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Metabolic surgery and oral health: A register-based study

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Abstract

Objective: The impact of weight loss surgery on oral health is not clear. The aim of the present study was to investigate its impact on the risk for dental interventions.

Materials and Methods: All adults who underwent metabolic surgery in Sweden between January 1, 2009 and December 31, 2018 were identified in the Scandinavian Obesity Surgery Registry (SOReg; $n = 53{,}643$). A control cohort from the general population was created, matched 10:1 on sex, age and place of residence ($n = 536{,}430$). All individuals were followed in the Swedish Dental Register regarding event rates for four types of dental intervention: restorative, endodontic and periodontal interventions, and tooth extractions.

Results: The surgical cohort had increased interventional rates postoperatively regarding all studied outcomes except periodontal interventions. Dental interventions were more common in the surgical cohort both pre- and postoperatively. The difference between the groups increased markedly in the postoperative period. The between-group comparison postoperatively showed increased event rates for restorations (IRR 1.8; 95% CI 1.7–1.8), extractions (1.9; 95% CI 1.9–2.0) and endodontics (2.1; 95% CI 2.0–2.1).

Conclusion: The surgical intervention might cause a substantial negative impact on oral health. These results imply an important role for counselling metabolic surgery patients regarding preventive oral health measures.

KEYWORDS
caries, clinical outcomes, eating behavior(s), obesity, oral diagnosis, surgery

1 | INTRODUCTION

Obesity is defined as a Body Mass Index (BMI) equal to or larger than 30 kg/m^2. Obesity is a worldwide health issue increasing in prevalence. It has been estimated that 12% of adults and 5% of children in the world are obese and that these numbers are increasing (GBDO Collaborators et al., 2017). Obesity has severe health effects with economic consequences (Tremmel et al., 2017). Type 2 diabetes (T2D), hyperlipidemia, hypertension, coronary heart disease, obstructive sleep apnea, stroke, and depression as well as many types of cancer are some of the conditions that are associated with overweight and obesity (Kissler & Settmacher, 2013; Kyrgiou et al., 2017).

Patients with a BMI above 35 kg/m^2 are candidates for metabolic surgery where the size of the stomach is reduced, restricting food intake per meal, and thus requiring more frequent eating. A gastric bypass operation (GBP) involves creating a small gastric pouch in the proximal part of the stomach. To that pouch an anastomosis is created to a segment of the small bowel so that a major part of the stomach is bypassed. Another anastomosis is created between small bowel segments to restore gastrointestinal continuity. A sleeve resection (SG) involves removing a major part of the stomach's major curvature creating a long narrow tube. Both procedures alter the levels of gut hormones and restricts the amount of food that can be consumed at a given time (Gu et al., 2021; Yang et al., 2018).

Metabolic surgery has a significant long-standing effect on weight, and results in improvement of most comorbid diseases associated with obesity (Shoar & Saber, 2017) and in an overall higher quality of life (Nielsen et al., 2022). However, the effect on oral health is less well studied. It is recognized that patients referred for metabolic surgery have poor eating habits with high sucrose intake and a high risk of caries and dental erosion already before surgery (Bastos et al., 2018). Metabolic surgery entails dietary changes into 6–8 small meals daily, and in particular sleeve resection may cause increased gastroesophageal reflux. This may affect oral health in a negative way. A questionnaire study in postmetabolic surgery patients revealed low OHQoL (Oral health related quality of life) in a large part of the respondents (Taghat et al., 2020). With metabolic surgery becoming more frequent in the population it is of interest to study the effects on oral health.

The aim of the present study was to investigate the impact of metabolic surgery on the risk for dental interventions.

2 | MATERIALS AND METHODS

This longitudinal observational cohort study was conducted using a register linkage between the Scandinavian Obesity Surgery Register (SOReg), the Swedish Dental Health Register and the Swedish Population Register, using the unique personal identity number assigned to every Swedish resident. The study was approved by the regional ethical committee in Stockholm (Dnr: 2017/857-32 and amendment 2017/2505-32) and conducted according to the Declaration of Helsinki. The linking of databases was approved and performed by the National Board of Health and Welfare. The study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement guidelines (von Elm et al., 2014).

2.1 | Data sources

The Scandinavian Obesity Surgery Register is a nationwide registry for metabolic surgery containing nearly all patients (99%) having metabolic surgery in Sweden since 2007. SOREG contains data on type of surgical procedure and weight development during the first five postoperative years, as well as data on surgical complications and certain comorbidities (SOReg, 2022).

The Swedish Longitudinal Integrated Database for Health Insurance and Labour Market Studies (LISA, Statistics Sweden) contains data on all Swedish citizens regarding birth year, sex, residential area, educational level, and income (Ludvigsson et al., 2019).

The Dental Health Register (DHR) was established in July 2008 and contains information regarding all dental diagnoses and all procedures approved by the Swedish Social Insurance Agency covered by state dental care support. Both municipal and private dental care are included. About 55% of the population aged 24 years and older visit dental clinics on a yearly basis (de Munter & Toorell, 2021). The DHR records clinical and administrative data, including number of teeth, diagnoses, dental procedures and visit dates; however, only diagnoses that are subject to an intervention or treatment during a dental visit are recorded (Ljung et al., 2019).

2.2 | Study population

All individuals in SOReg having metabolic surgery with either gastric bypass or sleeve gastrectomy between January 1, 2009 and December 31, 2018 were included. A reference cohort from the general population matched for age, gender, and county of residence at the time of case patient exposure, that is, metabolic surgery (matching ratio 1:10) was selected by Statistics Sweden, and socioeconomic data was retrieved for both cohorts from the Swedish Longitudinal Integrated Database for Health Insurance and Labour Market Studies. Linkage to the Dental Health Register was performed by the National Board of Health and Welfare. Pseudonymized data were delivered to the research group. The index date was defined as the date of the surgery, and the corresponding date was assigned as index date to the matched individuals in the reference cohort.

2.3 | Exposure

Main exposure was metabolic surgery.

2.4 | Outcome

The primary outcomes were as follows: Tooth extractions (intervention codes 401–406, 409), restorative interventions (intervention codes 701–707), endodontic interventions (intervention codes 501–522) and periodontal interventions (diagnostic codes 3043 or 3044, periodontitis, in combination with intervention codes 301–343, 451–454).

2.5 | Follow-up

All individuals were followed in the DHR from January 1, 2009 until December 31, 2018. Only complete follow-up years were used in the analyses.

2.6 | Covariates

The trend of event rates of dental outcomes was included as covariate in the model when comparing within each group. The baseline education level, marital status, income, number of teeth and dental visit rate for 2 years before the index date were included as covariates in the between-group comparisons.

2.7 | Statistics

Data are presented as mean with standard deviation, median with interquartile range or in categories as appropriate. Pearson's chi-squared test was used for comparing categorical variables. Two sample *t*-test was used for comparing normally distributed continuous variables and the Mann–Whitney *U*-test was used for comparing skewed distributed continuous variables.

The average yearly event rate of tooth extractions, direct restorations, periodontal and endodontic interventions were calculated and plotted as graphs. For each year, the event rates were calculated by the total number of events divided by the total number of subjects with entries in the Dental Health Register that year.

Poisson regressions were applied for estimating the effects of surgery on the event rates of dental outcomes. The effects of surgery were estimated in two ways. First, yearly event rates before surgery were compared with those after surgery, presented as incidence rate ratios (IRR) with 95% confidence interval (CI), in the surgical group and control group separately; Second, the yearly event rates in the surgical group were compared with the control group, by estimating the IRR with 95% CI, both before and after surgery, separately. The trend of event rates before index date, baseline education level, marital status, dispensable income, number of teeth and the two year dental visit rate before the index date were included as covariates in the between-group comparisons.

All the analyses were performed in Stata MP 17.1. We set the significance level at 0.05.

3 | RESULTS

A Consort diagram of the analytical sample is shown in Figure 1. The study population included all individuals exposed to metabolic surgery between January 1, 2009 and December 31, 2018 (n = 58,150) and their matched controls (n = 581,500). Only adults over 20 years old were included. When a surgical case was excluded, all matched controls were excluded.

The final analytical sample consisted of 53,643 individuals who had metabolic surgery (GBP: n = 47,708, sleeve resection: n = 6884) and 536,430 controls. Follow-up time preoperatively was on average 3.5 ± 2.1 years and postoperatively 4.0 ± 2.3 years for both cohorts.

Population characteristics are presented in Table 1. The groups were well balanced regarding age and sex. The mean age at surgery was 41.0 ± 11.0 years, and 76% were women. The surgical cohort had a significantly lower level of education, lower income and fewer remaining teeth compared to the control cohort.

The surgical cohort had a preoperative mean BMI of 41.8 ± 5.5 kg/m^2. During the first two postoperative years a significant weight loss was observed, and the mean BMI after 2 years was 28.5 ± 4.7 kg/m^2 (p < 0.05). No weight data was available in the control cohort.

3.1 | Dental outcomes

Dental visit rates of the two cohorts are presented in Figure 2a. Visit rates were slightly higher in the surgical cohort preoperatively (IRR 1.05; 95% CI 1.04–1.06). The visit rates increased in the surgical cohort from postoperative year one and onwards, and the postoperative IRR between groups was 1.23 (95% CI 1.22–1.24), see Table 2.

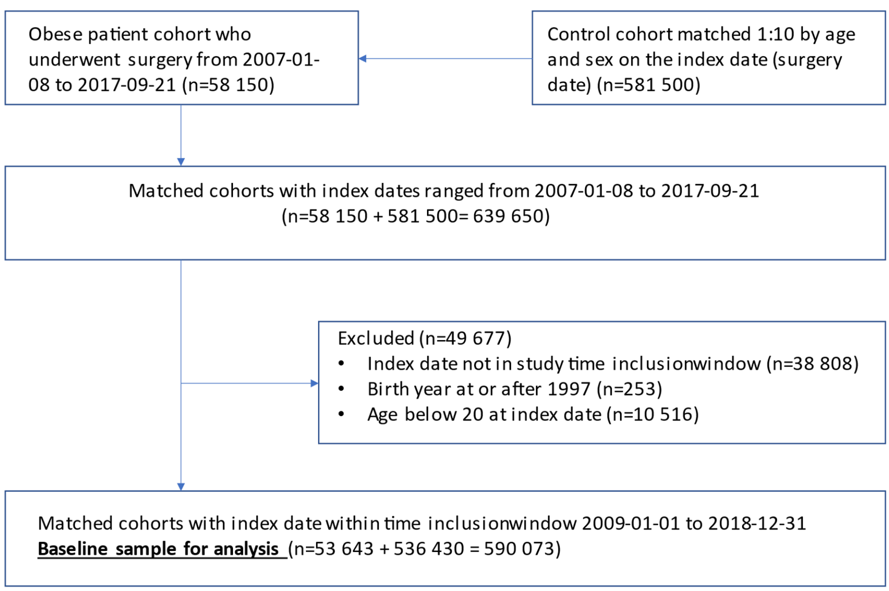

FIGURE 1 Consort diagram of the creation of the two cohorts.

TABLE 1 Baseline characteristics of the studied populations.

Sample characteristics[a]	Surgery cohort (*n* = 53,643)	Reference cohort (*N* = 536,430)
Age at baseline, mean ± SD	41.32 ± 10.89	41.32 ± 10.89
Sex		
Female	40,995 (76.4%)	409,950 (76.4%)
Male	12,648 (23.6%)	126,480 (23.6%)
Education*		
<9 years	8737 (16.3%)	59,646 (11.1%)
10–12 years	31,930 (59.5%)	237,164 (44.2%)
>12 years	12,737 (23.7%)	231,357 (43.1%)
Missing	239 (0.4%)	8263 (1.5%)
Marital status*		
Married/partner	23,402 (43.6%)	237,551 (44.3%)
Single	21,486 (40.1%)	228,498 (42.6%)
Divorced/widow	8755 (16.3%)	70,137 (13.1%)
Missing	0 (0.0%)	244 (<1%)
Household income*, kSEK, median (IQR)[b]	3666 (2261 to 5228)	4027 (2348 to 5845)
Number of teeth*		
0–10	529 (1.0%)	3190 (0.6%)
11–20	1565 (2.9%)	9435 (1.8%)
21–25	5669 (10.6%)	39,273 (7.3%)
26 and more	40,404 (75.3%)	419,255 (78.2%)
Missing	5476 (10.2%)	65,277 (12.2%)
No. of dental visits 1 year before baseline, mean ± SD*	1.30 ± 1.88	1.15 ± 1.59
No. of dental visits within 2 years before baseline*		
None	13,528 (12.2%)	12,2580 (22.9%)
Once	6546 (12.2%)	81,767 (15.2%)
Twice	6242 (11.6%)	76,903 (14.3%)
Three times and more	16,496 (30.8%)	146,870 (27.4%)
BMI baseline, mean ± SD	41.80 ± 5.49	N/A

[a]Presented as frequencies (*n*) and proportions (%) unless otherwise specified.

[b]Presented as multiples of 100 Swedish Krona (SEK; 100 SEK = approximately 11.7 US Dollar on August 31st 2021).

*Statistically significant difference between groups ($p < 0.05$).

Incidence rates of direct restorations are presented in Figure 2b. The corresponding incidence rate ratios are presented in Table 2. The number of restorative interventions increased after index date by 32% in the surgical cohort whereas a 4% decrease was seen in the control cohort. Restorative interventions were 1.75 times more common in the surgical cohort during the follow-up period.

Incidence rates of tooth extractions are presented in Figure 2c. The corresponding incidence rate ratios are presented in Table 2. Tooth extractions were more common preoperatively in the surgical cohort. Like restorations, an increase was seen after postoperative year 1. During the postoperative period the difference between the groups increased, with tooth extractions being 1.9 times more common in the surgical cohort during the follow-up period.

Incidence rates and incidence rate ratios for endodontic interventions are presented in Figure 2d and Table 2. Endodontic interventions were 1.5 times more common in the surgical cohort preoperatively and 2.1 times more common in the postoperative period. A 29% increase was observed in the surgical cohort when comparing the preoperative versus the postoperative time period.

Incidence rates and incidence rate ratios for periodontal interventions are presented in Figure 2e and Table 2. There was no difference between the groups preoperatively. In the postoperative period, a 12% decrease was seen in the surgical group.

4 | DISCUSSION

The present study investigates the effect on dental outcomes in patients with severe obesity before and after metabolic surgery. Compared to the reference cohort, the surgical cohort had a higher incidence regarding all dental outcomes in the preoperative period.

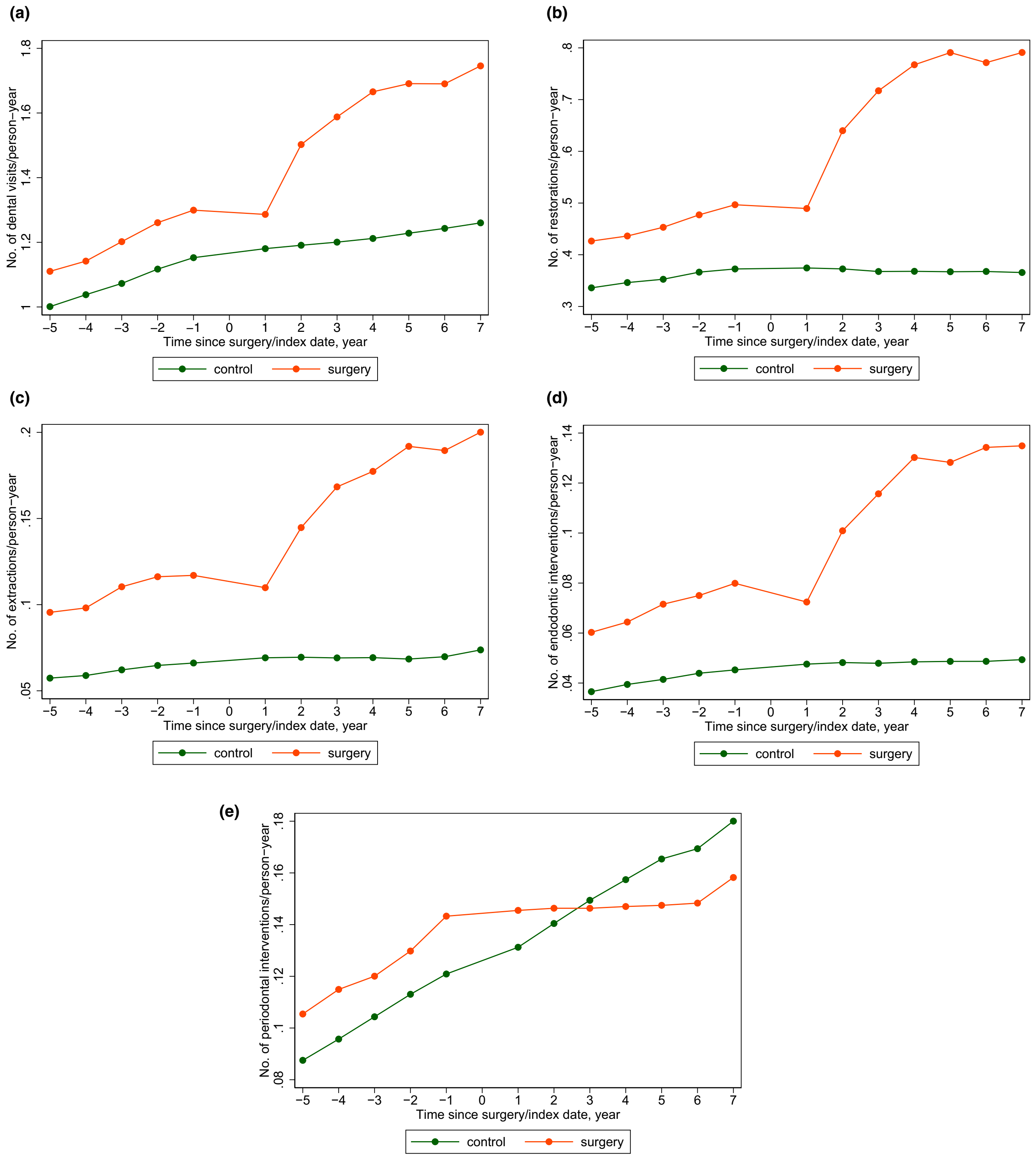

FIGURE 2 Observed incidence rates of dental interventions registered in the Dental Health Registry for the control and the surgical cohorts. (a) Dental visits; (b) Restorations; (c) Tooth extractions; (d) Endodontic interventions; (e) Periodontal interventions. Year 0 is the surgical index date for the surgical cohort, and the corresponding date for the matched control cohort.

All outcomes, except periodontal interventions, increased considerably after surgery.

The surgical cohort had more dental visits (all cause) than the reference population both pre- and postoperatively. Previous studies have shown obese individuals to be less prone to seek dental care (Forslund et al., 2002; Ostberg et al., 2012). This difference might suggest that individuals seeking bariatric surgery are more health conscious than obese individuals not seeking surgery.

The relationship between poor oral health and obesity is multifactorial, where both conditions share many of the underlying

TABLE 2 Event rates of dental outcomes, incidence rate ratios (IRR) and cross-over comparisons of IRR between surgery and control group, before and after baseline[a]

	Event rate			IRR[b]			IRR[c]
	Surgery	Control		Surgery	Control		Surgery vs. control
Dental visits							
Before surgery	1.22 (1.21, 1.23)	1.09 (1.09, 1.09)	After vs. before surgery	1.14 (1.13, 1.16)	1.01 (1.01, 1.01)	Before surgery	1.05 (1.04, 1.06)
After surgery	1.56 (1.55, 1.56)	1.21 (1.21, 1.21)				After surgery	1.23 (1.22, 1.24)
Restorative interv.							
Before surgery	0.47 (0.46, 0.47)	0.36 (0.36, 0.36)	After vs. before surgery	1.32 (1.29, 1.36)	0.96 (0.96, 0.97)	Before surgery	1.19 (1.17, 1.21)
After surgery	0.68 (0.68, 0.69)	0.37 (0.37, 0.37)				After surgery	1.75 (1.73, 1.77)
Endodontic interv.							
Before surgery	0.11 (0.11, 0.11)	0.06 (0.06, 0.06)	After vs. before surgery	1.29 (1.22, 1.36)	1.00 (0.98, 1.03)	Before surgery	1.49 (1.45, 1.53)
After surgery	0.16 (0.16, 0.16)	0.07 (0.07, 0.07)				After surgery	2.08 (2.03, 2.13)
Extractions							
Before surgery	0.07 (0.07, 0.07)	0.04 (0.04, 0.04)	After vs. before surgery	1.27 (1.21, 1.34)	1.01 (0.98, 1.03)	Before surgery	1.40 (1.36, 1.43)
After surgery	0.11 (0.11, 0.11)	0.05 (0.05, 0.05)				After surgery	1.92 (1.87, 1.96)
Periodontal interv.							
Before surgery	0.13 (0.12, 0.13)	0.11 (0.11, 0.11)	After vs. before surgery	0.96 (0.92, 1.01)	1.15 (1.13, 1.16)	Before surgery	1.00 (0.97, 1.03)
After surgery	0.15 (0.15, 0.15)	0.15 (0.15, 0.15)				After surgery	0.88 (0.86, 0.90)

[a]Baseline is the index date.

[b]IRR (95% confidence intervals). All models are adjusted for the trend of incidence rates before baseline.

[c]IRR (95% confidence intervals). All models are adjusted for the trend of incidence rates before baseline, education, marital status, income, number of teeth and 2 years of dental visits before the index date.

causes. Poor dietary habits is the most obvious common factor. Comorbid diseases such as type 2 diabetes and gastroesophageal reflux disease (GERD) are common among obese individuals and can also affect oral health. Low socioeconomic status is another factor closely linked to both obesity (Devaux & Sassi, 2013; Hemmingsson et al., 2021) and poor oral health (Celeste et al., 2020; Paulander et al., 2003). In the current study the surgical cohort had significantly lower educational levels and lower income. The surgical cohort had, as expected, a significantly impaired oral health compared to the reference cohort before surgery and this difference was amplified after surgery.

Dietary habits with energy dense, high fat and low fiber food is associated with obesity (Ambrosini, 2014). The frequency and amount of sugar and starch-containing food intake are risk factors for dental caries (Bernabe et al., 2016; Hancock et al., 2020). A high intake of sugar-sweetened beverages is a risk factor for both obesity (Malik et al., 2006) and dental caries and erosion (Valenzuela et al., 2021).

The dietary change after metabolic surgery includes a recommendation of a strict fluid diet during the first two postoperative weeks. During week 3–4 a soft food diet is started whereafter a solid food is reintroduced. Thereafter, the patients are instructed to eat 6–8 small meals every day. Fluid intake is recommended to be 1500–2000 mL daily, and the patients are instructed to drink at the end of the meal. If the dietary recommendations are followed by the patient but with an excess of sugar containing products, this may explain the increase of dental problems observed in this study. In the Swedish guidelines for postoperative care after metabolic surgery (SOReg, 2022), it is just briefly mentioned that "snacking" or "grazing" constitutes a risk for caries but there are no recommendations regarding dental hygiene or preventive measures.

The saliva plays a key role in the protection against dental caries and erosion (Bardow & Vissink, 2015). It is not clear whether metabolic surgery affects salivary flow and saliva composition, and the results from clinical studies are conflicting (Farias et al., 2019; Salgado-Peralvo et al., 2018). Further, oral and intestinal microbiota change considerably after metabolic surgery (Stefura et al., 2022), but there are no studies as to how this affects oral health.

After surgery, patients are prescribed lifelong supplements of several vitamins and trace elements. However, postoperative nutritional deficiencies are common, especially for vitamin D, iron, folate, and vitamin B12 (Nuzzo et al., 2021). Vitamin D deficiency has been associated with an increased risk of caries in children (Gyll et al., 2018). Whether nutritional deficiencies could have any impact on the deterioration in oral health after metabolic surgery is not clear.

Although several factors listed above are likely contributors to the observed decline in oral health after surgery, the main cause is not possible to ascertain. Almost all comorbid diseases improve after metabolic surgery. The effect on type 2 diabetes is well known, where metabolic surgery leads to a dramatic and fast improvement with over 70% of the patients being in remission after 1 year (Madsen et al., 2019). So, if any impact, remission of diabetes would lead to an improvement of the oral health. Gastroesophageal reflux disease (GERD) is common in obese persons and is associated with increased risk for both dental caries and erosion (Lechien et al., 2020). Weight loss per se decreases reflux related symptoms, and gastric bypass is a procedure that is considered effective against reflux. Indeed, obese patients with GERD are sometimes recommended gastric bypass rather than fundoplication due to its effectiveness on both weight and reflux, since the small gastric pouch does not produce enough gastric acid to make the refluxate acidic (Madalosso et al., 2016). However, after sleeve gastrectomy a higher prevalence of GERD has been reported. Some patients even need conversion to gastric bypass to control the GERD (Peng et al., 2020). In our surgical cohort, most of the patients (87%) had gastric bypass, which likely limits the number of patients with clinically significant GERD postoperatively. Thus, the increase of oral health problems observed postoperatively in the present study are less probably explained by increased incidence of GERD.

Our study's strength lies in the study design, the large cohorts, the completeness of data and the long follow-up time. The registers used have a very high coverage. Thus, the surgery cohort can be regarded as being representative of a western setting. The outcomes used were dental interventions rather than the clinical dental diagnoses. The rational was to obtain as robust outcome variables as possible, and the impression is that dental diagnoses are not always accurately reported. Since the interventions are directly linked to the remuneration system, they are considered as robust outcomes.

The study has some limitations. Since it is a register-based study, information is unavailable on important aspects such as oral hygiene practice, smoking and dietary habits, which contributes to the limitations of the study. As mentioned above, the reasons why dental treatment was provided could not be evaluated with the present design. Possibly, the bariatric surgery led to an increase in health care seeking behavior in general. The results indisputably show significantly higher dental visit rates postoperatively. However, it is not possible to establish whether these visits were prompted by newly acquired dental conditions, or if these were present even before. In addition, the study is performed in a Swedish population, which may affect the generalizability of the results.

In conclusion, metabolic surgery seems to have a substantial negative impact on oral health. The reasons for the deterioration are not apparent but the postoperative dietary change is possibly one of the main causes. There is a need for longitudinal clinical studies of patients before and after metabolic surgery, recording dental caries and erosion, and oral health related QoL over time, and also interventional studies to reduce these effects. The results of the present study imply an important role for counselling metabolic surgery patients regarding preventive oral health measures.

AUTHOR CONTRIBUTIONS

Richard Marsk: Conceptualization; data curation; writing – original draft; methodology; writing – review and editing. **Freja Freedman:**

Conceptualization; data curation; writing – original draft; methodology; writing – review and editing. **Jacinth Yan:** Data curation; formal analysis; software; validation. **Lena Karlsson:** Conceptualization; writing – review and editing; data curation. **Gunilla Sandborgh-Englund:** Conceptualization; writing – original draft; methodology; writing – review and editing; data curation.

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CONFLICT OF INTEREST STATEMENT

All authors have no conflicts of interest to disclose.

DATA AVAILABILITY STATEMENT

Data cannot be shared publicly because of patient confidentiality.

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