

Supplementary Online Content

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

eMethods 1. SOS study design and recruitment

Recruitment and matching

After recruitment campaigns in mass media and at primary health care centers, a *matching examination* was completed by 6905 patients. Among 5335 eligible individuals, 2010 choosing surgery formed the surgery group. A contemporaneously matched control group of 2037 individuals receiving customary nonsurgical obesity treatment was created using 18 matching variables. The matching variables were sex, age, weight, height, waist and hip circumferences, systolic blood pressure, serum cholesterol and triglyceride levels, smoking status, diabetes, menopausal status and four psychosocial variables with documented associations with the risk of death [social support, life events, health perception, psychosocial functioning], and two personality traits related to treatment preferences [monotony avoidance, psychastenia] (Karlsson J, Sjöström L & Sullivan M. J Clin Epidemiol, vol 48:817-823, 1995).

Although a surgery patient and his/her usual care treated control started the study on the same calendar day (day of surgery), matching was not performed at an individual level. Instead, a matching algorithm selected controls so that the current mean values of the matching variables in the control group became as similar as possible to the current mean values in the surgery group, according to the method of sequential treatment assignment (Pocock SJ, Simon R. Sequential treatment assignment with balancing for prognostic factors in the controlled clinical trial. Biometrics 1975;31:103-15.) Participants were recruited between September 1, 1987 and January 31, 2001.

Inclusion and exclusion criteria

The surgery and control groups had identical exclusion and inclusion criteria. The inclusion criteria were aged 37 to 60 years and body mass index (BMI) of 38 kg/m² or more for women and 34 kg/m² or more for men before or at the matching examination. These BMI cutoffs were selected because they corresponded to an approximate doubling in mortality risk compared to women and men with normal body weight (Waller HT. Height, weight and mortality. The Norwegian experience. Acta Med Scand Suppl 1984; 679: 1-56.).

The exclusion criteria were established to exclude patients with unacceptable surgical risks. The exclusion criteria were earlier surgery for gastric or duodenal ulcer, earlier bariatric surgery, gastric ulcer during the past 6 months, ongoing malignancy, active malignancy during the past 5 years, myocardial infarction during the past 6 months, bulimic eating pattern, drug or alcohol abuse, psychiatric or cooperative problems contraindicating bariatric surgery, other contraindicating conditions (such as chronic glucocorticoid or anti-inflammatory treatment). Patients with hypertension, diabetes, or lipid disturbances were allowed to participate.

Interventions

In the surgery group, 265 underwent gastric bypass (13.2%), 376 gastric banding (18.7%), and 1369 vertical banded gastroplasty (68.1%). The treating surgeons determined the type of surgery. Due to statistical power reasons, relationship status was analyzed using a combined bariatric surgery group.

Control patients received the customary nonsurgical obesity treatment at their primary health care center. No attempt was made to standardize this treatment, which ranged from sophisticated lifestyle intervention and behavior modification to no treatment.

Follow up

The matching and baseline examinations as well as all later follow-up examinations were performed at 480 primary health care centers and 25 surgical departments in Sweden. Baseline examinations were performed on average four weeks before inclusion. Both study groups had identical follow-up with physical examinations and questionnaires at baseline and after 0.5, 1, 2, 3, 4, 6, 8, 10, 15 and 20 years. Centralized biochemistry was performed at baseline and after 2, 10, 15 and 20 years.

Outcomes

The primary outcome of the Swedish Obese Subjects study, overall mortality, was published in 2007 (Sjöström L, Narbro K, Sjöström CD *et al.* Effects of bariatric surgery on mortality in Swedish Obese Subjects. *New Engl J Med* 2007; 357: 741–52). Power calculations for the SOS study was based on the primary outcome. Several secondary aims, related to the effects of

bariatric surgery on diabetes and other morbidities, risk factors, health-related quality of life and health economics, were also defined. However, relationship status was not a pre-specified endpoint in the SOS study.

eMethods 2. SOReg study design and matching

Description of cohort

The Scandinavian Obesity Surgery Registry (SOReg) was initiated in 2004. Initial and current funding are from different government bodies. After several pilot studies, the current registry was launched in 2007. All (~40 units), public and private bariatric surgery centers in Sweden enter data into the registry as part of clinical practice. A core set of questions in the registry are mandatory with a completion rate of close to 100%. Data are entered at base-line approximately one month before surgery, on the surgery day, and at follow-up visits at 6 weeks, 1, 2 and 5 years. Different types of audits have shown that more than 98% of the data in the registry is accurate. (Hedenbro, J; Näslund, E; Boman, L; et al. Formation of the Scandinavian Obesity Surgery Registry, SOReg. *Obes Surg* 2015; 25: 1893-1900). Surgical clinics reporting to SOReg essentially follow the NIH guidelines of eligibility for bariatric surgery (Gastrointestinal Surgery for Severe Obesity. NIH Consensus Statement 1991 Mar 25-27;9(1):1-20.)

To each surgery patient, up to 10 controls from the general population in Sweden were matched on sex, birth year, and place of residence (parish). The 1:10 ration was selected since it gives a good balance between precision and availability of controls which can be matched.

Inclusion and exclusion criteria

In the current study, we included bariatric surgery performed between 2007 and 2012 and we retrieved all patient available at the time of register-linkage. We restricted the cohort to participants above 18 years of age. In our SOReg linkage, 97,4% of all surgery was performed with a gastric bypass procedure. To make the intervention for the SOReg cohort more homogeneous, we restricted our study to patients undergoing gastric bypass surgery.

Follow up

The SOReg cohort and the general population controls were linked to the Total Population Registry in Sweden which provides up-to-date coverage of the Swedish population. Information

on demographic changes such as marriage and divorce are entered into the registry with the type and date of the event.

Results from SOReg have been published in several studies (e.g. Sundbom M, Hedberg J, Marsk R, et al. Scandinavian Obesity Surgery Registry study group: Substantial decreases in comorbidity 5 years after gastric bypass. A population study from the Scandinavian Obesity Surgery Registry. *Ann Surg* 2017 Jun;265(6):1166-1171).

Outcomes

The outcomes for the SOReg cohort and the general population controls were legal marriage and legal divorce. We excluded information on registered partnerships which is a legal union for two individuals of the same sex.

eTable 1. Multivariate Analysis of Relationship Status in the SOS Study and the SOReg/General Population Cohort.

	Marriage/new relationship		Marriage		Divorce/separation		Divorce	
	SOS (n=993)		SOReg/Gen. pop (n=174055)		SOS (n=2859)		SOReg/Gen. pop. (n=138927)	
	HR 95%CI	p-value	HR 95%CI	p-value	HR 95%CI	p-value	HR 95%CI	p-value
Surgery (Y/N)	2.03 (1.52-2.71)	<.001	1.35 (1.28-1.42)	<.001	1.28 (1.03-1.60)	.03	1.41 (1.33-1.49)	<.001
Age (years, per 5 years)	0.69 (0.61-0.77)	<.001	0.86 (0.85-0.87)	<.001	0.67 (0.60-0.76)	<.001	0.83 (0.82-0.85)	<.001
Sex	1.20 (0.90-1.61)	.21	0.98 (0.94-1.01)	.19	1.09 (0.86-1.37)	.49	1.05 (1.00-1.10)	.07
BMI	0.88 (0.75-1.03)	.10	N.A.		0.94 (0.83-1.07)	.37	N.A.	
High school	0.94 (0.68-1.32)	.73	1.28 (1.22-1.35)	<.001	0.83 (0.63-1.09)	.17	0.79 (0.75-0.83)	<.001
University	1.39 (0.98-1.99)	.07	1.85 (1.76-1.94)	<.001	0.95 (0.71-1.27)	.75	0.62 (0.58-0.66)	<.001
Previous divorce/separation (Y/N)	2.02 (1.47-2.77)	<.001	1.34 (1.28-1.40)	<.001	1.50 (1.15-1.96)	.003	1.73 (1.62-1.84)	<.001
Time in relationship /marriage (per 5 years)	n.a.		n.a.		0.85 (0.78-0.93)	<.001	0.84 (0.83-0.86)	<.001
Poor family relations	n.a.		n.a.		2.56 (2.02-3.25)	<.001	N.A.	
Psychotropic medications	1.29 (0.94-1.77)	.11	0.90 (0.87-0.94)	<.001	1.14 (0.84-1.56)	.40	1.58 (1.51-1.65)	<.001
Substance abuse	0.90 (0.43-1.89)	.78	0.83 (0.76-0.90)	<.001	1.24 (0.57-2.70)	.59	1.71 (1.54-1.91)	<.001

N.A., Not available, n.a., not applicable, Gen. pop., General population

eTable 2. Multivariate Analysis of Relationship Status in the SOS Study Surgery Group and the SOReg Cohort.

	Marriage/new relationship		Marriage		Divorce/separation		Divorce	
	SOS (n=425)		SOReg (n=13922)		SOS (n=1290)		SOReg (n=10923)	
	HR 95%CI	p-value	HR 95%CI	p-value	HR 95%CI	p-value	HR 95%CI	p-value
Above median* 1 year weight-loss	1.98 (1.33 – 2.93)	<.001	1.17 (1.04 – 1.32)	.008	1.31 (0.96 – 1.77)	.08	1.26 (1.09 – 1.44)	.001
Age (years, per 5 years)	0.68 (0.57 – 0.80)	<.001	0.85 (0.82 – 0.87)	<.001	0.68 (0.58 – 0.81)	<.001	0.78 (0.74 – 0.82)	<.001
Sex	1.80 (1.19 – 2.72)	.005	0.75 (0.65 – 0.88)	<.001	1.18 (0.85 – 1.65)	.33	0.92 (0.76 – 1.11)	.39
BMI	0.95 (0.76 – 1.17)	.61	N.A.		0.94 (0.79 – 1.13)	.94	N.A.	
High school	1.55 (1.00 – 2.42)	.05	1.37 (1.17 – 1.61)	<.001	0.83 (0.56 – 1.24)	.37	0.83 (0.69 – 1.00)	.049
University	2.09 (1.12 – 3.61)	.008	1.38 (1.13 – 1.62)	.002	0.82 (0.51 – 1.32)	.41	0.82 (0.66 – 1.01)	.064
Previous divorce/separation (Y/N)	1.80 (1.15 – 2.82)	.01	1.37 (1.18 – 1.59)	<.001	1.17 (0.79 – 1.72)	.43	1.75 (1.45 – 2.12)	<.001
Time in relationship /marriage (per 5 years)	n.a.		n.a.		0.81 (0.72 – 0.91)	<.001	0.83 (0.78 – 0.88)	<.001
Poor family relations	n.a.		n.a.		2.14 (1.51 – 3.05)	<.001	N.A.	
Psychotropic medications	1.81 (1.16 – 2.81)	.009	0.91 (0.81 – 1.03)	.12	1.31 (0.86 – 2.00)	.21	1.27 (1.10 – 1.45)	<.001
Substance abuse	0.54 (0.13 – 2.25)	.40	0.89 (0.68 – 1.17)	.39	1.15 (0.36 – 3.69)	.82	1.78 (1.32 – 2.41)	<.001

N.A., Not available, n.a., not applicable. * median 1 year weight-loss: SOS not in a relationship at baseline 25.0%, SOS in a relationship at baseline 24.7%, SOReg married at baseline 31.4%, SOReg unmarried at baseline 31.8%.