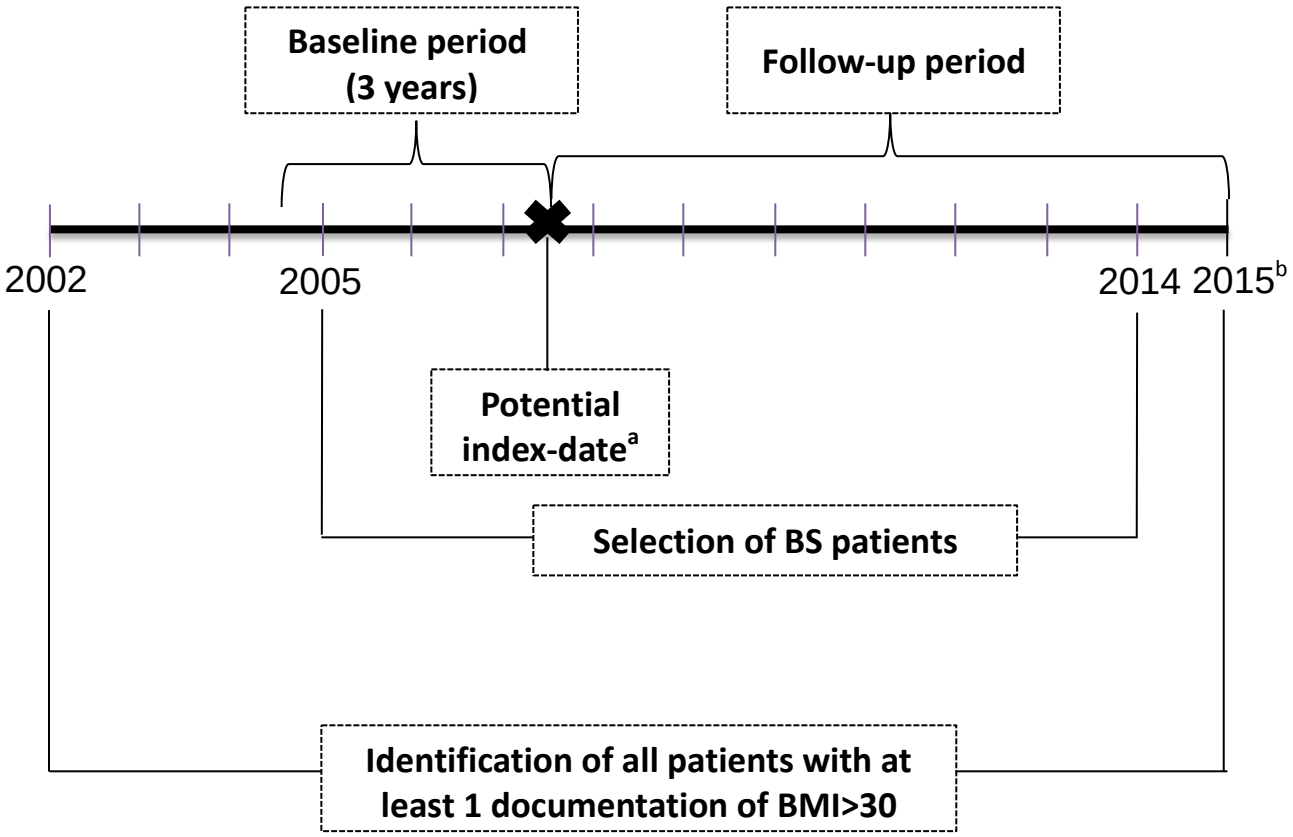
Supplementary Online Content

Reges O, Greenland P, Dicker D, et al. Association of bariatric surgery using laparoscopic banding, Roux-en-Y gastric bypass, or laparoscopic sleeve gastrectomy vs usual care obesity management with all-cause mortality. *JAMA*. doi:10.1001/jama.2017.20513

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

eFigure 1. Study design



Abbreviations: BS, bariatric surgery; BMI, body mass index.

a Patients who underwent bariatric surgery between January 1, 2005 to December 31, 2014 and three non-surgical matched patients, for each surgical patient, were selected for the study population. A specific index-date, equivalent to bariatric surgery date, was defined for each surgical patient and his/her three matches.

b End of follow up period was determined to December 31 2015. Clalit Health Service data warehouse~~DWH~~ was partially missing for the year 2016 at the time of data extraction.

eMethods 1: Clalit Health Services (CHS) population

CHS has maintained a comprehensive healthcare data warehouse (DWH) for well over 15 years, which incorporates both ambulatory and inpatient care, demographic data, diagnosis, clinical measures, laboratory, and imaging values, prescribed and dispensed medications, and vital statistics from the Ministry of the Interior for all the members. Since the late 1990's, all clinical files have been unified, with all primary care physicians utilizing uniform data systems, the contents of which are extracted daily, and numerous fields are housed in databases in the DWH. Given the Israeli identity number system, each member's full data file, containing healthcare information, such as diagnoses, can be identified and linked to other data fields in the DWH. All studies conducted utilizing the data in the DWH must undergo approval by an IRB committee, a patient ombudsman, and a separate CHS data utilization committee charged with assessing the importance of the research. All data when linked for research purposes are de-identified and matching is accomplished by a machine assigned ID number to completely de-identify the data. All laboratory tests are performed within CHS laboratories and the results are recorded using Logical Observation Identifiers Names and Codes (LOINC) coding as well as national coding systems. Additionally, the CHS DWH links to the Ministry of Interior's records of birth and death certificates, and has thus complete vital statistics. Through its billing and payments systems, CHS also receives full information of members' medical procedures performed outside of CHS hospitals. Subsequently, all prescription medication purchases (using ATC coding, inter alia) are also recorded in the data warehouse. Regular checkups, clinical measurements, such as blood pressure, height and weight, smoking status), and various disability parameters are registered and stored, with the coverage monitored using a rigorous health quality indicator system.

Information regarding individual socioeconomic status (SES) is not available by law. Geo code level information is provided by the Central Bureau of Statistics (CBS), based on various factors (e.g. average numbers of persons, cars and computers per household, average household income, years of education, employment levels, etc.). This information is averaged over the clinics, which are further categorized into tertiles (high, medium and low SES clinics). While the geocoded values are not stored historically, and thus cannot be used for retrospective studies, the clinic levels are available, and were utilized in this study.

In 2008 body mass index measurements became a quality measure in patients' electronic health records and, at present, it is available with frequency of measurement mandated by patient age on virtually all patients visiting their health care provider.

eTable 1: ICD-9 codes of medical diagnoses

Diagnosis	ICD-9-CM codes
Bariatric surgery	43.82; 44.31; 44.95; 44.96; 44.97; 44.98; 539.01; 539.09; 539.81; 539.89; 649.2; 649.21; 649.22; 649.23; 649.24; V45.86.
Diabetes	250 and 250.x
Hyperlipidemia	272.0; 272.1; 272.2; 272.4; 272.5; 272.9; 272.0; 272.1; 272.2; 272.4; 272.5; 272.9
Hypertension	401.xx-405.xx;I1.xx-I5.xx
Cardiovascular disease	Any of the following diagnoses/interventions: Acute myocardial infarction : 410.x;411.0;412.x Unstable angina: 411; 411.1; 411.8; 411.81; 411.89; 413.0; 413.1 Stable angina pectoris: 413;413.9 Percutaneous transluminal coronary angioplasty: 36.0x Coronary artery bypass grafting: 36.1x; 36.3x Ischemic heart disease: 414.xx, 429.2 Ischemic stroke: 433.x1, 434.x1, 436, 437.1, 437.9
Lower leg amputation	997.6; 997.60; 997.61; 997.62; 997.69; 84.1; 84.10; 84.11; 84.12; 84.13; 84.14; 84.15; 84.16; 84.17; 84.18; 84.91; V49.71; V49.72; V49.73; V49.74; V49.75; V49.76
Hypoglycemia	251.0;251.1;251.2
Intestinal obstruction	560 (excluding 560.1 and 560.32)
Hernia of abdominal cavity	550-553
Esophageal stricture	530.3
Gastric ulcer	531.0; 531.1; 531.2; 531.3; 531.4; 531.5; 531.6; 531.7; 531.9

eTable 2: ATC codes

Blood glucose lowering drugs	**ATC code**
Biguanides	A10BA
Sulfonamides	A10BB
Combinations of oral blood glucose lowering drugs	A10BD
Thiazolidinediones	A10BG
Dipeptidyl peptidase 4 inhibitors	A10BH
Insulins	A10A
Non-insulin injectable therapy	A10BX07, A10BX10, A10BX04, A10BX14
Cardiovascular system drugs	
Beta blocking agents	C07
Calcium channel blockers	C08
Renin-angiotensin system Agents	C09
Lipid modifying agents	C10

Abbreviations: ATC, Anatomical Therapeutic Chemical.

eTable 3: Valid range of values for lab tests

Laboratory test	Range (	n (%) of improbable laboratory values[a]
Glucose **(mg/dL)**	36-500	0 (0)
HbA1c **(%)**	2.5-20	2 (0)
Total-C **(mg/dL)**	80-1000	9 (0)
HDL-C **(mg/dL)**	10-250	1 (0)
LDL-C **(mg/dL)**	10-300	14 (0)
TG **(mg/dL)**	40-3000	61 (0)

Abbreviations: HbA1c, glycated hemoglobin; Total-C, total cholesterol; HDL-C, high-density lipoprotein; LDL-C, low-density lipoprotein; TG, triglycerides.

SI conversion factors: To convert glucose to mmol/L, multiply values by 0.0555, to convert cholesterol to mmol/L, multiply values by 0.0259, to convert triglyceride values to mmol/L, multiply by 0.0113.

[a] All values exceeding these limits were removed as they were likely erroneous and were imputed instead.

eMethods 2: Multiple imputation process and results for imputing missing data

Missing data were imputed for covariates that were included in the adjusted Stratified Cox proportional hazards regression, using R package *mice* version 2.22 applying chained equations. For multi-valued categorical variables (SES) polynomial logistic regression was used, while for other variables predictive mean matching was employed (Total-C, HDL-C, and TG, LDL-C and smoking-ever). Non-normally distributed continuous variables were log transformed when appropriate (HDL-C and TG). Five imputations were performed using ten iterations. In order to assess the level of departure from missing at random, the distribution of the pre-imputed covariates was compared with that of the imputed variables. Likewise, as a sensitivity analysis, the model coefficients for the pre-imputed data and for the imputed data were compared. Rubin's laws were applied to model the standard errors of the model under imputation. HbA1c levels are tested frequently among patients with diabetes but rarely among patients without diabetes (missing not completely at random). Consequently, missing HbA1c values were not imputed, and "missing" was defined as a separate category for HbA1c level. By multiple imputation, 16.8% missing values were imputed: SES - 0.3% (103), smoking status - 7.4% (2,798), glucose level – 6.3% (2,126), total-C - 6.7% (2,276), LDL-C - 9.3% (3,131), HDL-C - 7.4% (2,512), TG - 6.9% (2,363).

eTable 4 : A comparison between final surgical cohort and those surgical who were excluded

		Included in the study n= 8,385	Excluded from the study n= 1,088
Age			
Years	Mean (SD)	45.6 (11.3)	37.1 (9.5)
	Median (IQR)	46.0 (37.0-54.0)	36.0 (29.0-44.0)
Sex			
Male	n (%)	2,895 (34.5%)	318 (29.2%)
Female	n (%)	5,490 (65.5%)	770 (70.8%)
SES[a,b]			
Low	n (%)	2,209 (26.4%)	424 (39.7%)
Medium	n (%)	3,712 (44.4%)	403 (37.8%)
High	n (%)	2,433 (29.1%)	240 (22.5%)
Population sector[a]			
Jewish	n (%)	6,779 (80.8%)	733 (67.4%)
Non-Jewish	n (%)	1,606 (19.2%)	355 (32.6%)
Immigrant status			
Born in Israel	n (%)	6,322 (75.4%)	928 (85.3%)
Immigrant	n (%)	2,063 (24.6%)	160 (14.7%)
Diabetes			
Diagnosis[c]	n (%)	2,391 (28.5%)	224 (20.6%)
Dyslipidemia			
Diagnosis[c]	n (%)	4,432 (52.9%)	387 (35.6%)
Hypertension			
Diagnosis[c]	n (%)	3,721 (44.4%)	335 (30.8%)
CVD			
CVD Diagnosis[c]	n (%)	990 (11.8%)	62 (5.7%)
Myocardial infarction	n (%)	318 (3.8%)	10 (0.9%)
Unstable angina	n (%)	268 (3.2%)	14 (1.3%)
Angioplasty	n (%)	289 (3.4%)	19 (1.7%)
Coronary artery bypass graft	n (%)	78 (0.9%)	4 (0.4%)
Stable angina	n (%)	289 (3.4%)	15 (1.4%)
Ischemic stroke	n (%)	248 (3.0%)	15 (1.4%)
Body mass index			
>30-35	n (%)	463 (5.5%)	4 (0.4%)
>35-40	n (%)	2,942 (35.1%)	64 (5.9%)
>40-45	n (%)	3,418 (40.8%)	507 (46.6%)

>45-50	n (%)	1,068 (12.7%)	293 (26.9%)
>50	n (%)	494 (5.9%)	220 (20.2%)
	Mean (SD)	41.5 (5.0)	45.8 (5.8)
	Median (IQR)	40.6 (38.5-43.7)	44.6 (41.4-48.7)

Abbreviations: ~~Band, adjustable gastric band; Bypass, Roux-en-Y gastric bypass; Sleeve, sleeve gastrectomy;~~ SD, standard deviation; IQR, interquartile range; SES, socio-economic status; CVD, cardiovascular disease; HbA1c, glycated hemoglobon; Total-C, total cholesterol; HDL-C, high-density lipoprotein; LDL-C, low-density lipoprotein; TG, triglycerides.

SI conversion factors: To convert glucose to mmol/L, multiply values by 0.0555, to convert cholesterol to mmol/L, multiply values by 0.0259, to convert triglyceride values to mmol/L, multiply by 0.0113.

[a] Variable was determined at the clinic level in accordance with the designation of each individual's primary care clinic based on census designations from the Israel Bureau of Statistics.

[b] Data on socio-economic status was missing for 31 of the surgical patients and for 72 of the non-surgical patients (103 in total).

[c] Any time before index-date.

[d] Data on smoking status was missing data for 638 of the surgical patients and for 2,160 of the non-surgical patients (2,798 in total).

[e] Data on HbA1c level was missing for 63 of the surgical patients with diabetes at index date and for 364 of the non-surgical patients with diabetes at index date (427 in total).

[f] Data on glucose level was missing for 73 of the surgical patients and for 2,053 of the non-surgical patients (2,126 in total).

[g] Data on Total-C was missing for 128 of the surgical patients and for 2,148 of the non-surgical patients (2,276 in total).

[h] Data on HDL-C was missing for 164 of the surgical patients and for 2,348 of the non-surgical patients (2,512 in total).

[I] Data on LDL-C was missing for 325 of the surgical patients and for 2,806 of the non-surgical patients (3,131 in total).

[j] Data on TG was missing for 144 of the surgical patients and for 2,219 of the non-surgical patients (2,363 in total).