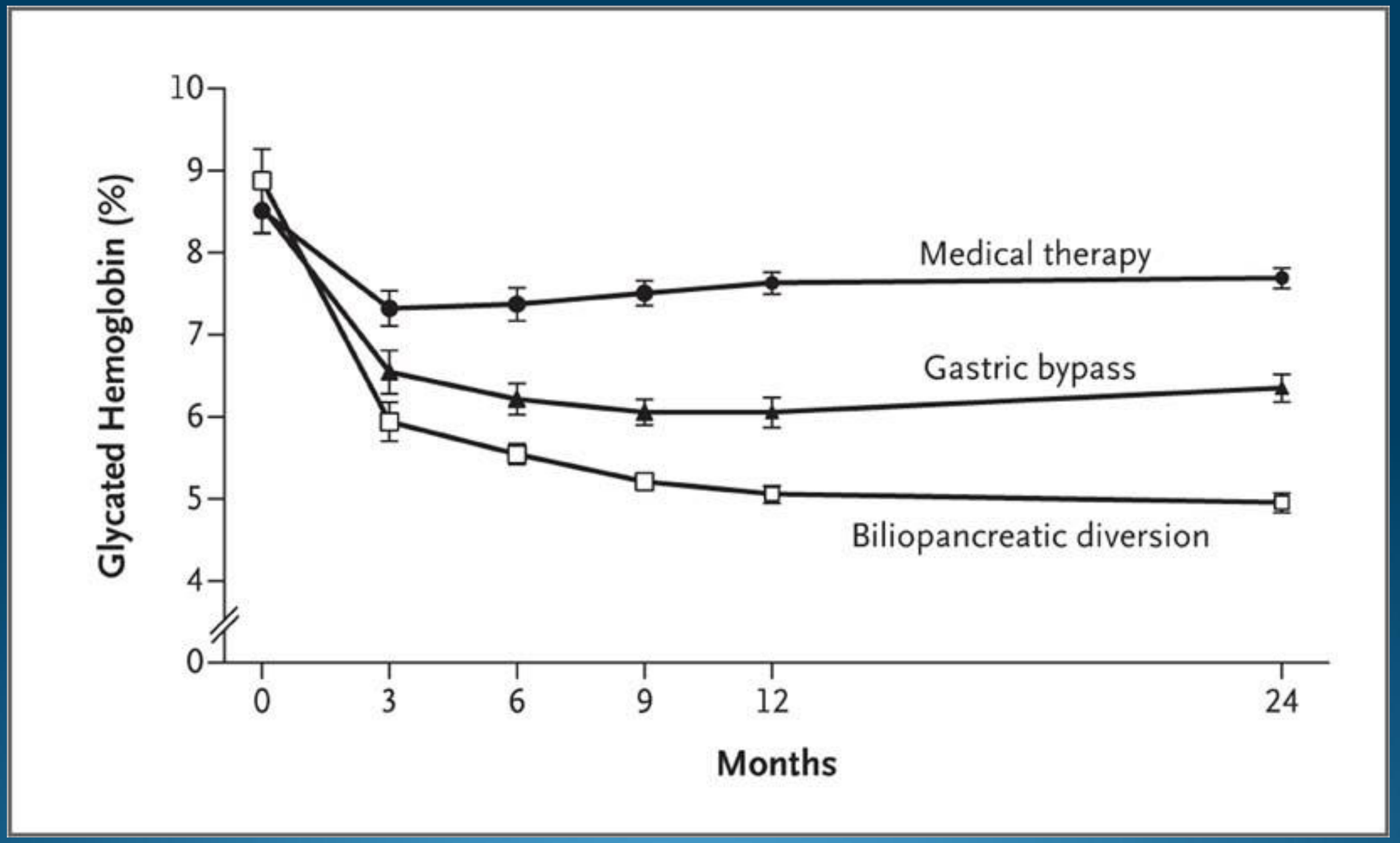
Westmount Square Surgical Center, Westmount, QC, Canada

Disclosures

- Stock ownership:
- Lexington medical,
- GT Metabolic



Glycated Hemoglobin Levels during 2 Years of Follow-up.



Mingrone G et al. N Engl J Med 2012;366:1577-1585

The NEW ENGLAND JOURNAL of MEDICINE

5 years follow-up (Lancet Sept 2015)

- Complete remission was 63% in BPD group vs. 37% in Gastric bypass group
- (Overall 50% at 5 years)

- Complications in med. Group (5) Myocardial infarction
- Complications in gastric bypass (1)
- Complications in BPD (0)

Lancet. 2015 Sep 5;386(9997):964-73.

Specifically, 10-year remission rates in the were:

5% for medical therapy

50% for BPD,

and 25% for RYGB

p=0·0082

Mingrone G, Panunzi S, De Gaetano A, Guidone C, Iaconelli A, Capristo E, Chamseddine G, Bornstein

Ten-year remission rates in insulin-treated type 2 diabetes after biliopancreatic diversion with duodenal switch

Jordanna E. Kapeluto, M.D., André Tchernof, Ph.D., Daiana Masckauchan, M.D., Simon Biron, M.D., Simon Marceau, M.D., Frédéric-Simon Hould, M.D., Stéfane Lebel, M.D., Odette Lescelleur, M.D., François Julien, M.D., Laurent Biertho, M.D.

Surgery for Obesity and Related Diseases

DOI: 10.1016/j.soard.2020.06.052

ARTICLE IN PRESS

ELSEVIER

Surgery for Obesity and Related Diseases ■ (2020) 1–12

SURGERY FOR OBESITY AND RELATED DISEASES

Original article

Ten-year remission rates in insulin-treated type 2 diabetes after biliopancreatic diversion with duodenal switch

Jordanna E. Kapeluto, M.D.[a,b], André Tchernof, Ph.D.[c,d], Daiana Masckauchan, M.D.[a], Simon Biron, M.D.[a], Simon Marceau, M.D.[a], Frédéric-Simon Hould, M.D.[a], Stéfane Lebel, M.D.[a], Odette Lescelleur, M.D.[a], François Julien, M.D.[a], Laurent Biertho, M.D.[a,*]

[a]*Department of Surgery, Division of Bariatric and General Surgery, Institut Universitaire de Cardiologie et de Pneumologie de Québec, Quebec City, Canada*

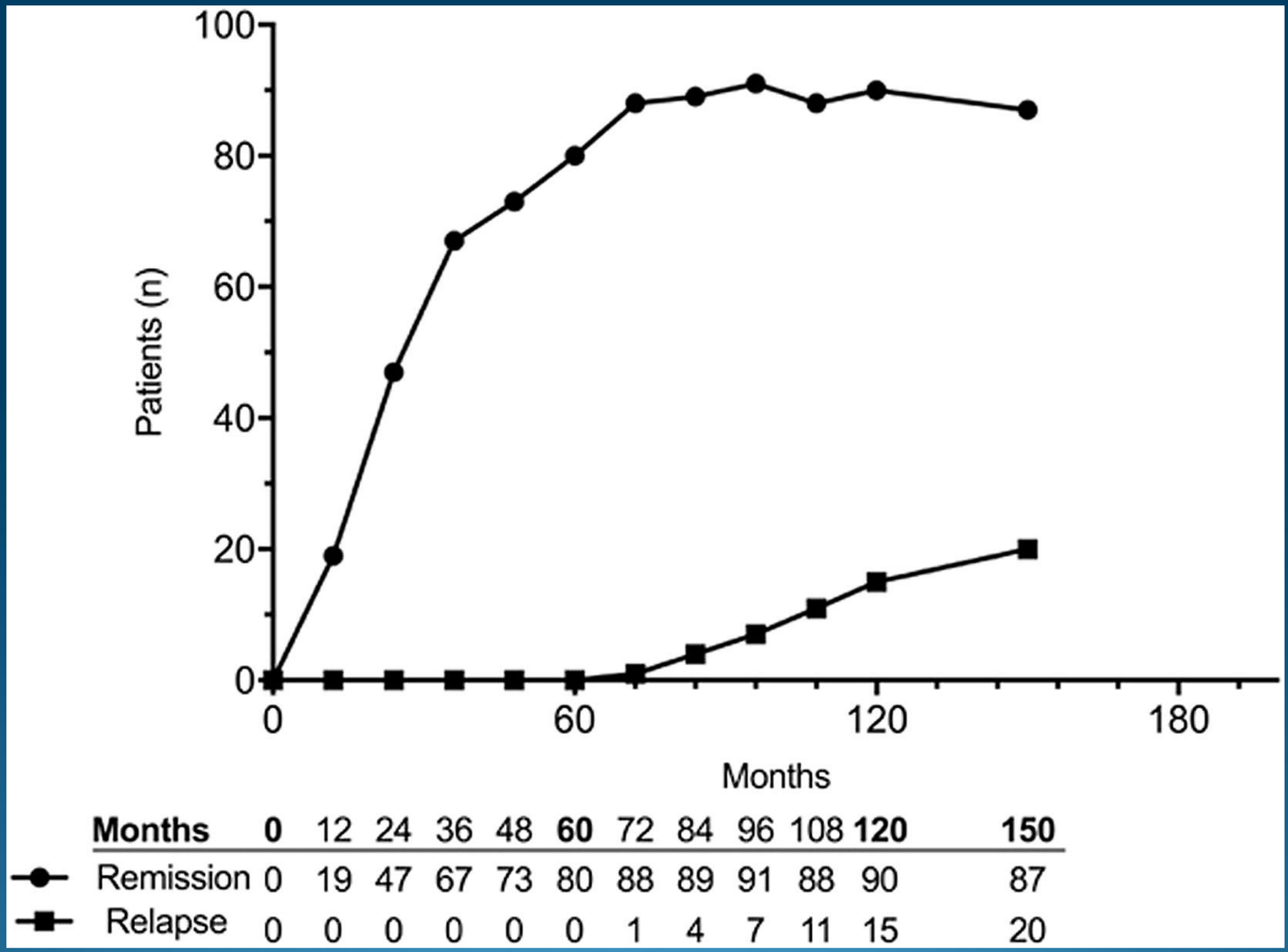
[b]*Division of Endocrinology, Department of Medicine, University of British Columbia, Vancouver, Canada*

[c]*School of Nutrition, Laval University, Quebec City, Canada*

[d]*Research Center, Institut Universitaire de Cardiologie et de Pneumologie de Québec, Québec City, Canada*

Received 29 March 2020; accepted 27 June 2020

Fig. 2



Months	0	12	24	36	48	60	72	84	96	108	120	150
Remission	0	19	47	67	73	80	88	89	91	88	90	87
Relapse	0	0	0	0	0	0	1	4	7	11	15	20

Surgery for Obesity and Related Diseases DOI: (10.1016/j.soard.2020.06.052)

From: **Effect of Laparoscopic Sleeve Gastrectomy vs Roux-en-Y Gastric Bypass on Weight Loss, Comorbidities, and Reflux at 10 Years in Adult Patients With Obesity: The SLEEVEPASS Randomized Clinical Trial**

JAMA Surg. 2022;157(8):656-666. doi:10.1001/jamasurg.2022.2229

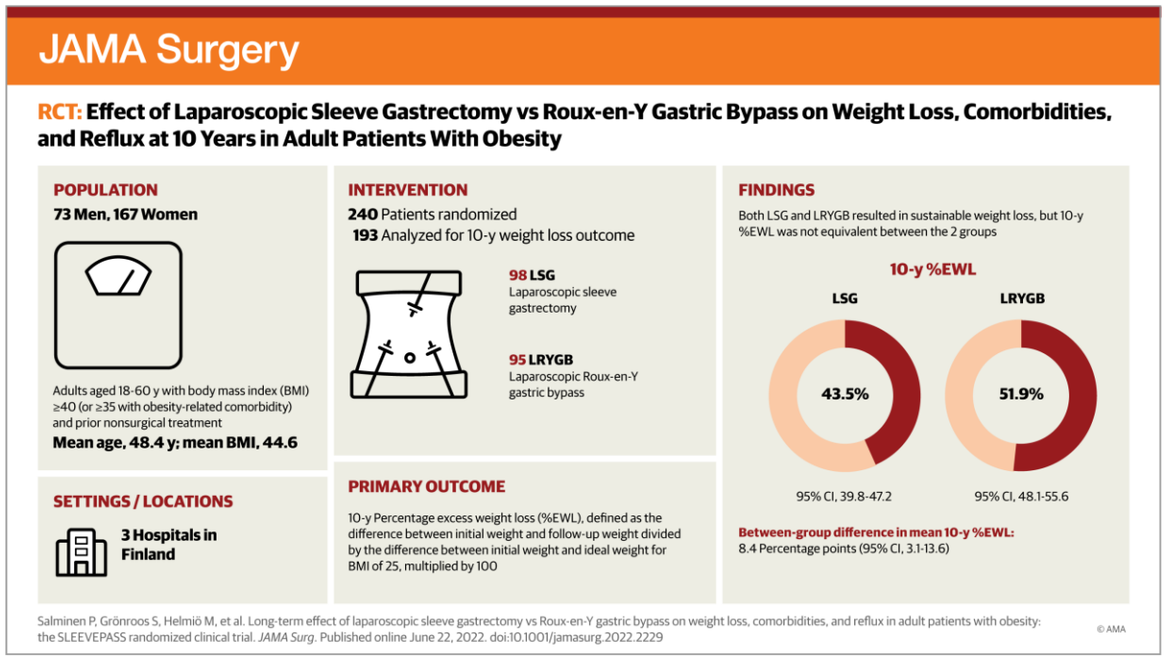
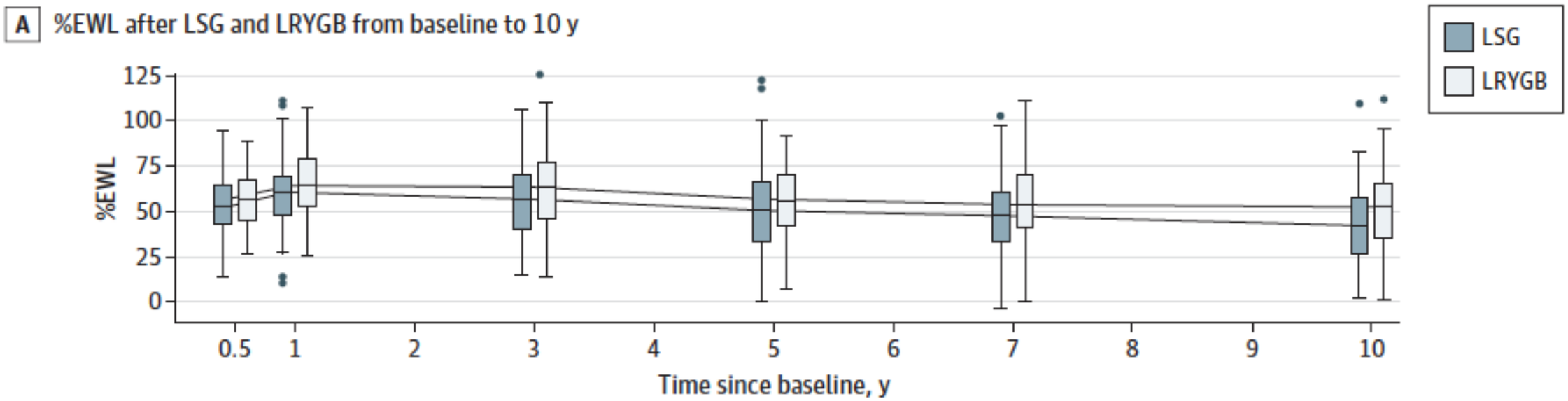


Figure Legend:

Long-term effect of LSG vs LRYGB on weight loss, comorbidities, and reflux in adults with obesity

Figure 2. Percentage Excess Weight Loss (%EWL) and Percentage Total Weight Loss (%TWL) for All Patients and Individual Patients After Laparoscopic Sleeve Gastrectomy (LSG) and Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) From Baseline to 10 years



eTable 4. Improvement in glycemic control in patients with diabetes after LSG and LRYGB from baseline to 10 years of follow-up

	Time		LSG	LRYGB	P Value
Fasting glucose, mmol/l[a,b]		Mean estimate	6.9	6.8	.42
		(95% CI)	(6.6 to 7.3)	(6.4 to 7.1)	
Glycated hemoglobin, %[a,c]	**Baseline**	Mean estimate	7.0	7.3	
		(95% CI)	(6.8 to 7.2)	(7.1 to 7.6)	
		No.	52	49	
	0.5 y	Mean estimate	6.4	6.3	.26
		(95% CI)	(6.2 to 6.6)	(6.1 to 6.5)	
		No.	50	43	
	1 y	Mean estimate	6.3	6.2	.47
		(95% CI)	(6.1 to 6.5)	(6.0 to 6.4)	
		No.	50	43	
	3 y	Mean estimate	6.4	6.5	.57
		(95% CI)	(6.1 to 6.6)	(6.2 to 6.7)	
		No.	46	43	
	5 y	Mean estimate	6.8	6.6	.23
		(95% CI)	(6.5 to 7.2)	(6.3 to 6.9)	
		No.	41	40	
	7 y	Mean estimate	6.8	6.8	.99
		(95% CI)	(6.4 to 7.2)	(6.4 to 7.2)	
		No.	39	39	
	10 y	Mean estimate	6.9	7.0	.64
		(95% CI)	(6.6 to 7.2)	(6.7 to 7.4)	
		No.	41	38	
Glycemic status, No./total (%)	**0.5 y**	T2DM remission[d]	20/50 (40)	22/44 (50)	.41
		No remission	30/50 (60)	22/44 (50)	
	1 y	T2DM remission[d]	22/50 (44)	23/43 (53)	.41
		No remission	28/50 (56)	20/43 (47)	
	3 y	T2DM remission[d]	21/46 (46)	21/42 (50)	.83
		No remission	25/46 (54)	21/42 (50)	
	5 y	T2DM remission[d]	16/41 (39)	21/41 (51)	.37
		No remission	25/41 (61)	20/41 (49)	
	7 y	T2DM remission[d]	12/37 (32)	17/38 (45)	.35
		No remission	25/37 (68)	21/38 (55)	
	10 y	T2DM remission[d]	11/42 (26)	13/39 (33)	.63
		No remission	31/42 (74)	26/39 (67)	

Abbrevations: ANOVA, analysis of variance; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; LSG, laparoscopic sleeve gastrectomy; LRYGB, laparoscopic Roux-en-Y gastric bypass

SI conversion factor: To convert glucose values to mg/dL, divide by 0.0555.

[a] Repeated-measurements ANOVA; logarithmic transformation was used in the analyses, and results are transformed back to original scale. Results are adjusted for center and preoperative use of insulin.

[b] p=.07 for operation x time interaction, p=.42 for main effect of operation and p<.001 for main effect of time

[c] p=.02 for operation x time interaction

[d] The new consensus of American Diabetes Association; a return of HbA1c to <6.5% (<48 mmol/mol) that occurs spontaneously or following an intervention and that persists for at least 3 months in the absence of usual glucose-lowering pharmacotherapy

NS

From: **Long-Term Outcomes of Medical Management vs Bariatric Surgery in Type 2 Diabetes**

JAMA. 2024;331(8):654-664. doi:10.1001/jama.2024.0318

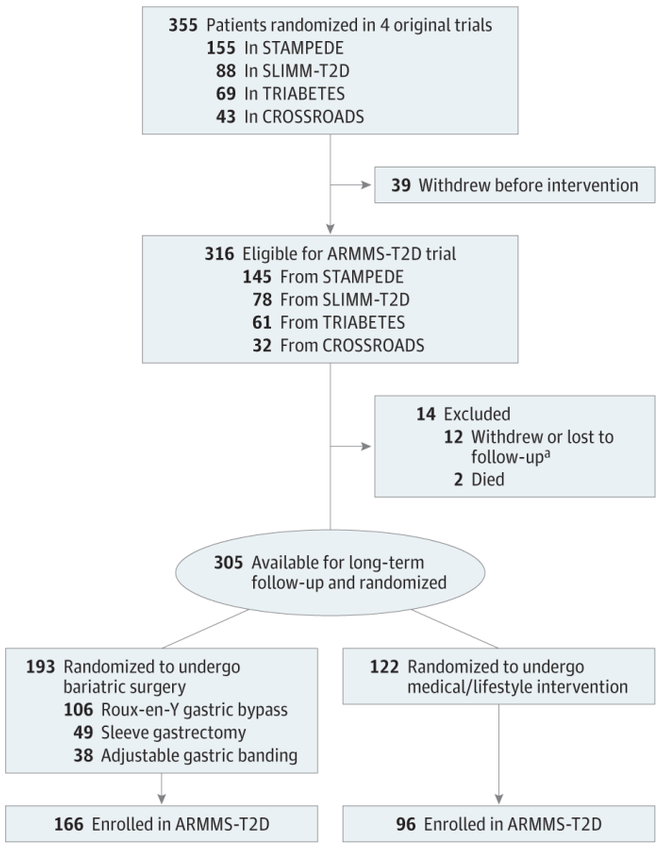
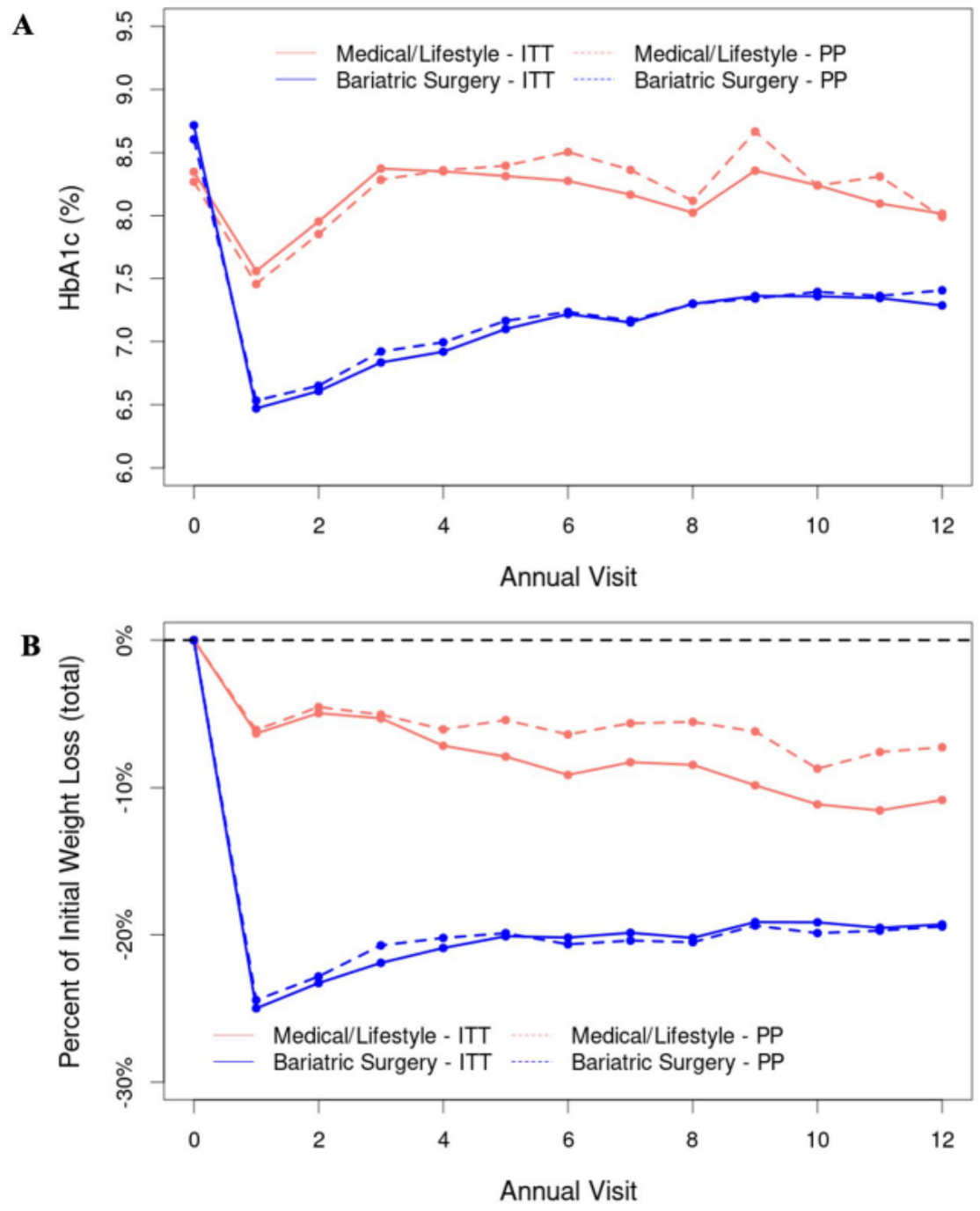


Figure Legend:

Assembly of the Trials in the Alliance of Randomized Trials of Medicine vs Metabolic Surgery in Type 2 Diabetes (ARMMS-T2D)[a]Three participants who were lost to follow-up in the original trials were successfully rerecruited into ARMMS-T2D.[8]

eFigure 2. Comparison of per-protocol analysis and intention-to-treat analysis of HbA_{1c} and weight change. A. HbA_{1c} over time. B. Weight loss over time. The solid lines show the results of intention-to-treat (ITT) analysis, and the dashed lines show the results of the per-protocol (PP) analysis. The per-protocol analysis accounted for the crossovers from medical/lifestyle group to surgery using the inverse probability weighting approach. Least-squared means are plotted over time.



In the ITT analysis, weight loss at year 7 was 8.3% for the medical group and 19.9% for the surgical group, respectively. Using the PP analysis, weight loss at year 7 was 5.6% and 20.4% for the medical and surgical groups, respectively.

NS between Sleeve and Bypass

eTable 3. Frequency of nutritional abnormalities in the bariatric surgery group, individual surgery subgroups, and medical group through 12 years

Nutritional Abnormality	Definition of Abnormality	Study Group	n	N[b]	%	p-value[a]
Anemia	Hemoglobin <11.5 g/dL	**MED**	11	87	12.6%	--
		SURG	35	147	23.8%	0.04
		RYGB	25	78	32.1%	0.003
		SG	8	36	22.2%	0.18
		AGB	2	33	6.1%	0.30
Low Iron	Iron <59 µg/dL or <6.6 µmol/L	**MED**	15	88	17.0%	--
		SURG	48	151	31.8%	0.01
		RYGB	30	81	37.0%	0.003
		SG	10	37	27.0%	0.20
		AGB	8	33	24.2%	0.37
Vitamin B12 deficiency	Vitamin B12 <230 pg/mL	**MED**	8	88	9.1%	--
		SURG	20	151	13.2%	0.34
		RYGB	15	81	18.5%	0.07
		SG	4	37	10.8%	0.77
		AGB	1	33	3.0%	0.26
Vitamin D deficiency	Vitamin D2 (1,25 Dihydroxy) ≤20 ng/mL	**MED**	23	88	26.1%	--
		SURG	35	151	23.2%	0.61
		RYGB	22	81	27.2%	0.88
		SG	2	37	5.4%	0.008
		AGB	11	33	33.3%	0.43
Hypocalcemia	Calcium <8.4 mg/dL	**MED**	0	88	0	--
		SURG	1	151	0.7%	0.44
		RYGB	1	81	1.2%	0.30
		SG	0	37	0	NA
		AGB	0	33	0	NA
Elevated PTH	PTH (intact) > 65 pg/mL	**MED**	29	88	33.0%	--
		SURG	66	151	43.7%	0.10
		RYGB	41	81	50.6%	0.02
		SG	12	37	32.4%	0.95
		AGB	13	33	39.4%	0.51
Hypoalbuminemia	Albumin <3.5 g/dL	**MED**	9	88	10.2%	--
		SURG	23	151	15.2%	0.27
		RYGB	14	81	17.3%	0.18
		SG	5	37	13.5%	0.60
		AGB	4	33	12.1%	0.76
Severe hypoalbuminemia	Albumin <2.8 g/dL	**MED**	1	88	1.1%	--
		SURG	0	151	0	0.19

[a] Compared to the medical/lifestyle group; [b] Number of participants with observed data. Abbreviations: MED, medical/lifestyle group; SURG, Bariatric surgery; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy; AGB, adjustable gastric band

Long term mortality

ORIGINAL ARTICLE

Five-year Longitudinal Cohort Study of Reinterventions After Sleeve Gastrectomy and Roux-en-Y Gastric Bypass

Robert A. Li, MD, Liyan Liu, MS,* David Arterburn, MD,† Karen J. Coleman, PhD,‡*
Anita P. Courcoulas, MD,§ David Fisher, MD,† Sebastien Haneuse, PhD,¶ Eric Johnson, PhD,†
*Mary Kay Theis, MS,† Tae K. Yoon, MS,‡ Heidi Fisher, MD,‡ James R. Fraser, BA,† and Lisa J. Herrington, PhD**

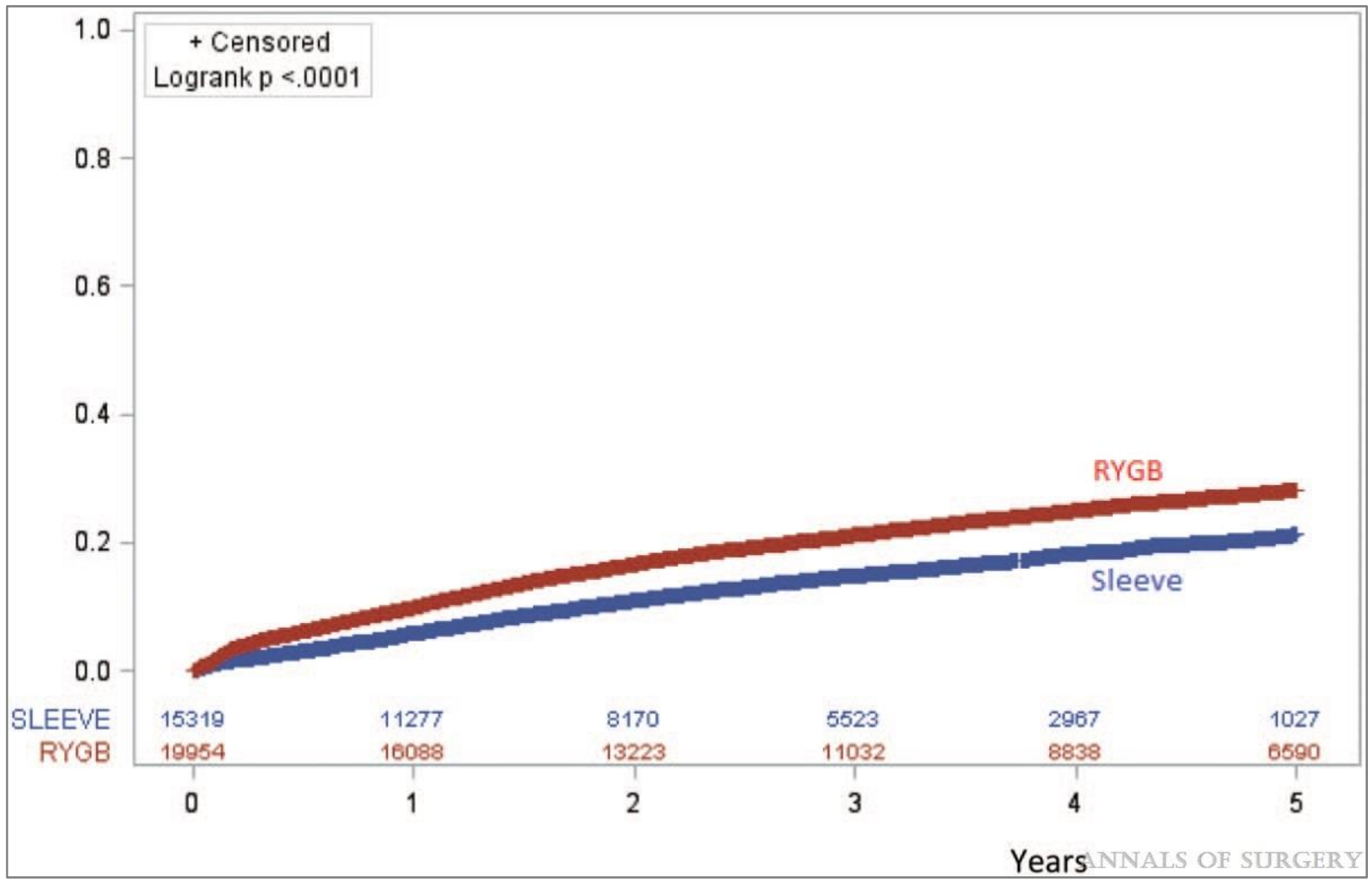
FIGURE 1

[Five-year Longitudinal Cohort Study of Reinterventions After Sleeve Gastrectomy and Roux-en-Y Gastric Bypass]

Li, Robert A.; Liu, Liyan; Arterburn, David; Coleman, Karen J.; Courcoulas, Anita P.; Fisher, David; Haneuse, Sebastien; Johnson, Eric; Theis, Mary Kay; Yoon, Tae K.; Fisher, Heidi; Fraser, James R.; Herrinton, Lisa J.

Annals of Surgery273(4):758-765, April 2021.

doi: 10.1097/SLA.0000000000003401



Kaplan-Meier cumulative probability of any reintervention∗ at 5 years†. ∗Reinterventions, measured from the day of surgery, included total parenteral nutrition, endoscopic intervention, interventional radiology reinterventions, and surgical reinterventions. The surgical reinterventions included diagnostic laparoscopy or exploratory laparotomy, lysis of adhesions/ repair of internal hernia, cholecystectomy, repair of abdominal wall hernia, and other gastrointestinal/abdominal operations (including bariatric reoperative or revisional surgery). †The numbers at the bottom of the graph are the number of individuals still observed at that time point.

TABLE 2. Number and Unadjusted Cumulative Incidence of Reinterventions at 1, 3, and 5 Years: Kaiser Permanente, 2005–2015*

	Year 1		Year 3		Year 5	
	SG	**RYGB**	**SG**	**RYGB**	**SG**	**RYGB**
Number potentially eligible for follow-up at each time point‖	12,576	18,749	7483	16,113	1674	11,650
Complete follow-up, %	95.5%	95.2%	87.1%	86.5%	82.9%	78.7%
Censored at disenrollment, %	4.3%	4.4%	12.3%	12.6%	15.7%	19.4%
Censored on the death date, %	0.1%	0.4%	0.6%	0.9%	1.3%	1.9%
Reintervention**						
Total parenteral nutrition	87 (0.59)	132 (0.68)†	100 (0.72)	190 (1.04)§	101 (0.74)	233 (1.41)
Endoscopy	237 (1.68)	1040 (5.41)	380 (3.24)	1730 (9.73)	441 (4.96)	2153 (13.34)
Interventional radiology reintervention	155 (1.08)	270 (1.41)	257 (2.18)	565 (3.26)	305 (3.57)	757 (4.87)
Surgical reintervention						
Laparoscopy/laparotomy	31 (0.21)	114 (0.60)	75 (0.68)	279 (1.63)	87 (1.02)	380 (2.50)
Lysis adhesions/repair internal hernia	42 (0.31)	121 (0.64)	99 (0.93)	332 (1.95)	129 (1.65)	410 (2.63)
Repair abdominal wall hernia	109 (0.81)	229 (1.23)	286 (2.67)	729 (4.30)	352 (4.36)	896 (5.74)
Cholecystectomy	283 (2.14)	324 (1.73)‡	626 (5.74)	768 (4.49)	710 (7.96)	969 (6.18)
Other gastrointestinal/abdominal	203 (1.44)	489 (2.56)	462 (4.29)	1122 (6.50)	574 (7.37)	1423 (9.08)
Any surgical reintervention	559 (4.13)	946 (5.00)	1260 (11.55)	2304 (13.39)	1453 (16.79)	2829 (17.84)¶
Any reintervention**	809 (5.89)	1885 (9.88)	1654 (14.88)	3725 (21.26)	1892 (21.26)	4550 (28.25)

JAMA Surgery | Original Investigation

Comparative Safety of Sleeve Gastrectomy and Gastric Bypass Up to 5 Years After Surgery in Patients With Severe Obesity

Ryan Howard, MD; Grace F. Chao, MD, MSc; Jie Yang, PhD; Jyothi Thumma, MPH; Karan Chhabra, MD, MSc; David E. Arterburn, MD, MPH; Andrew Ryan, PhD; Dana A. Telem, MD, MPH; Justin B. Dimick, MD, MPH

IMPORTANCE Sleeve gastrectomy is the most widely used bariatric operation; however, its long-term safety is largely unknown.

OBJECTIVE To compare the risk of mortality, complications, reintervention, and health care use 5 years after sleeve gastrectomy and gastric bypass.

DESIGN, SETTING, AND PARTICIPANTS This retrospective cohort study included adult patients in a national Medicare claims database who underwent sleeve gastrectomy or gastric bypass from January 1, 2012, to December 31, 2018. Instrumental variables survival analysis was used to estimate the cumulative incidence of outcomes up to 5 years after surgery.

EXPOSURES Laparoscopic sleeve gastrectomy and laparoscopic Roux-en-Y gastric bypass.

MAIN OUTCOMES AND MEASURES The main outcome was risk of mortality, complications, and reinterventions up to 5 years after surgery. Secondary outcomes were health care use after surgery, including hospitalization, emergency department (ED) use, and total spending.

Invited Commentary
page 1169

Supplemental content

From: **Comparative Safety of Sleeve Gastrectomy and Gastric Bypass Up to 5 Years After Surgery in Patients With Severe Obesity**

JAMA Surg. 2021;156(12):1160-1169. doi:10.1001/jamasurg.2021.4981

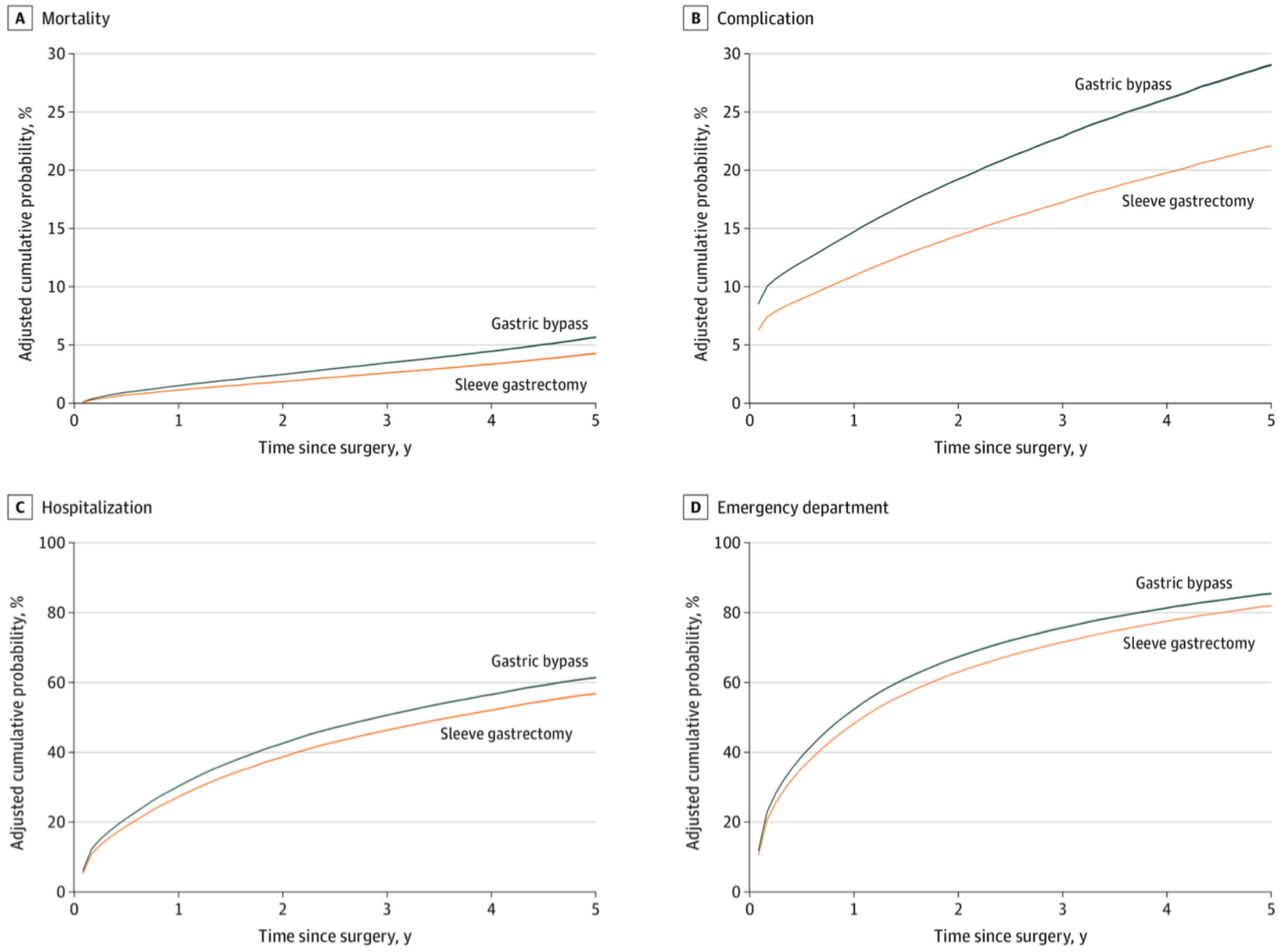
Table Title:

Cohort Characteristics

Table 1. Cohort Characteristics

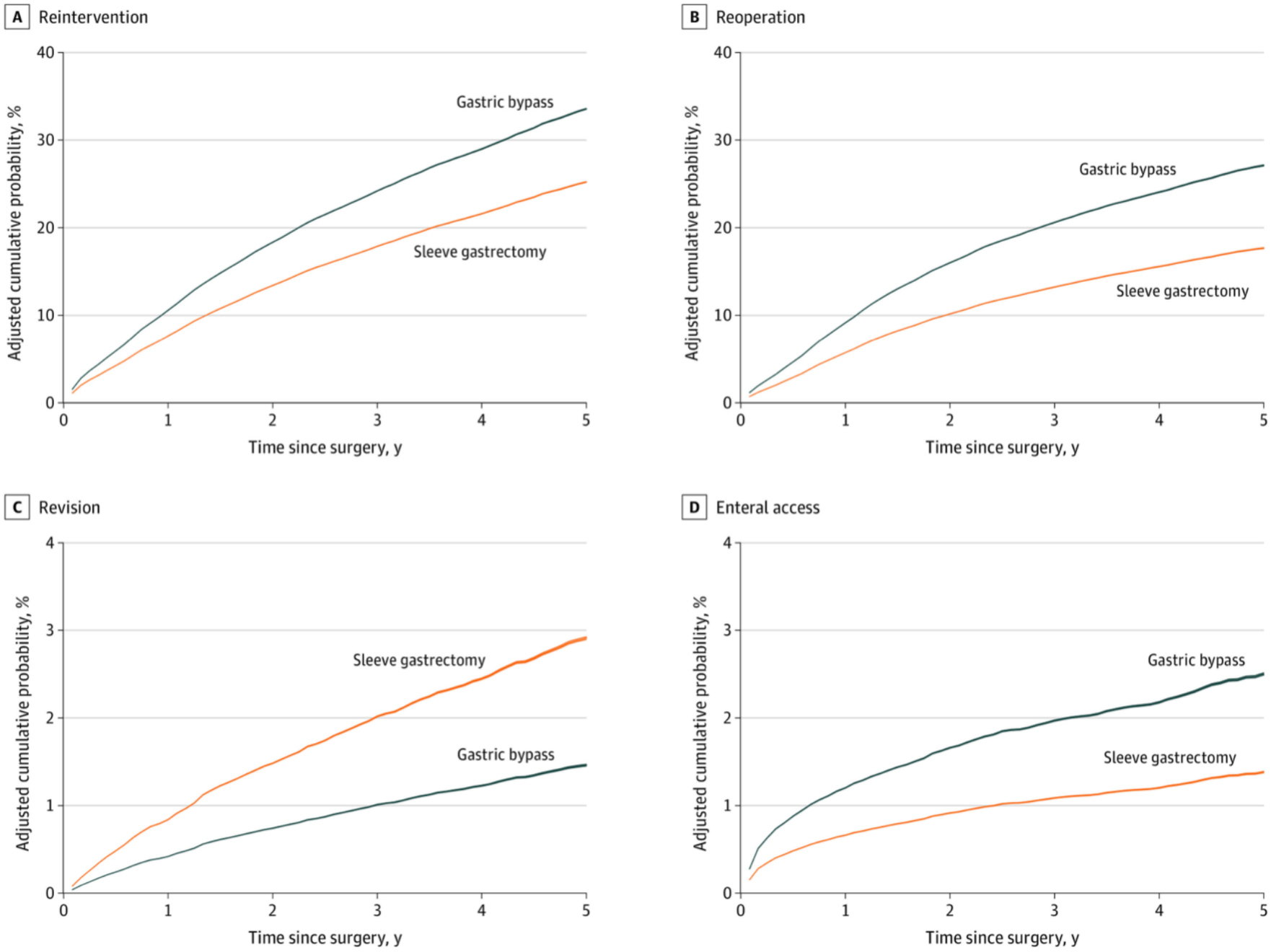
Characteristic	No. (%)	
	Gastric bypass (n = 38 402)	Sleeve gastrectomy (n = 57 003)
Age, mean (SD), y	55.9 (11.7)	57.1 (11.8)
Women	29 050 (75.7)	42 299 (74.2)
Men	9352 (24.4)	14 704 (25.8)
Race		
Asian	109 (0.3)	124 (0.2)
Black	6038 (15.7)	10 101 (17.7)
North American Native	278 (0.7)	314 (0.6)
White	29 986 (78.1)	43 194 (75.8)
Other	373 (1.0)	534 (0.9)
Unknown	404 (1.1)	785 (1.4)
Ethnicity		
Hispanic	1215 (3.2)	1951 (3.4)
Year of operation		
2012	8417 (21.9)	519 (0.9)
2013	6593 (17.2)	6727 (11.8)
2014	5672 (14.8)	8904 (15.6)
2015	5100 (13.3)	10 102 (17.7)
2016	4493 (11.7)	10 407 (18.3)
2017	4267 (11.1)	10 831 (19.0)
2018	3861 (10.1)	9513 (16.7)
Comorbidities		
Hypertension	29 513 (76.9)	43 253 (75.9)
Diabetes without chronic complications	17 094 (44.5)	20 745 (36.4)
Depression	11 562 (30.1)	14 861 (26.1)
Chronic pulmonary disease	10 914 (28.4)	15 062 (26.4)
Hypothyroidism	6895 (18.0)	10 364 (18.2)
Liver disease	5691 (14.8)	7424 (13.0)
Diabetes with chronic complications	4182 (10.9)	5212 (9.1)
Psychoses	3013 (7.9)	3619 (6.4)
Deficiency anemias	2435 (6.3)	3293 (5.8)
Fluid and electrolyte disorders	2395 (6.2)	2923 (5.1)
Congestive heart failure	2338 (6.1)	3736 (6.6)
Kidney failure	2308 (6.0)	3428 (6.0)
Other neurologic disorders	2145 (5.6)	3114 (5.5)
Rheumatoid arthritis/collagen vascular disease	1495 (3.9)	2596 (4.6)
Peripheral vascular disease	698 (1.8)	919 (1.6)
Pulmonary circulation disease	477 (1.2)	409 (0.7)
Valvular disease	683 (1.8)	1113 (2.0)
Coagulopathy	354 (0.9)	497 (0.9)
Weight loss	162 (0.4)	140 (0.3)
Paralysis	195 (0.5)	337 (0.6)
Solid tumor without metastasis	93 (0.2)	162 (0.3)
Chronic blood loss anemia	76 (0.2)	69 (0.1)
Lymphoma	39 (0.1)	76 (0.1)
AIDS	43 (0.1)	85 (0.2)

Figure 1.



Cumulative Incidence of Mortality, Complication, All-Cause Hospitalization, and All-Cause Emergency Department Use Comparing Sleeve Gastrectomy and Gastric Bypass

Figure 2.



Cumulative Incidence of Reintervention, Reoperation, Revision, and Enteral Access Comparing Sleeve Gastrectomy and Gastric Bypass

Ann Surg 277(6): p 979-87. June 2023

ORIGINAL ARTICLE

Comparative Safety of Sleeve Gastrectomy and Gastric Bypass up to 5 Years After Surgery in Patients With Medicaid

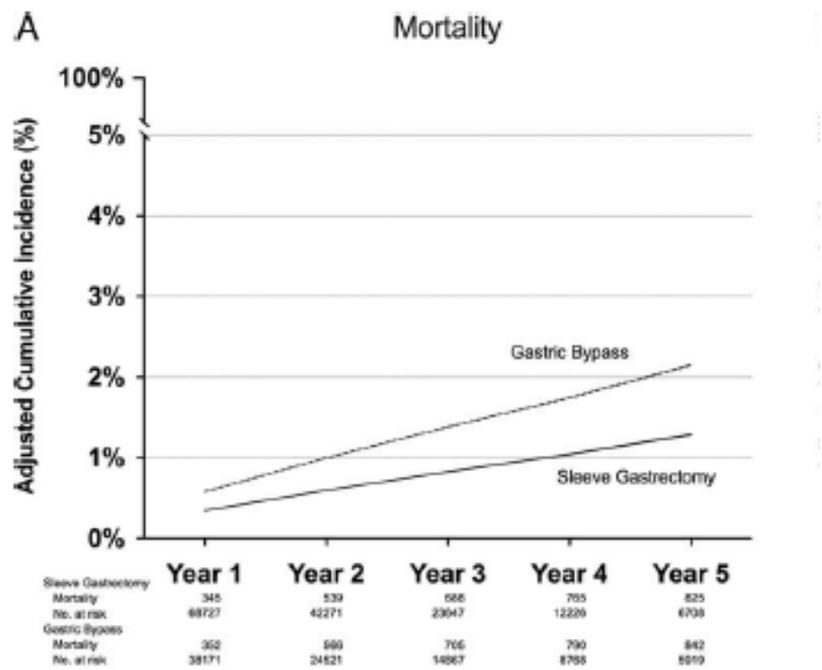
Ryan Howard, MD, MS,†✉ Jie Yang, PhD,† Jyothi Thumma, MPH,†*
Anne Ehlers, MD, MPH,† Sean O'Neill, MD, PhD,*† David Arterburn, MD, MPH,‡*
Andrew Ryan, PhD,†§|| Dana Telem, MD, MPH,†¶*
and Justin B. Dimick, MD, MPH†¶*

- 132,788 patient Medicaid
- 84,717 Sleeve Gastrectomy (64%)
- 48,071 Gastric bypass

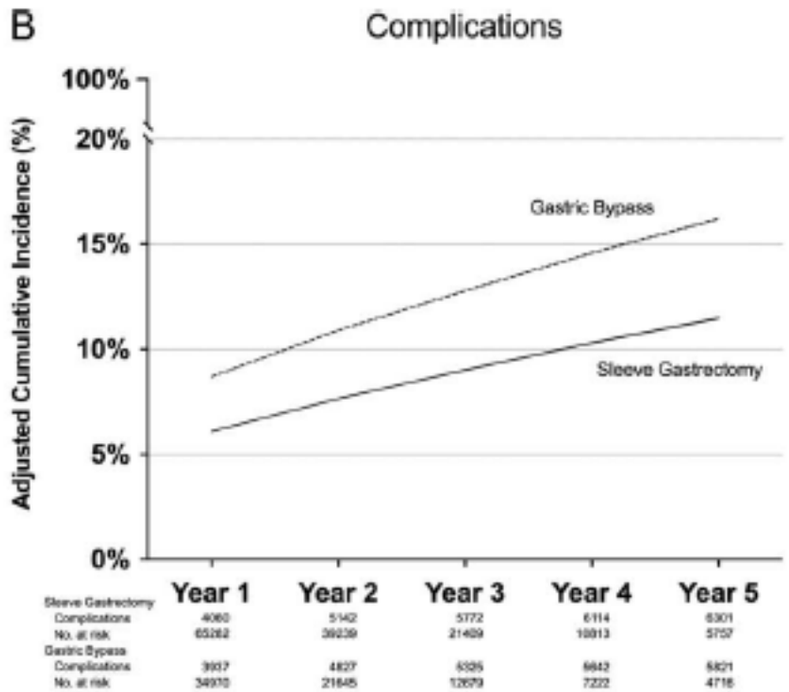
- After 5 years. MORTALITY

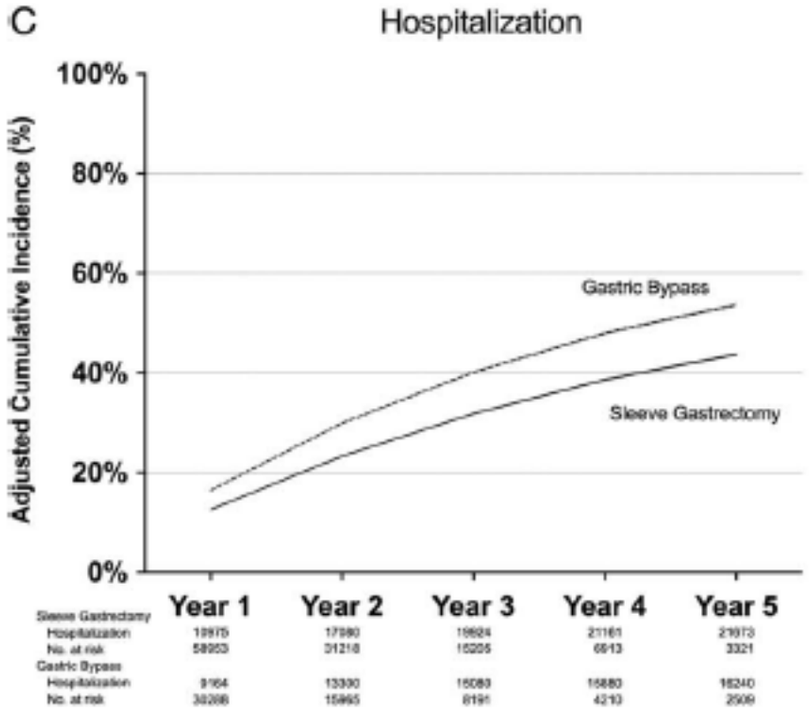
- 1.29% Sleeve
- 2.15% Gastric bypass

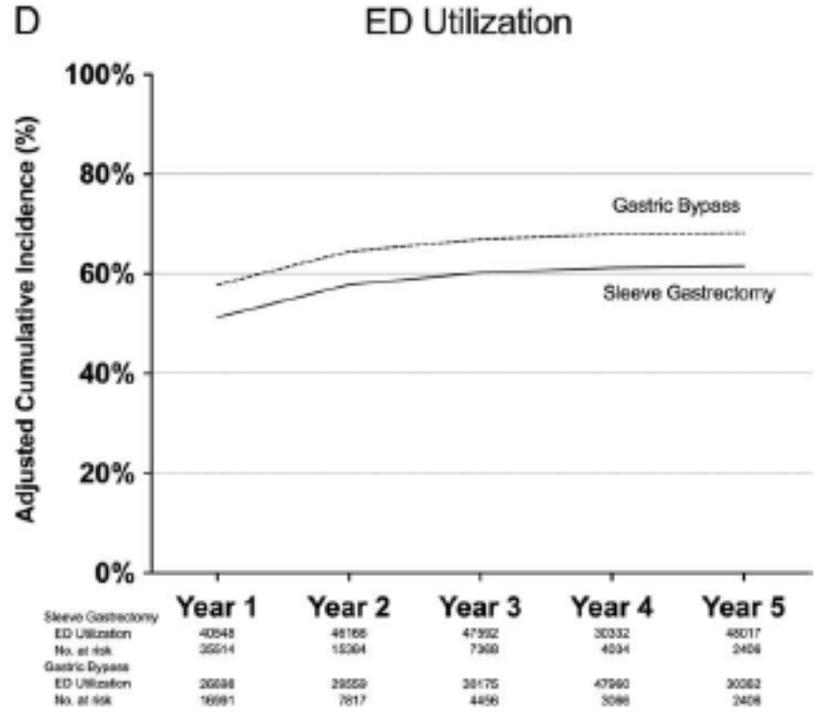
- More complications, reoperations, ED visits, rehospitalizations

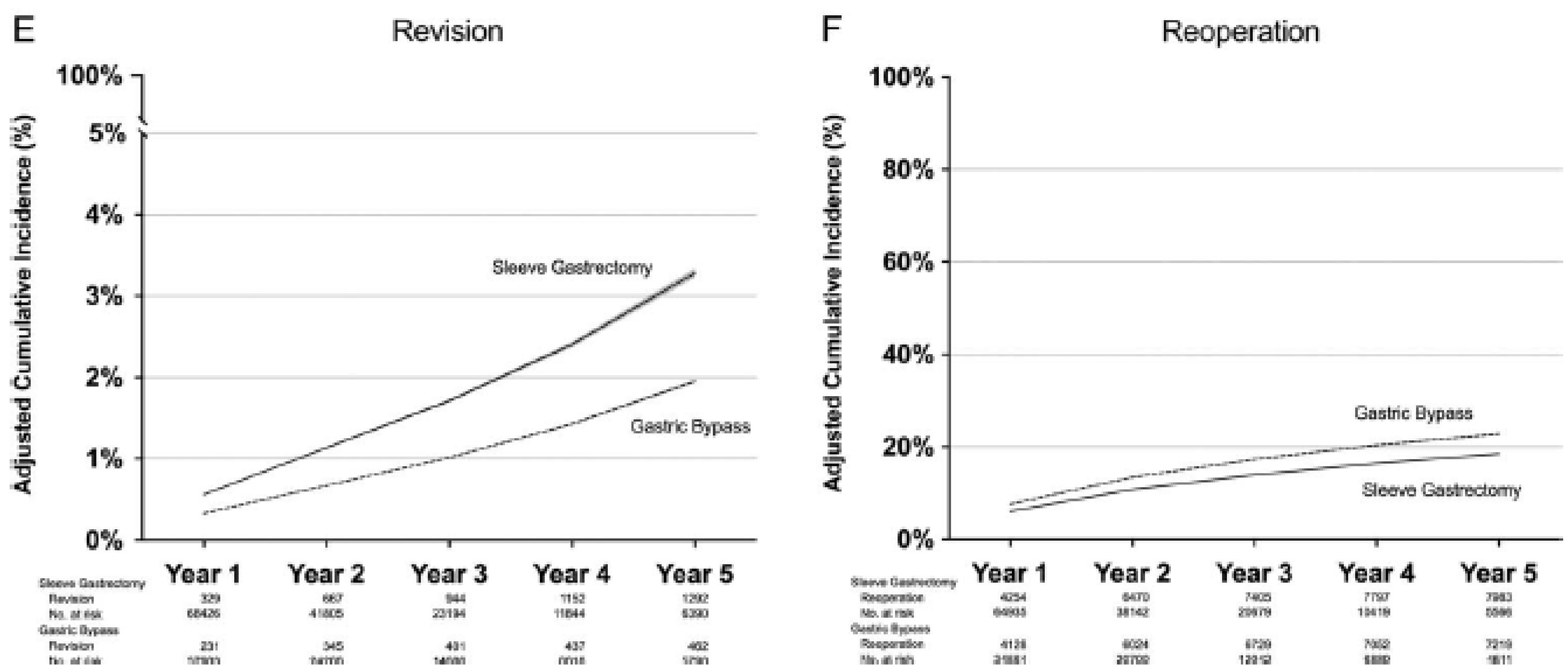

A
Mortality
100%
5%
4%
3%
2%
1%
0%
Adjusted Cumulative Incidence (%)
Gastric Bypass
Sleeve Gastrectomy
Year 1
Year 2
Year 3
Year 4
Year 5
Sleeve Gastrectomy
Mortality 345 539 686 765 825
No. at risk 68727 42271 23047 12229 6708
Gastric Bypass
Mortality 352 499 705 790 842
No. at risk 38171 24521 14867 8768 5019

B


Complications
100%
20%
15%
10%
5%
0%
Adjusted Cumulative Incidence (%)
Gastric Bypass
Sleeve Gastrectomy
Year 1
Year 2
Year 3
Year 4
Year 5
Sleeve Gastrectomy
Complications 4060 5142 5772 6114 6301
No. at risk 65262 39239 21409 10813 5757
Gastric Bypass
Complications 3937 4827 5325 5643 5821
No. at risk 34970 21645 12679 7222 4716


C
Hospitalization
Adjusted Cumulative Incidence (%)
100%
80%
60%
40%
20%
0%
Gastric Bypass
Sleeve Gastrectomy
Year 1
Year 2
Year 3
Year 4
Year 5
Sleeve Gastrectomy
Hospitalization 19975 17980 16624 21161 21973
No. at risk 58953 31218 15205 6513 3321
Gastric Bypass
Hospitalization 9164 13330 15089 15880 16240
No. at risk 30288 15965 8191 4210 2509


D
ED Utilization
Adjusted Cumulative Incidence (%)
100%
80%
60%
40%
20%
0%
Gastric Bypass
Sleeve Gastrectomy
Year 1
Year 2
Year 3
Year 4
Year 5
Sleeve Gastrectomy
ED Utilization 40548 46166 47592 30332 46017
No. at risk 35514 15364 7369 4094 2406
Gastric Bypass
ED Utilization 29698 29559 39175 47990 30362
No. at risk 16991 7817 4456 3086 2408


E
Revision
Adjusted Cumulative Incidence (%)
100%
5%
4%
3%
2%
1%
0%
Sleeve Gastrectomy
Gastric Bypass
Year 1
Year 2
Year 3
Year 4
Year 5
Sleeve Gastrectomy
Revision 329 667 944 1152 1292
No. at risk 68426 41805 23194 11844 6390
Gastric Bypass
Revision 231 345 401 437 462
F
Reoperation
Adjusted Cumulative Incidence (%)
100%
80%
60%
40%
20%
0%
Gastric Bypass
Sleeve Gastrectomy
Year 1
Year 2
Year 3
Year 4
Year 5
Sleeve Gastrectomy
Reoperation 4254 6470 7405 7797 7983
Gastric Bypass
Reoperation 4128 6024 6729 7052 7219

Long-term Survival After Sleeve Gastrectomy Versus Gastric Bypass in a Binational Cohort Study

Dag Holmberg,[1] Giola Santoni,[1] Joonas H. Kauppila,[1,2] Sheraz R. Markar,[1,3] and Jesper Lagergren[1,4]

Diabetes Care 2022;45:1981–1986 | https://doi.org/10.2337/dc22-0485

From: **Long-term Survival After Sleeve Gastrectomy Versus Gastric Bypass in a Binational Cohort Study**

Diabetes Care. 2022;45(9):1981-1986. doi:10.2337/dc22-0485

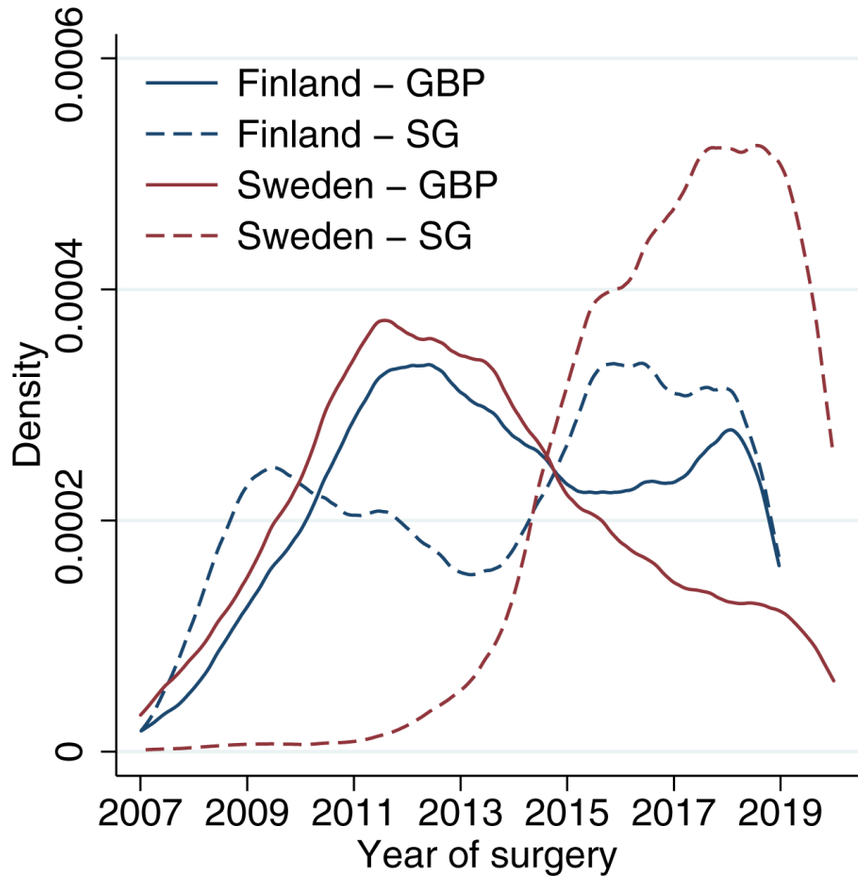


Figure Legend:

Distribution of primary laparoscopic sleeve gastrectomy (SG) and primary laparoscopic gastric bypass (GBP) by country over the study period.

Table 1—Characteristics of 61,503 patients operated on with primary laparoscopic sleeve gastrectomy or primary laparoscopic gastric bypass in 2007–2019 in Sweden or Finland

	Sleeve gastrectomy	Gastric bypass
Total	9,612 (15.6)	51,891 (84.4)
Follow-up, years	3.7 (2.2–5.3)	7.7 (5.0–9.7)
Person-years	38,235 (9.2)	377,477 (90.8)
Sex		
Male	2,276 (23.7)	12,874 (24.8)
Female	7,336 (76.3)	39,017 (75.2)
Age, years	43 (34–51)	42 (34–50)
Obesity-related comorbidities		
Diabetes	1,486 (15.5)	9,117 (17.6)
Hypertension	3,060 (31.8)	17,292 (33.3)
Charlson comorbidity index score*		
0	6,950 (72.3)	36,285 (69.9)
≥1	2,662 (27.7)	15,606 (30.1)
Country		
Sweden	7,928 (82.5)	44,851 (86.4)
Finland	1,684 (17.5)	7,040 (13.6)
Calendar year, median	2017	2013
Mortality		
All-cause	122 (1.3)	1,449 (2.8)
Cardiovascular-specific	43 (0.5)	481 (0.9)
Cancer-specific	35 (0.4)	277 (0.5)

Data are presented as median (interquartile range), as *n* (%), or as indicated otherwise.
*Not including diabetes or hypertension.

Received: 27 July 2022 | Revised: 5 October 2022 | Accepted: 18 October 2022

DOI: 10.1002/oby.23646

Obesity A Research Journal | THE OBESITY SOCIETY | WILEY

ORIGINAL ARTICLE

Epidemiology/Genetics

Long-term all-cause and cause-specific mortality for four bariatric surgery procedures

Ted D. Adams[1,2,3] | Huong Meeks[4] | Alison Fraser[4] | Lance E. Davidson[2,5] | John Holmen[6] | Michael Newman[7] | Anna R. Ibele[8] | Nathan Richards[1] | Steven C. Hunt[2,9] | Jaewhan Kim[10]

Surgical patient records identified from Utah bariatric surgery registries that linked with the Utah Population Database (n=27,032)

Records missing a surgery year (n=245)
Records with surgery dates before 1982 or after 2018 (n=658)
Duplicates with discrepant information (n=82)
Measured BMI<33 or >120 kg/m^2 (n=1)
Age missing or <18 or >80 years (n=187)
Surgery type is missing or not one of the four procedures studied (n=33)

Potentially eligible surgical subjects (n=25,845)

Did not reside in Utah at surgery date (n=3,768)
Stomach cancer prior to surgery (n=15)
Surgical record of a patient who had a previous surgical revision (n=36)

Eligible surgical subjects (n=22,035)

Unable to match with non-surgical subjects (n=198)

Surgical subjects (n=21,837)

Non-surgical Utah Driver License Division records linked with Utah Population Database with history of self-reported BMI and no bariatric surgery (multiple records/subject; n=3,997,223)

Driver license records dated before 1980 or after 2019 (n=1,097,733)
BMI year is missing or age is missing (n=641,198)
Age <18 or >80 years (n=971,827)
Adjusted BMI<33 or >120 kg/m^2 or unadjusted BMI<30 kg/m^2 (n=3,070,197)

Potentially eligible non-surgical subject records with BMI (multiple records/subject; n=777,474)

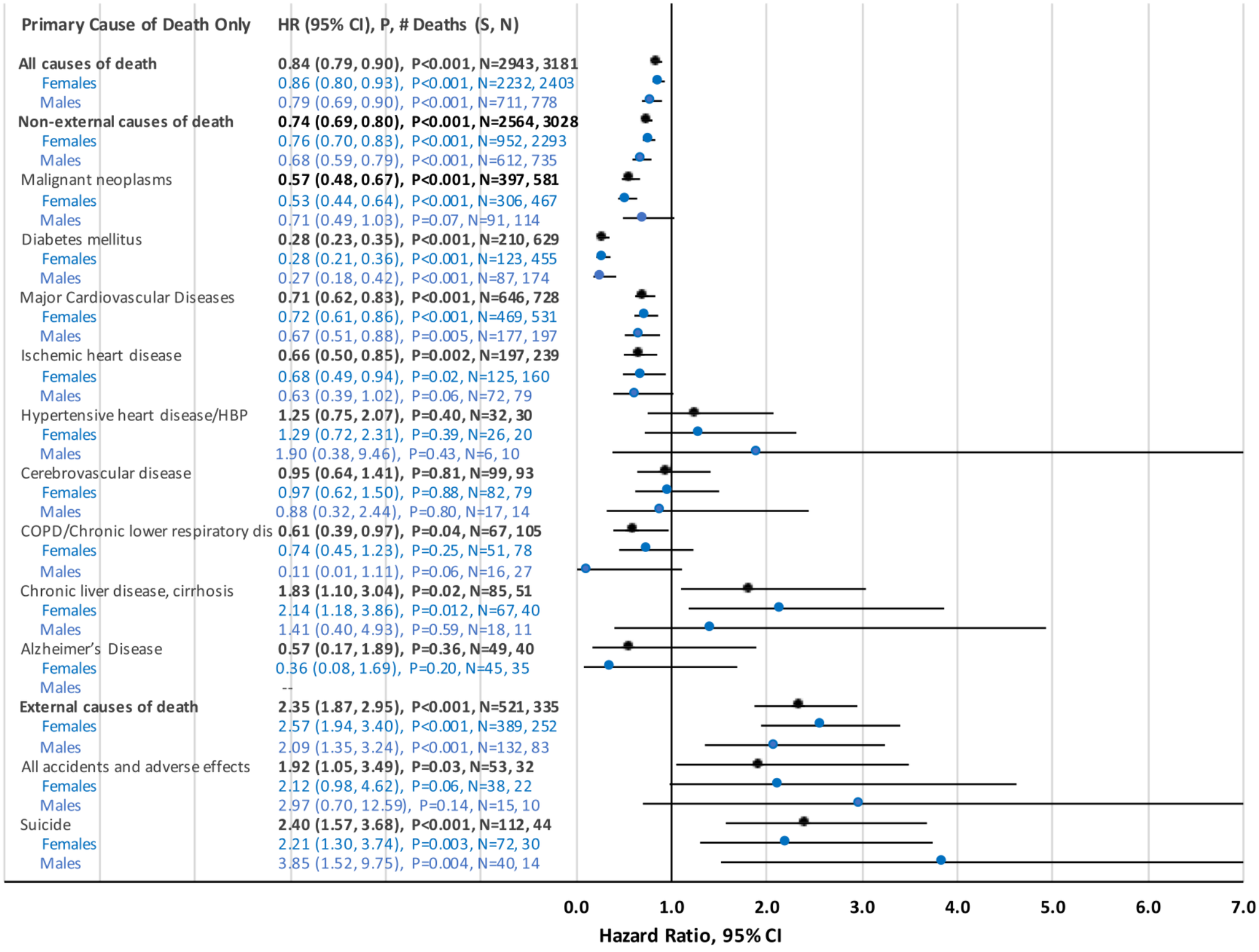
Did not reside in Utah at date of BMI (n=2,102)
Non-surgical subjects cannot be followed after BMI date (n=110,815)

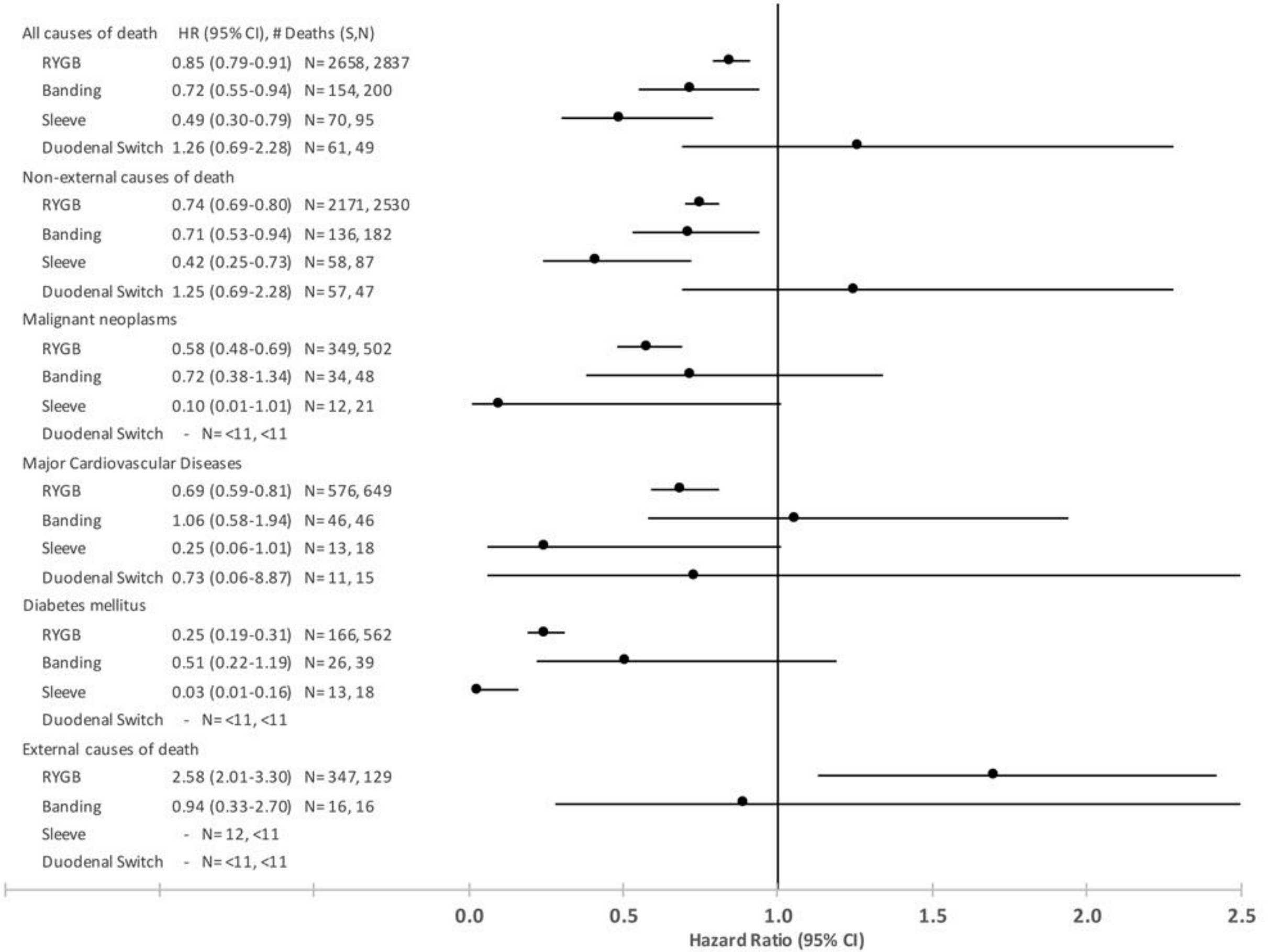
Eligible non-surgical subject records (n=694,909)

Not selected to match with surgical subjects (n=673,072)

Non-surgical subjects (n=21,837)

Primary Cause of Death Only	HR (95% CI), P, # Deaths (S, N)
All causes of death	**0.84 (0.79, 0.90), P<0.001, N=2943, 3181**
Females	0.86 (0.80, 0.93), P<0.001, N=2232, 2403
Males	0.79 (0.69, 0.90), P<0.001, N=711, 778
Non-external causes of death	**0.74 (0.69, 0.80), P<0.001, N=2564, 3028**
Females	0.76 (0.70, 0.83), P<0.001, N=952, 2293
Males	0.68 (0.59, 0.79), P<0.001, N=612, 735
Malignant neoplasms	**0.57 (0.48, 0.67), P<0.001, N=397, 581**
Females	0.53 (0.44, 0.64), P<0.001, N=306, 467
Males	0.71 (0.49, 1.03), P=0.07, N=91, 114
Diabetes mellitus	**0.28 (0.23, 0.35), P<0.001, N=210, 629**
Females	0.28 (0.21, 0.36), P<0.001, N=123, 455
Males	0.27 (0.18, 0.42), P<0.001, N=87, 174
Major Cardiovascular Diseases	**0.71 (0.62, 0.83), P<0.001, N=646, 728**
Females	0.72 (0.61, 0.86), P<0.001, N=469, 531
Males	0.67 (0.51, 0.88), P=0.005, N=177, 197
Ischemic heart disease	**0.66 (0.50, 0.85), P=0.002, N=197, 239**
Females	0.68 (0.49, 0.94), P=0.02, N=125, 160
Males	0.63 (0.39, 1.02), P=0.06, N=72, 79
Hypertensive heart disease/HBP	**1.25 (0.75, 2.07), P=0.40, N=32, 30**
Females	1.29 (0.72, 2.31), P=0.39, N=26, 20
Males	1.90 (0.38, 9.46), P=0.43, N=6, 10
Cerebrovascular disease	**0.95 (0.64, 1.41), P=0.81, N=99, 93**
Females	0.97 (0.62, 1.50), P=0.88, N=82, 79
Males	0.88 (0.32, 2.44), P=0.80, N=17, 14
COPD/Chronic lower respiratory dis	**0.61 (0.39, 0.97), P=0.04, N=67, 105**
Females	0.74 (0.45, 1.23), P=0.25, N=51, 78
Males	0.11 (0.01, 1.11), P=0.06, N=16, 27
Chronic liver disease, cirrhosis	**1.83 (1.10, 3.04), P=0.02, N=85, 51**
Females	2.14 (1.18, 3.86), P=0.012, N=67, 40
Males	1.41 (0.40, 4.93), P=0.59, N=18, 11
Alzheimer's Disease	**0.57 (0.17, 1.89), P=0.36, N=49, 40**
Females	0.36 (0.08, 1.69), P=0.20, N=45, 35
Males	--
External causes of death	**2.35 (1.87, 2.95), P<0.001, N=521, 335**
Females	2.57 (1.94, 3.40), P<0.001, N=389, 252
Males	2.09 (1.35, 3.24), P<0.001, N=132, 83
All accidents and adverse effects	**1.92 (1.05, 3.49), P=0.03, N=53, 32**
Females	2.12 (0.98, 4.62), P=0.06, N=38, 22
Males	2.97 (0.70, 12.59), P=0.14, N=15, 10
Suicide	**2.40 (1.57, 3.68), P<0.001, N=112, 44**
Females	2.21 (1.30, 3.74), P=0.003, N=72, 30
Males	3.85 (1.52, 9.75), P=0.004, N=40, 14




All causes of death HR (95% CI), # Deaths (S,N)
RYGB 0.85 (0.79-0.91) N= 2658, 2837
Banding 0.72 (0.55-0.94) N= 154, 200
Sleeve 0.49 (0.30-0.79) N= 70, 95
Duodenal Switch 1.26 (0.69-2.28) N= 61, 49
Non-external causes of death
RYGB 0.74 (0.69-0.80) N= 2171, 2530
Banding 0.71 (0.53-0.94) N= 136, 182
Sleeve 0.42 (0.25-0.73) N= 58, 87
Duodenal Switch 1.25 (0.69-2.28) N= 57, 47
Malignant neoplasms
RYGB 0.58 (0.48-0.69) N= 349, 502
Banding 0.72 (0.38-1.34) N= 34, 48
Sleeve 0.10 (0.01-1.01) N= 12, 21
Duodenal Switch - N= <11, <11
Major Cardiovascular Diseases
RYGB 0.69 (0.59-0.81) N= 576, 649
Banding 1.06 (0.58-1.94) N= 46, 46
Sleeve 0.25 (0.06-1.01) N= 13, 18
Duodenal Switch 0.73 (0.06-8.87) N= 11, 15
Diabetes mellitus
RYGB 0.25 (0.19-0.31) N= 166, 562
Banding 0.51 (0.22-1.19) N= 26, 39
Sleeve 0.03 (0.01-0.16) N= 13, 18
Duodenal Switch - N= <11, <11
External causes of death
RYGB 2.58 (2.01-3.30) N= 347, 129
Banding 0.94 (0.33-2.70) N= 16, 16
Sleeve - N= 12, <11
Duodenal Switch - N= <11, <11
0.0
0.5
1.0
1.5
2.0
2.5
Hazard Ratio (95% CI)

Summary

Small weight loss differences

Non-significant differences in diabetes resolutions

Long-term mortality is lower with SLEEVE GASTRECTOMY than with gastric bypass

Despite higher revision rates with Sleeve Gastrectomy

Sleeve Gastrectomy can be revised to SADI-S for better weight loss and diabetes resolution