5-year mental health and eating pattern outcomes following bariatric surgery in adolescents: a prospective cohort study

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Summary

Background Mental health problems are prevalent among adolescents with severe obesity, but long-term mental health outcomes after adolescent bariatric surgery are not well known. We aimed to assess mental health outcomes over 5 years of follow-up after Roux-en-Y gastric bypass surgery in adolescents who participated in the Adolescent Morbid Obesity Surgery (AMOS) study.

Methods This was a non-randomised matched-control study in adolescents aged 13–18 years who had a BMI of 40 kg/m² or higher, or 35 kg/m² or higher in addition to obesity-related comorbidity; who had previously undergone failed comprehensive conservative treatment; and were of pubertal Tanner stage III or higher, with height growth velocity beyond peak. A contemporary control group, matched for BMI, age, and sex, who underwent conventional obesity treatment, was obtained from the Swedish Childhood Obesity Treatment Register. Data on dispensed psychiatric drugs and specialist treatment for mental disorders were retrieved from national registers with complete coverage. In the surgical group only, questionnaires were used to assess self-esteem (Rosenberg Self-Esteem [RSE] score), mood (Mood Adjective Checklist [MACL]), and eating patterns (Binge Eating Scale [BES] and Three-Factor Eating Questionnaire-R21 [TFEQ]). This study is registered with ClinicalTrials.gov (NCT00289705).

Findings Between April 10, 2006, and May 20, 2009, 81 adolescents (53 [65%] female) underwent Roux-en-Y gastric bypass surgery, and 80 control participants received conventional treatment. The proportion of participants prescribed psychiatric drugs did not differ between groups in the years before study inclusion (pre-baseline; absolute risk difference 5% [95% CI −7 to 16], p=0·4263) or after intervention (10% [−6 to 24], p=0·2175). Treatment for mental and behavioural disorders did not differ between groups before baseline (2% [−10 to 14], p=0·7135); however, adolescents in the surgical group had more specialised psychiatric treatment in the 5 years after obesity treatment than did the control group (15% [1 to 28], p=0·0410). There were few patients who discontinued psychiatric treatment post-surgery (three [4%] receiving psychiatric drug treatment and six [7%] receiving specialised care for a mental disorder before surgery). In the surgical group, self-esteem (RSE score) was improved after 5 years (mixed model mean 21·6 [95% CI 19·9 to 23·4]) relative to baseline (18·9 [17·4 to 20·4], p=0·0059), but overall mood (MACL score) was not (2·8 [2·7 to 2·9] at 5 years *vs* 2·7 [2·6 to 2·8] at baseline, p=0·0737). Binge eating was improved at 5 years (9·3 [7·4 to 11·2]) relative to baseline (15·0 [13·5 to 16·5], p<0·0001). Relative changes in BMI were not associated with the presence or absence of binge eating at baseline.

Interpretation Mental health problems persist in adolescents 5 years after bariatric surgery despite substantial weight loss. Although bariatric surgery can improve many aspects of health, alleviation of mental health problems should not be expected, and a multidisciplinary bariatric team should offer long-term mental health support after surgery.

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Introduction

Severe obesity is associated not only with increased physical health risks[1] but also with impaired mental health,[2] especially during adolescence and young adulthood.[3,4] Adolescents and young adults, regardless of their weight, are susceptible to mental health problems, and epidemiological studies have shown that common mental disorders, such as anxiety and depression, peak in incidence during these years.[5] Little is known, however, about the long-term course of mental health from adolescence to young adulthood in adolescents with severe obesity who have undergone metabolic and bariatric surgery.

Metabolic and bariatric surgery has been shown to be safe and efficacious in adolescents followed up for up to 5 years post-surgery, with similar outcomes (in terms of weight loss and improvements in physical health and weight-related quality of life) to those seen in adults who undergo this treatment.[6–8] In addition, self-reported mental health improvements and decreased eating-related

Research in context

Evidence before this study

The number of bariatric procedures in adolescents with severe obesity is rapidly increasing. Previous research has shown that bariatric surgery is safe and effective in adolescents, and the 2018 guidelines from the American Society for Metabolic and Bariatric Surgery state that this type of surgery should be considered the standard of care in adolescents with severe obesity. However, a substantial minority of adolescents with severe obesity have coexisting mental health problems and little is known about the long-term mental health consequences of bariatric surgery. We searched PubMed for publications from Oct 12, 1969, to Oct 12, 2019, using the terms "adolescent" OR "child*" AND "gastric bypass" AND "obesity" AND "mental health" OR "psych,*" with no restrictions on language. Of the 52 items returned, we identified four relevant articles describing mental health outcomes in two adolescent cohorts: one from the USA and our own Adolescent Morbid Obesity Surgery (AMOS) cohort. 2-year data from the US studies and our own have shown improvements in self-reported mental health and improved eating behaviours after bariatric surgery. However, a US study showed that more than half of adolescents with baseline psychopathology reported sustained elevated symptoms 2 years after surgery; no 2-year difference in total levels of psychopathology was found between adolescents undergoing bariatric surgery or lifestyle intervention. The only long-term data available are from the US cohort, in which outcomes were examined at least 6 years after Roux-en-Y gastric bypass (although only in 14 participants). These results showed that, despite some individuals having improvements in mental health-related symptoms, preoperative mental health status was largely unchanged after surgery in most participants. Importantly, no participant developed new mental health issues after Roux-en-Y gastric bypass.

Added value of this study

To our knowledge, the present study represents the largest cohort of patients with 5-year follow-up mental health data after undergoing bariatric surgery as adolescents, and is the first to include both self-reported (subjective) and registry (objective) data on mental health outcomes. The data suggest that bariatric surgery does not improve adolescents' mental health problems; adolescents undergoing surgery received more specialist mental health treatment than did non-surgical controls over 5 years of follow-up. Among participants who had surgery, roughly a quarter initiated psychiatric drug treatment and specialised mental health treatment during 5 years of follow-up.

Implications of all the available evidence

Metabolic and bariatric surgery improves many aspects of physical health and quality of life in adolescents with severe obesity. However, long-term alleviation of mental health problems should not be expected, and adolescents and their caregivers should be given realistic expectations in advance of embarking on a surgical pathway. A multidisciplinary team should offer long-term mental health support after adolescent bariatric surgery.

problems after 1–2 years of follow-up have been reported in adolescents who have undergone metabolic and bariatric surgery.[9–11] However, a substantial minority of such patients report severe mental health problems and suicidal behaviour, and a previous study showed that more than half of adolescents with psychopathology at baseline reported sustained elevated symptomatology 2 years after metabolic and bariatric surgery.[11–14]

We aimed to compare specific mental health outcomes during 5 years of follow-up between adolescents undergoing metabolic and bariatric surgery and a conventionally treated adolescent control group with severe obesity (matched for age, sex, and body-mass index [BMI]). We also explored associations between self-reported mental health and eating-related problems and weight loss 5 years after surgery. On the basis of previous outcome data for adolescents and adults, we hypothesised that adolescents who underwent metabolic and bariatric surgery would report improvements in self-assessed mental health 5 years post-surgery, but also that a substantial minority would continue to need mental health treatment. We also hypothesised that baseline mental health and eating-related problems would not affect weight loss after surgery, but that more reported problems after surgery would be associated with poorer weight loss.

Methods

Study design and participants

All adolescents were participants in the Adolescent Morbid Obesity Surgery (AMOS) study, a nationwide study in Sweden for which outcome data on weight, physical health, and quality of life for 81 operated adolescents and a matched control group (n=80) were previously reported.[6] AMOS is a non-randomised matched-control study in which the primary endpoints are the safety and efficacy of Roux-en-Y gastric bypass surgery in adolescents. Patients were eligible for inclusion if they met the following criteria: age 13–18 years; BMI of 40 kg/m² or higher, or 35 kg/m² or higher with obesity-related comorbidity (eg, type 2 diabetes, dyslipidaemia, or metabolic syndrome); history of at least 1 year of comprehensive conservative treatment; pubertal Tanner stage III or higher; and height growth velocity beyond peak. Exclusion criteria included presence of insufficiently treated severe psychiatric disorders (eg, psychosis or severe depression); ongoing substance misuse; obesity secondary to brain injury; and syndromic or monogenic

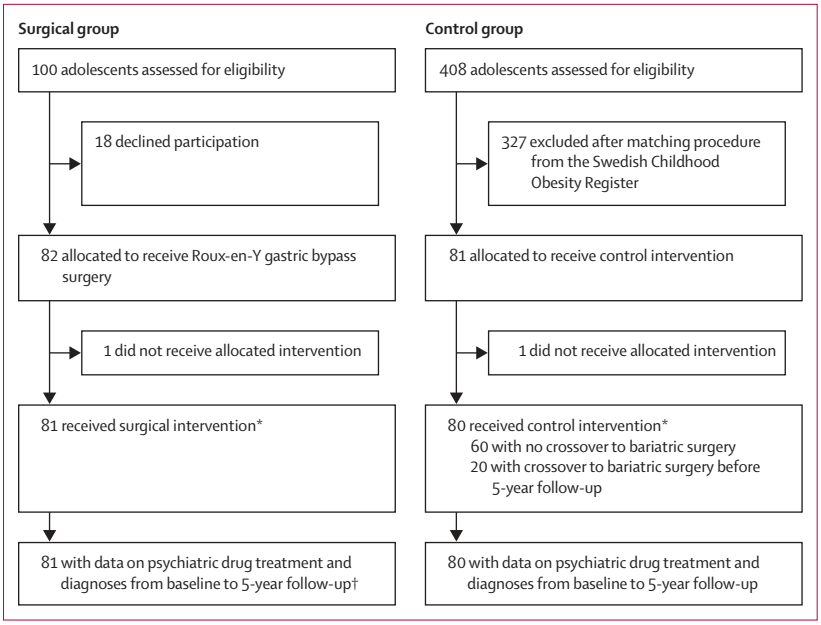

Figure 1: **Study profile**
*All patients had available pre-baseline data on psychiatric drug treatments (July 2005 to inclusion) and psychiatric diagnoses (January 2001 to inclusion). †Rosenberg Self-Esteem scores were available for 78 patients at baseline, 80 at 1-year follow-up, 72 at 2-year follow-up, and 73 at 5-year follow-up; Mood Adjective Checklist scores were available for 78 patients at baseline, 79 at 1-year follow-up, 72 at 2-year follow-up, and 75 at 5-year follow-up; Binge Eating Scale scores were available for 77 patients at baseline, 79 at 1-year follow-up, 71 at 2-year follow-up, and 75 at 5-year follow-up; and Three Factor Eating Questionnaire-R21 scores were available for 77 patients at baseline, 80 at 1-year follow-up, 72 at 2-year follow-up, and 75 at 5-year follow-up.

	Surgical group (n=81)	Control group (n=80)	p value
Sex	..	..	0·2605
Female	53 (65%)	45 (56%)	..
Male	28 (35%)	35 (44%)	..
Age at baseline, years	16·5 (1·2)	15·8 (1·2)	0·0002
BMI at baseline	45·5 (6·1)	42·2 (5·2)	0·0002
BMI at 5 years	32·3 (6·3)	41·7 (10·4)*	<0·0001

Data are n (%) or mean (SD). BMI=body-mass index. *Available for 72 patients at follow-up.

Table 1: **Characteristics of adolescents at baseline and 5 years after either Roux-en-Y gastric bypass (surgical group) or conservative treatment (control group)**

obesity (sequencing of melanocortin 4 receptor was done >50% of patients on the basis of clinical suspicion). Adolescents reporting self-induced vomiting to regulate weight were also excluded.

A matched-control group of conventionally treated adolescents was retrieved from the Swedish Childhood Obesity Treatment Register (BORIS), each identified on the basis of their baseline weight within 1 month of the operated adolescent's date of surgery. Controls were sequentially matched, ensuring that the mean values of matching variables (BMI, age, and sex) in the control group moved closer to the mean values in the surgical group with each additional control patient. Treatments for controls varied by centre but included family therapy and cognitive behavioural therapy.

The regional ethics committee in Gothenburg approved the protocol (registration number 532-04) and the study was done in accordance with the Declaration of Helsinki. A signed record of informed consent was collected from all adolescents and their parents.

Data sources

Data on psychiatric drugs coded N05 (psycholeptics, including antipsychotics, hypnotics, and sedatives) and N06 (psychoanaleptics, including antidepressants and psychostimulants) in the Anatomic Therapeutic Chemical classification system dispensed from July 1, 2005, to September 30, 2015, were retrieved from the Swedish Prescription Drug Register. Prescription Drug Register data are linked to the Swedish personal identity number, allowing retrieval of individual data for operated patients and controls. Registration in the Prescription Drug Register is mandatory; therefore, it captures all prescribed drugs dispensed from pharmacies in Sweden.

Data on inpatient and outpatient care for mental and behavioural disorders as the main diagnosis (codes F00–F99 in the International Classification of Diseases, 10th revision) from Jan 1, 2001, to Dec 31, 2014, were retrieved from the National Patient Register. Data in the National Patient Register are also linked to the Swedish personal identity number. The National Patient Register covers all inpatient and outpatient care in Sweden, including psychiatric care. The only care not covered by National Patient Register is primary care. Officials at the National Board of Health and Welfare provided the linked Prescription Drug Register and National Patient Register data.

Procedures

Adolescents undergoing metabolic and bariatric surgery were assessed for height, weight, mental health, and eating patterns at baseline (enrolment) and after 1 year, 2 years, and 5 years following surgery, at the three largest childhood obesity units in Sweden (in Stockholm, Gothenburg, and Malmö). All underwent laparoscopic Roux-en-Y gastric bypass by the same surgical team in Gothenburg.

Weight was measured to the nearest 0·1 kg with an electronic scale, and height to the nearest 0·1 cm with a wall-mounted stadiometer. Weight outcome after surgery was evaluated as the percentage change in BMI at 5 years relative to baseline BMI.

Questionnaires were administered at baseline and at each follow-up visit to assess mental health and eating patterns in the operated adolescents. Self-esteem was evaluated on the Rosenberg Self-Esteem (RSE) scale, a ten-item questionnaire for the assessment of global self-esteem in adolescents and adults.[15] Total scores range from 0 (lower self-esteem) to 30 (higher self-esteem), with a score of 15 or lower commonly used as a cutoff for low self-esteem.

Mood was assessed using the Mood Adjective Checklist (MACL), which consists of 38 adjectives describing positive and negative facets of mood. Respondents rate their current mood by indicating how strongly they agree or disagree with each adjective. The MACL assesses three basic dimensions of mood: pleasantness or unpleasantness, activation or deactivation (ie, attentive and energetic *vs* unfocused and apathetic), and calmness or tension. An overall mood score is also reported.[16] Scale scores range from 1 to 4, with higher scores representing more positive moods. Age-specific and gender-specific norms are available, and the mean overall mood of the age group comparable to AMOS participants is 3·17 (SD 0·43).[17]

Binge eating in participants was rated on the Binge Eating Scale (BES), a questionnaire consisting of 16 items for assessing behaviours such as loss of control over eating and eating unusually large amounts of food. Total scores range from 0 (less binge eating) to 46 (more binge eating).[18] The BES is a good indicator of binge eating in patients undergoing metabolic and bariatric surgery, and a BES score of 17 or lower is suggested as a cutoff for distinguishing between patients with no binge eating from patients with binge eating (those with scores >17).[19]

The Three-Factor Eating Questionnaire-R21 (TFEQ-R21) assesses three aspects of eating behaviour: emotional eating (eating as a response to negative emotions), uncontrolled eating (eating in response to food exposure or hunger), and cognitive restraint (trying consciously to restrict eating).[20] Scale scores range from 0 to 100. A higher score indicates more of the respective eating behaviour. The TFEQ-R21 has been validated in adolescents.[21]

No standardised mental health assessment was done in the control group.

Outcomes

The proportions of individuals with medication for a psychiatric condition and the proportion receiving specialised care with a psychiatric diagnosis as the main diagnosis were compared between the surgical and the control group, as was the change in use of medication and treatment for mental disorders throughout the study period. For operated adolescents, changes in self-reported mental health and eating-related problems from baseline to 5-year follow-up and between follow-ups were also recorded, as well as relative changes in BMI in subgroups reporting or not reporting binge eating. Mental health and eating-related variables at baseline and at 1 year, 2 years, and 5 years of follow-up were tested as predictors of relative change in BMI at 5 years.

Statistical analysis

Between-group differences were analysed on the basis of the intention-to-treat principle. Differences in proportions with medication and a psychiatric diagnosis were evaluated with a χ^2 test, and 95% CIs were calculated for the absolute difference in proportions between the groups. The change in use of medication and treatment for mental disorders in the surgical group relative to that in the control group was analysed using a difference-in-difference regression. Standard errors in the difference-in-difference model were calculated through bootstrapping (1000 replications), clustering repeated observations over time at the level of the individual. Changes in self-reported mental health and eating-related problems from baseline to 5-year follow-up and between follow-ups were analysed with multilevel mixed-effect regression models. Similarly, relative changes in BMI in subgroups reporting or not reporting binge eating were evaluated using mixed models. In the mixed-effect regressions, all individuals were included in the analyses regardless of missing data. Changes between assessment timepoints were evaluated as standardised response means (calculated as mean change divided by SD of change), and categorised according to standard

	Pre-baseline*				After treatment (to 5-year follow-up)			
	Surgical group (n=81)	Control group (n=80)	Absolute risk difference	p value	Surgical group (n=81)	Control group (n=80)	Absolute risk difference	p value
Psychiatric drug treatments ever								
Any psychiatric drugs (N05 or N06)	16 (20%)	12 (15%)	5% (−7 to 16)	0·4263	35 (43%)	27 (34%)	10% (−6 to 24)	0·2175
Psycholeptics (N05)	8 (10%)	9 (11%)	−1% (−11 to 8)	0·7768	28 (35%)	17 (21%)	13% (0 to 27)	0·0597
Psychoanaleptics (N06)	15 (18%)	7 (9%)	10% (−1 to 20)	0·0712	27 (33%)	20 (25%)	8% (−6 to 22)	0·2449
Psychiatric diagnoses ever (ICD-10 codes F00–F99)								
Any†	16 (20%)	14 (18%)	2% (−10 to 14)	0·7135	29 (36%)	17 (21%)	15% (1 to 28)	0·0410
Inpatient‡	6 (7%)	4 (5%)	2% (−5 to 10)	0·5269	9 (11%)	2 (2%)	9% (1 to 16)	0·0304
Outpatient§	14 (17%)	12 (15%)	2% (−9 to 14)	0·6938	29 (36%)	17 (21%)	15% (1 to 28)	0·0410

Frequency data are n (%). Between-group differences are absolute risk difference (95% CI), based on an intention-to-treat analysis. Registration, which is automatic and mandatory, generated complete data. ICD-10=International Classification of Diseases, tenth revision. *From July 1, 2005 (for psychiatric treatments) or from Jan 1, 2001 (for psychiatric diagnoses), to start of gastric bypass or conventional treatment. †From inpatient or outpatient specialist treatment. ‡Hospitalisation with a psychiatric diagnosis as the main diagnosis. §Specialist outpatient treatment with a psychiatric diagnosis as the main diagnosis.

Table 2: **Psychiatric drug treatment and psychiatric diagnoses in adolescents undergoing Roux-en-Y gastric bypass (surgery group) and matched conservatively managed adolescents (controls group)**

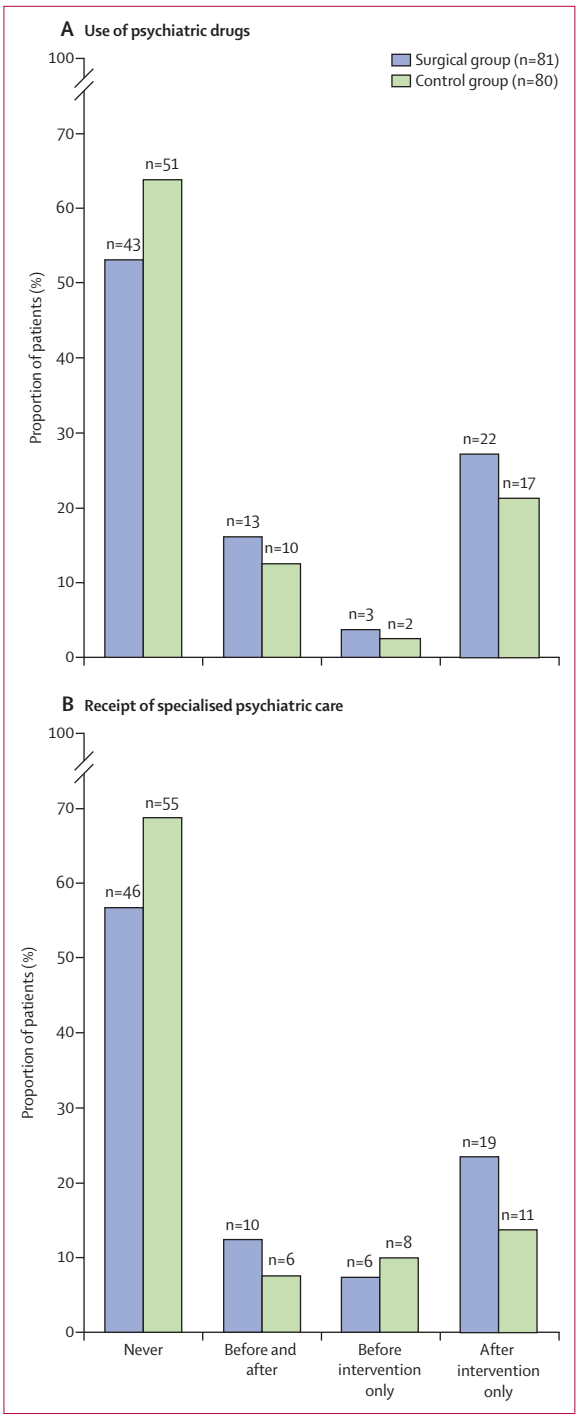

Figure 2: **Prevalence of psychiatric drug treatment (A) or specialised care with a psychiatric diagnosis as the main diagnosis (B) before and after Roux-en-Y gastric bypass (surgical group) or conservative management (control group) for obesity during 5 years of follow-up**

criteria for effect size (values <0·2 are regarded as trivial, 0·2 to <0·5 as small, 0·5 to <0·8 as moderate, and ≥0·8 as large).[22] Statistical analyses were carried out using the Stata statistical package version 15.1.

The study is registered with ClinicalTrials.gov (NCT00289705).

Role of the funding source

The funders of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had the final responsibility for the decision to submit for publication.

Results

Between Jan 1, 2006, and March 15, 2009, 100 adolescents were assessed for eligibility to undergo laparoscopic Roux-en-Y gastric bypass, of whom 18 declined to participate (figure 1). 81 (99%) of 82 patients allocated to receive the surgical intervention underwent laparoscopic Roux-en-Y gastric bypass by the same surgical team in Gothenburg between April 10, 2006 and May 20, 2009, and were included in the analysis. For the control group, 81 (20%) of 408 adolescents assessed for eligibility were matched to participants in the surgical group, of whom 80 (99%) received the allocated intervention and were analysed.

The sex distribution (53 [65%] girls in the surgical group *vs* 45 [56%] in the control group) did not differ significantly between groups, but mean age and mean BMI at baseline were significantly higher in the surgical group than in the control group (table 1). 5 years after surgery, mean BMI was significantly lower in the surgical group than in the control group (table 1). The mean 5-year change in weight for adolescents undergoing metabolic and bariatric surgery was –36·8 kg (95% CI –40·9 to –32·8); however, nine (11%) participants lost less than 10% of their baseline weight. Mean BMI changes across 5 years were –13·1 kg/m² (–14·5 to –11·8) for the surgical group and 3·3 kg/m² (1·1 to 4·8) for the control group.[6] At the 5-year follow-up, 20 (25%) individuals in the control group had undergone metabolic and bariatric surgery.

Data on psychiatric drug treatments and diagnoses were available for all patients in both groups, from pre-baseline to 5-year follow-up. The proportions of patients prescribed psychiatric drugs did not significantly differ between groups pre-baseline or during 5 years of follow-up (table 2). These proportions increased longitudinally from before treatment to 5 years after treatment in both groups, with no significant between-group difference in this increase (absolute difference 4·7% [95% CI –10·4 to 19·8], p=0·54). In the surgical group, most adolescents had no change in psychiatric medication before and after surgery; 22 (27%) had new need for psychiatric medication after treatment, and only three (4%) had discontinued need for these medications, while 13 (16%) continued to need medication that they had been receiving before surgery (figure 2). Similar trends were seen in the control group.

	Baseline	Follow-up			p value (5-year follow-up *vs* baseline)	Standardised response mean*
		1 year	2 years	5 years		
Self-esteem (RSE score)	18·9 (17·4–20·4), n=78	22·6 (21·1–24·1), n=80	22·3 (20·8–23·8), n=72	21·6 (19·9–23·4), n=73	0·0059	0·26
Pleasantness (MACL score)	2·9 (2·7–3·0), n=78	3·1 (3·0–3·2), n=79	3·0 (2·9–3·2), n=71	3·0 (2·8–3·1), n=74	0·2367	0·08
Activation (MACL score)	2·6 (2·5–2·7), n=77	2·8 (2·7–2·9), n=79	2·7 (2·6–2·8), n=72	2·8 (2·6–2·9), n=75	0·0185	0·25
Calmness (MACL score)	2·6 (2·5–2·7), n=78	2·8 (2·7–3·0), n=79	2·8 (2·6–2·9), n=72	2·7 (2·6–2·9), n=75	0·2155	0·08
Overall mood (MACL score)	2·7 (2·6–2·8), n=78	2·9 (2·8–3·0), n=79	2·8 (2·7–2·9), n=72	2·8 (2·7–2·9), n=75	0·0737	0·16
Binge eating (BES score)	15·0 (13·5–16·5), n=77	7·0 (5·5–8·5), n=79	8·0 (6·4–9·7), n=71	9·3 (7·4–11·2), n=75	<0·0001	0·55
Emotional eating (TFEQ score)	39·7 (34·5–44·9), n=77	20·8 (15·7–25·9), n=80	25·2 (19·8–30·5), n=72	24·8 (18·7–30·8), n=75	<0·0001	0·47
Uncontrolled eating (TFEQ score)	44·9 (41·0–48·8), n=77	23·5 (19·5–27·4), n=80	27·1 (22·9–31·4), n=72	27·3 (22·5–32·2), n=75	<0·0001	0·70
Cognitive restraint (TFEQ score)	39·5 (35·2–43·8), n=77	46·5 (42·1–50·8), n=80	43·8 (39·1–48·5), n=72	49·9 (44·5–55·3), n=75	0·0007	0·37

Data are mixed-model mean (95% CI), n. Higher RSE scores represent higher self-esteem (range 0–30). Higher MACL scores represent better mood (range 1–4). Higher BES scores represent more binge eating (range 0–46). Higher TFEQ scores represent more emotional or uncontrolled eating or cognitive restraint (range 0–100). RSE=Rosenberg Self-Esteem. MACL=Mood Adjective Checklist. BES=Binge Eating Scale. TFEQ=Three-Factor Eating Questionnaire-R21. *Mean change divided by SD of change between baseline and 5-year follow-up.

Table 3: **Self-reported mental health and eating-related problems in adolescents at baseline and at 1 year, 2 years, and 5 years after Roux-en-Y gastric bypass**

The proportion of adolescents treated for a psychiatric disorder (ICD-10 codes F00–F99) in specialised care did not differ significantly between the surgical and control groups pre-baseline (table 2). Pre-baseline, the two most common diagnoses from specialised care among all adolescents in the study were disturbance of activity and attention (F90.0; 25 [15%] of 162 diagnoses) and mixed anxiety and depressive disorder (F41.2; 21 [13%]). In the first 5 years after initiation of treatment, adolescents in the surgical group received significantly more treatment for mental and behavioural disorders, both in inpatient (ie, hospitalisation) and specialist outpatient settings (table 2). However, the longitudinal increase in the proportion of participants treated for these disorders did not differ significantly between groups (absolute difference 12·3% [–3·9 to 28·5], p=0·14). Over the 5 years of follow-up, depressive episode, unspecified (F32.9; 57 [13%] of 442 diagnoses), and emotionally unstable personality disorder (F60.3; 47 [11%]) were the most common diagnoses. In the surgical group, most adolescents had no change in treatment for psychiatric diagnoses before and after surgery; 19 (24%) had new specialised psychiatric treatment after surgery and only six (7%) had such treatment before, but not after, surgery (figure 2). In the control group, 11 (14%) adolescents received new treatment for a psychiatric diagnosis after initiation of obesity treatment, and eight (10%) were no longer treated for such a diagnoses after obesity treatment.

Adolescents in the surgical group reported small but significant improvements in self-esteem (RSE score) and in activation (MACL score) 5 years after surgery (table 3). No significant 5-year changes in MACL scores for overall mood, calmness, or pleasantness were found. At the 5-year follow-up, 54 (72%) of 75 surgical patients with self-report data scored below the mean value for overall mood in an age-matched norm group, with 32 (43%) scoring at least 1 SD and 15 (20%) scoring at least 2 SDs below the norm mean. 15 (21%) adolescents reported low self-esteem only before but not after surgery, and nine (13%) developed low self-esteem after surgery (figure 3A).

Binge eating and uncontrolled eating were moderately improved 5 years after surgery (table 3). 20 (28%) of 71 adolescents reported binge eating only before but not after surgery, and three (4%) had onset of binge eating after surgery (figure 3B). A small decrease in emotional eating and a small increase in cognitive restraint (TFEQ scores) were also noted between baseline and 5 years after surgery (table 3).

None of the variables for mental health (self-esteem and overall mood) or eating-related problems (binge eating, emotional eating, uncontrolled eating, and cognitive restraint) at baseline were significantly associated with weight loss (percentage change in BMI) 5 years after surgery (appendix). Relative BMI changes over 5 years did not significantly differ whether or not adolescents were classified as having binge eating (BES score >17) before surgery (p=0·4487; figure 4A).

See Online for appendix

Neither self-reported mental health nor eating-related problems at the 1-year follow-up were significantly associated with 5-year percentage change in BMI relative to baseline (appendix). However, percentage change in BMI at 5 years post-surgery was significantly related to overall mood and self-esteem at the 2-year follow-up, indicating a greater relative reduction in BMI in patients with a better mood and higher self-esteem at 2 years post-surgery (table 4). Higher scores for binge eating and emotional eating at 2 years and 5 years, and for uncontrolled eating at 2 years after surgery, were also significantly associated with smaller percentage changes in BMI at 5 years relative to baseline (table 4). No significant difference was found in percentage change in BMI after 5 years between patients reporting binge eating at one or more follow-ups and patients never reporting binge eating at any follow-up (figure 4B; p=0·0568).

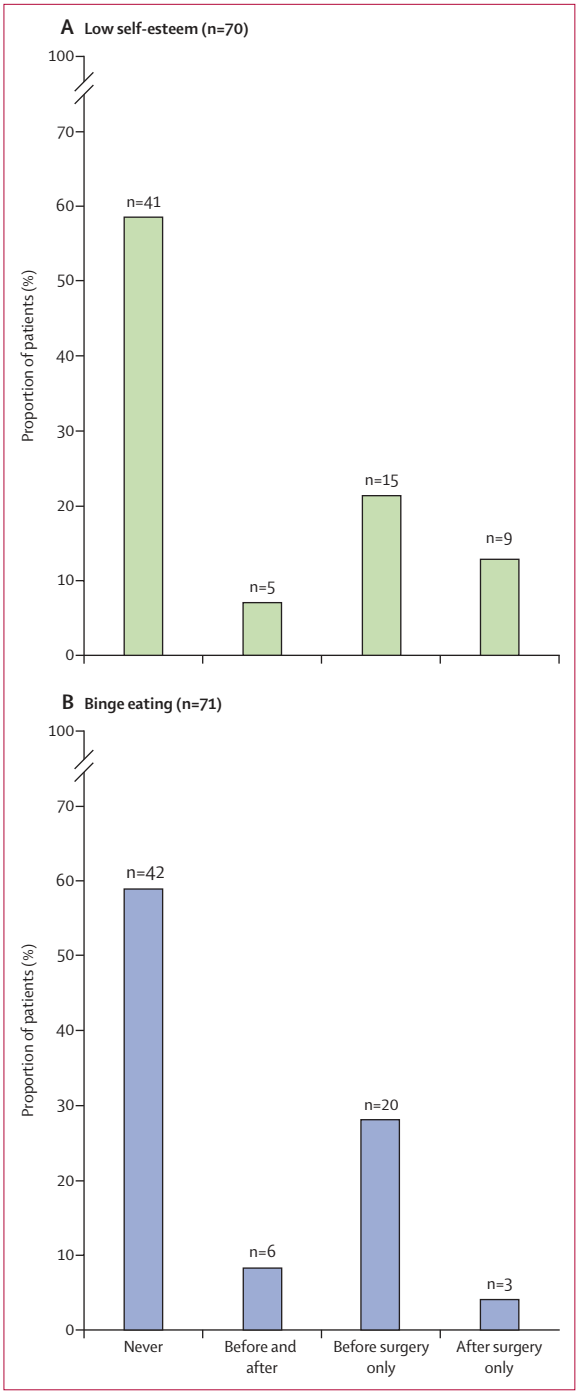

Figure 3: **Prevalence of low self-esteem (A) and binge eating (B) before and after Roux-en-Y gastric bypass during 5 years of follow-up**
Low self-esteem was defined as a total Rosenberg Self-Esteem score of 15 or less. Binge eating was defined as a total Binge Eating Scale score of more than 17.

Discussion

The American Society for Metabolic and Bariatric Surgery (2018 guidelines) suggests metabolic and bariatric surgery as the standard of care for adolescents with severe obesity. The guidelines do not recommend excluding patients with co-existing mental health conditions from undergoing surgery, but do emphasise that these conditions should be optimised and treated.[23]

Although improvements in weight, physical health, and quality of life have been reported after adolescent bariatric surgery, our study shows that both operated and conventionally treated adolescents received more mental health treatment over 5 years of follow-up than in the years before baseline. Adolescents who had metabolic and bariatric surgery had significantly more inpatient and outpatient care for mental problems than matched controls. When data were analysed on an individual level, only a small percentage of patients who had had psychiatric treatment (drugs or specialised care) before metabolic and bariatric surgery or conventional obesity treatment were no longer treated during follow-up, indicating few cases of remission. The continued need for treatment is in line with our hypothesis and with observations in adults, in whom treatment with psychiatric drugs is reported to approximately the same extent (in about 40% of patients) before and after metabolic and bariatric surgery.[24]

Further supporting our hypothesis, participants in our study reported improvements in mood, self-esteem, and eating-related problems at the 5-year follow-up relative to baseline. However, improvements in self-esteem and activation were small, overall mood was unchanged, 72% of participants reported an overall mood below age-matched norms, and 20% reported very low mood (ie, ≥2 SDs below the mean in age-matched norms) at 5 years post-surgery. From an individual perspective, 21% reported improved self-esteem (ie, low self-esteem before but not after surgery), while 13% reported deterioration in self-esteem (ie, low self-esteem after but not before surgery).

The prevalence of mental health problems is high in adolescents with severe obesity who seek treatment.[4,25] In this study, the proportions of adolescents dispensed psychiatric drugs before metabolic and bariatric surgery (20%) or conventional treatment (15%) were higher than those in the same-aged Swedish general population in any given year from 2006 to 2009 (about 2% [N05] and 3% [N06]).[26] Adolescents who seek metabolic and bariatric surgery, therefore, might also hope for improved mental health after a massive weight loss.

However, individual registry data over 5 years of follow-up show an increased need for mental health treatment in late adolescence and young adulthood in patients undergoing metabolic and bariatric surgery or conventional treatment. About 23% of the surgical group had new onset of specialised inpatient or outpatient psychiatric treatment after metabolic and bariatric surgery. That adolescents who underwent surgery had significantly more inpatient and outpatient treatment for mental disorders compared with the control group during follow-up does not necessarily

suggest that metabolic and bariatric surgery during adolescence causes mental health problems; the increased prevalence of interventions might instead be due to closer follow-up in adolescents who have undergone surgery, resulting in improved access to health and mental health care. In addition, mental health problems might be undetected in patients in the control group, who were not systematically assessed. Nevertheless, it is reasonable to conclude that metabolic and bariatric surgery does not result in a substantial alleviation of mental health problems in adolescents with severe obesity. Similar results were reported by Hunsaker and colleagues,[14] who showed no difference in total levels of psychopathology between adolescents undergoing metabolic and bariatric surgery or those receiving lifestyle intervention over 2 years.

Systematic assessments of mental health in adolescents more than 2 years after metabolic and bariatric surgery are scarce. A previous long-term follow-up study (n=14) by Zeller and colleagues[27] showed that mental health does not develop uniformly. Psychological disorders at follow-up did not appear to be a consequence of metabolic and bariatric surgery, since all adolescents who reported substantial mental health problems after surgery also reported problems at baseline. In contrast to Zeller and colleagues' findings, we found onset of psychiatric drug treatments in 27% and initiation of specialised mental health treatment in 24% during follow-up. Zeller and colleagues emphasised that personalised care and long-term follow-up are necessary for these patients.[27] Our study confirms this observation and indicates that a substantial minority of adolescents need careful monitoring of their mental health over several years after metabolic and bariatric surgery.

Self-reported data in the present study are, to some extent, inconsistent with the registry data. The contrast between registry data showing an increased consumption of mental health treatment and self-reported data showing improved or stable mood could indicate that the psychiatric treatments are effective. Such discrepancy between the two data sources indicates that use of only self-report questionnaires is insufficient to comprehensively assess mental health in adolescents after metabolic and bariatric surgery.

Improvements in eating patterns in our study were substantial and consistent: 20 (28%) of 71 reported remission of binge eating 5 years after surgery. In support of previous studies in adolescents and adults,[10,28,29] and our own hypothesis, we found no associations between baseline mental health or eating-related problems and weight loss after surgery. Also in line with our hypothesis and studies in adults,[30] weight outcomes 5 years after surgery were associated with mental health and eating-related problems at 2 years after surgery, but only with eating-related problems at 5 years after surgery. Although the explained variance in weight outcome was low for each significant variable (12–18%), these findings might indicate that addressing mental health issues and eating-related problems after surgery is also important for improving weight outcomes. These exploratory findings need to be confirmed in future studies.

The 2-year follow-up stands out as a pivotal timepoint to identify patients needing additional support to achieve a positive long-term outcome after metabolic and bariatric surgery.[12,14] After that point, weight-loss phase is over and further improvements are unlikely. Our clinical impression is also that adolescents with persisting or new mental health issues or eating-related problems are more susceptible to additional interventions at 2 years post-surgery.

A 4-year follow-up of adolescents in an American multisite observational study (Teen-LABS) showed that self-reported loss of control at one or more assessment

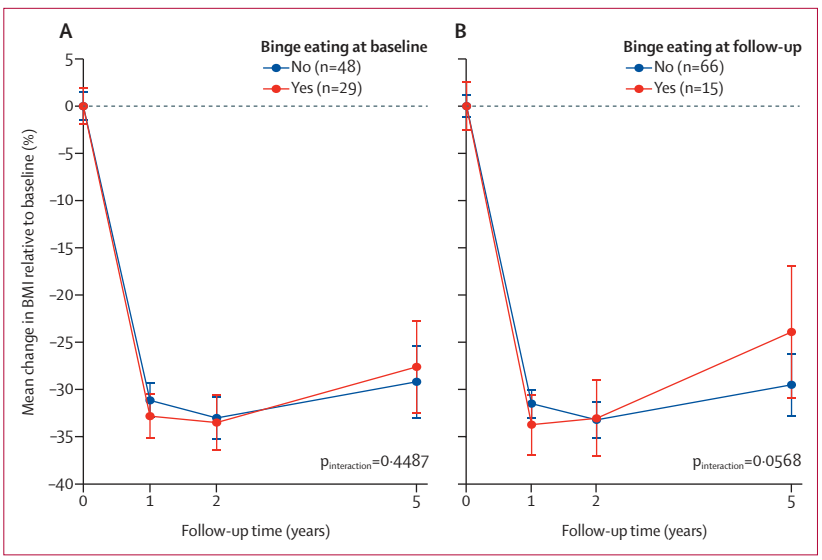

Figure 4: **Relative change in BMI in adolescents in the surgical group with and without binge eating at baseline (A) and during 5-year follow-up (B)**
Binge eating was defined as a total Binge Eating Scale score of more than 17. Error bars are 95% CIs. BMI=body-mass index.

	n	Regression coefficient (95% CI)*	p value	r2 (adjusted)
2-year follow-up				
Self-esteem (RSE score)	72	−0·52 (−0·92 to −0·13)	0·0097	0·127
Overall mood (MACL score)	72	−8·49 (−13·29 to −3·69)	0·0007	0·183
Binge eating (BES score)	71	0·55 (0·15 to 0·94)	0·0075	0·125
Emotional eating (TFEQ score)	72	0·17 (0·06 to 0·28)	0·0023	0·161
Uncontrolled eating (TFEQ score)	72	0·21 (0·06 to 0·36)	0·0077	0·144
5-year follow-up				
Binge eating (BES score)	75	0·34 (0·01 to 0·67)	0·0457	0·136
Emotional eating (TFEQ score)	75	0·13 (0·04 to 0·22)	0·0050	0·162

BMI=body-mass index. RSE=Rosenberg Self-Esteem. MACL=Mood Adjective Checklist. BES=Binge Eating Scale. TFEQ=Three-Factor Eating Questionnaire-R21. *Represents percentage change in BMI associated with a 1-unit change in the predictor variable (questionnaire score); higher RSE scores represent higher self-esteem (range 0–30); higher MACL scores represent better mood (range 1–4); higher BES scores represent more binge eating (range 0–46); higher TFEQ scores represent more emotional or uncontrolled eating (range 0–100).

Table 4: **Significant predictors of relative change in BMI 5 years post-surgery, adjusted for baseline BMI**

points after surgery was related to inferior weight loss.[28] We were not able to confirm this association in patients who were classified as having binge eating after surgery, perhaps because of the smaller sample size. Another possible explanation is between-study differences in assessment: the Teen-LABS study used loss of control for classification, whereas we used a complete questionnaire assessing several symptoms of binge eating.

The findings in this study must be interpreted in light of its broad non-selected surgical sample, the result of few exclusion criteria and the publicly funded health care in Sweden. Additionally, parents' participation was subsidised, making selection bias due to economic reasons unlikely. These factors might partly explain the high frequency of psychosocial problems in our surgical sample.[12,31] Taking all data together, findings from AMOS suggest improvements in physical health and quality of life in our non-selected sample compared with previously reported results for adolescents after metabolic and bariatric surgery.[6,31] However, the use of a less selective inclusion strategy implies that more psychosocial support must be offered.[11,12] A future aim should be to develop and study adjunctive care and interventions to improve long-term outcomes, especially in adolescents with substantial psychosocial challenges.

This study has several limitations. The cohorts were not randomised, and it is not known whether the mental health of adolescents with severe obesity who seek metabolic and bariatric surgery is typically better, worse, or equal to that in those seeking other treatment alternatives. We found no pre-baseline differences in registry data; however, despite BORIS having national coverage, there were not enough adolescents with the same degree of severe obesity to create a perfectly matched control group. Psychosocial problems in adolescents undergoing surgery might have been more prevalent in comparison to a control group with a somewhat lower BMI and age at baseline, which highlights the necessity for randomised controlled trials. The small sample size might furthermore have prevented us from detecting important differences between the groups. In an international context, the vertical sleeve gastrectomy is currently the procedure most used in adolescents.[23] Long-term data on adolescents after vertical sleeve gastrectomy are, however, unknown and should not immediately be expected to be similar to long-term data based on outcome after Roux-en-Y gastric bypass.[25] Other limitations of the present study include non-uniformity in the offered conventional treatment and the absence of self-reported data from participants in the control group.

A strength of the present study is the combination of registry data (unbiased by attrition or impression management) and self-reported data. Although the National Patient Register does not provide data from primary care units, ongoing mental health treatment in adolescents other than provision of medication is uncommon in Swedish primary care. All specialised psychiatric care in Sweden is registered in the National Patient Register and all prescribed drugs, including those from primary care, are registered in the Prescription Drug Register. Therefore, data from National Patient Register and Prescription Drug Register together provided good coverage of total mental health care consumption in both groups. In addition, the retention rate in surgical group was high, leading to a high rate of completion of the self-reported section. The broadly selected surgical sample makes the findings more generalisable.

From a mental health perspective, the transition from adolescence to young adulthood is a vulnerable time, not least in adolescents with severe obesity. Metabolic and bariatric surgery does not seem to improve this situation; therefore, we suggest that long-term mental health support should be required in programmes providing adolescent metabolic and bariatric surgery. Communicating to adolescents with severe obesity and their caregivers that mental health problems will not automatically improve after a massive weight-loss appears important in order to encourage realistic expectations in advance of embarking upon a surgical pathway.

Contributors

KJ conceptualised and designed the study, did the literature search, collected data, drafted the initial manuscript, and reviewed and revised the manuscript. JK and TO conceptualised and designed the study, designed the data collection instruments, and reviewed and revised the manuscript. C-EF, CM, and JD conceptualised and designed the study, and critically reviewed the manuscript. EG coordinated and supervised data collection, collected data, and critically reviewed the manuscript. GB coordinated and supervised data collection, collected data, did the statistical analyses, and reviewed and revised the manuscript. MP did the statistical analyses and reviewed and revised the manuscript. AJB and PH collected data and reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

Declaration of interests

KJ has received grants from Tore Nilsson's Foundation, SUS Foundations and Donations, Capio Research Foundation, and Mary von Sydow's Foundation during the conduct of the study; and personal fees from NovoNordisk and Merck unrelated to the submitted article. CM has received grants from Region Stockholm, Swedish Child Diabetes Foundation, and Swedish Heart and Lung Foundation during the conduct of the study. CM is also a shareholder in Health Support Sweden AB and has received grants and personal fees from Sigrid AB; personal fees from Itrim AB and Weight Watchers Int; and grants from FORTE, Barnhus Foundation in Stockholm, Novo Nordisk, and Vinnova unrelated to the submitted article. TO has received grants from the Swedish Research Council, VINNOVA, Västra Götalandsregionen, and ALF VG-region during the conduct of the study; and other reimbursement unrelated to the submitted article from Johnson&Johnson, NovoNordisk, Merck, and Mölnlycke. All other authors declare no competing interests.

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