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Original article

High estimated prevalence of bariatric surgery in young adults treated for pediatric obesity

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Abstract

Background: Despite the modest effects of behavioral treatment on obesity in adolescence, bariatric surgery is rarely performed. Obesity often persists from childhood to adulthood, but it is not known how many individuals proceed with bariatric surgery in young adulthood.

Objective: The aim of this study was to determine what proportion of individuals who received pediatric behavioral obesity treatment subsequently underwent bariatric surgery in early adulthood, and to identify predictors thereof.

Setting: National registries, Sweden.

Methods: In this prospective cohort study, the Swedish Childhood Obesity Treatment Register was linked to several national registers.

Results: The childhood obesity cohort included 6502 (45% females) with a median age at follow-up of 21.7 years (interquartile range [IQR] 5.2). Of these, 8.2% underwent bariatric surgery at a median age of 20.9 years (IQR 4.2). The estimated cumulative incidence of bariatric surgery at age 30 was 21.5%. Obesity-related co-morbidities were identified in 31.7% before bariatric surgery in the childhood obesity cohort. Predictors of bariatric surgery were female sex, high body mass index standard deviation score (BMI SDS) at the start and end of treatment, poor treatment response, as well as own or parental cardiometabolic disease.

Conclusions: More than a fifth are estimated to undergo bariatric surgery in early adulthood, despite having received pediatric behavioral obesity treatment. Our results indicate that for many children, behavioral treatment is insufficient in reducing obesity and preventing obesity-related co-morbidity. Therefore, it is reasonable to assume that more effective treatment of adolescents with severe obesity, including more rigorous behavioral support and pharmacologic treatment, but also more frequent use of bariatric surgery, would benefit this group of patients. (Surg Obes Relat Dis 2021;17:398–405.) © 2020 American Society for Bariatric Surgery. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Key words: Pediatrics; Bariatric surgery; Childhood obesity; Metabolic disease

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First-line pediatric obesity treatment is largely founded upon lifestyle behavioral modification, which has been shown to have only a modest effect on severe obesity, with especially poor results in adolescents [1,2]. Untreated obesity progresses from childhood to adulthood [3] and unsuccessful treatment of childhood obesity leads to a protracted disease course and increasing risk of obesity-related co-morbidity [4,5].

In adults, bariatric surgery is regarded as the most effective treatment for severe obesity [6,7]. The most commonly performed procedures are sleeve gastrectomy (SG) and Roux-en-Y gastric bypass (RYGB). Although a number of guidance documents exist outlining eligibility criteria for bariatric surgery, most are variations on the 1991 National Health Institute (NHI) statement [8], incorporating: age 18–60 years, BMI$\geq$40 kg/m^2 or $\geq$35 kg/m^2 with obesity-related co-morbidity and previous unsuccessful weight loss attempts. According to these criteria, individuals under the age of 18 years, who otherwise may fulfill the criteria, are rarely eligible in Sweden. Evidence from several high-quality studies indicates that bariatric surgery is safe and effective for adolescents, with treatment outcomes comparable to adults [9,10]. Though bariatric surgery incurs substantial initial cost, it has been demonstrated to be cost-effective in adolescents [11], with resolution of co-morbidities and extremely low incidence of cardiometabolic disease across follow-up periods of 5 years and beyond [9,10]. Despite this, the debate over whether to provide bariatric surgery to adolescents or delay until adulthood endures, both from a clinical [12,13] and an ethical point of view [14].

The American Society for Metabolic and Bariatric Surgery (ASMBS) recent update of pediatric surgical guidelines [15] and the American Academy for Pediatrics (AAP) policy statement [16] advocate that bariatric surgery should be considered for adolescents with severe obesity. Despite this, adolescents with severe obesity are often required to wait until 18 years of age before being considered eligible for bariatric surgery. The heavy reliance of current pediatric behavioral obesity treatment guidelines upon lifestyle behavioral modification therefore presents an obstacle to the use of the most effective existing obesity treatment—bariatric surgery. Current practice may, therefore, promote a surge in bariatric surgery among individuals with obesity as they turn 18 years of age. However, the proportion of individuals proceeding with bariatric surgery in early adulthood, despite childhood obesity treatment, is currently unknown.

The aim of this study was to determine the proportion of patients previously treated in Swedish childhood obesity treatment programs, proceeding to bariatric surgery in early adulthood, and to determine relevant factors influencing this.

Methods

Data source

Childhood obesity cohort

This cohort consisted of individuals included in the Swedish Childhood Obesity Treatment Register—BORIS (www.e-boris.se)—from December 1994 until September 2016. Local healthcare providers register children and adolescents undergoing obesity treatment in BORIS. Treatment is intended to be long-term and comprises lifestyle behavioral modification interventions, as described previously [17]. In breif, treatment is often delivered in outpatient clinics where children and their caregivers receive tailored treatment by multidisciplinary teams. Evidence-based guidelines are implemented and both individual and group treatment is often avaliable. BORIS covers data from all of Sweden and therefore treatment may vary between clinics in different regions and at different levels of care, (univerisity hospital, primary care).

Inclusion criteria were as follows: all children first registered in BORIS between 5 and 18 years of age, diagnosed with obesity according to the International Obesity Task Force (IOTF) [18], aged 18 years or older and living in Sweden at follow-up (December 31, 2017). Patients with brain tumors (n = 23) and genetic syndromes (Prader Willi, Laurence-Moon-Bardet-Biedl, Down, Russell-Silver, Noonan, Klinefelter, Fragile X, and Turner) (n = 67) were excluded, as were individuals who underwent bariatric surgery before 18 years of age (n = 107), i.e., children included in clinical trials, NCT00289705 and NCT02378259. Flowchart, Fig. A1.

Data acquisition

The governmental agency Statistics Sweden (www.scb.se/en) and the Swedish National Board of Health and Welfare (www.socialstyrelsen.se/en) performed linkage and subsequent anonymization of data from BORIS to several national registries using the personal identification number, unique to all Swedish residents. Data were retrieved for all patients and their parents. The study was approved by the regional ethical committee in Stockholm, Sweden; number 2016/922-31/1.

Definitions

The main outcome, bariatric surgery, was identified in the national patient register by using the NOMESCO Classification of Surgical procedures (code JDF) and verified with a diagnosis of obesity defined by ICD-10 code E66, in conjunction with the surgical procedure.

We use the term early adulthood to describe the participants >18 years of age, n = 6098 (93.8%) of the participants were between 18 to 30 years old at the time of follow-up.

Data on height and weight were repeatedly collected during childhood and extracted from BORIS. Weight status classification (normal weight, overweight and obesity) and degree of obesity (BMI SDS) in childhood were determined according to the sex- and age-specific IOTF definition [18]. Change in weight status classification and response to obesity treatment were calculated as the difference between the first and the last clinical visit (treatment duration, ranged 1–12 years). Response to treatment was categorized within 4 groups: "Good response", decrease in BMI SDS by ≥.25; "No response", maintenance of BMI SDS within ±.25; "Poor response", increase in BMI SDS by ≥.25 [19]; "Dropouts" were defined as children without clinical follow-up after their first registered visit or with <1 year between their first and last visit. Blood chemistry from the first clinical visit, including fasting glucose (FG), glycated hemoglobin (A1C), total cholesterol (TC), triglycerides (TG), LDL, HDL, and alanine aminotransferase (ALT), were extracted from BORIS. These samples were collected in various centers across Sweden and analyzed within accredited laboratories. Impaired FG was defined by FG levels ≥6.1 mmol/L, since lower cutoffs in children have proven not to be associated with future diabetes [20] or impaired glucose-insulin homeostasis [21]. Prediabetes was defined as A1C >39 mmol/mol. Hypertriglyceridemia was defined for children below 10 years of age as TG >1.13 mmol/L (>100 mg/dL) and for children 10 years and above as TG >1.45 mmol/L (>130 mg/dL); LDL was considered elevated if >3.36 mmol/L (>130 mg/dL), and low HDL was defined as <1.04 mmol/L (<40 mg/dL) [22]. Elevated ALT was defined as ≥.374 μkat/L (≥22 mg/dL) for females and ≥.442 μkat/L (≥26 mg/dL) for males [23]. To compare blood pressure levels in children, a sex-, age-, and height-adjusted reference from the National High Blood Pressure Education Program Working Group was applied [24].

Data on deaths were retrieved from the Swedish Cause of Death Register. Data regarding genetic syndromes and neurodevelopmental conditions (e.g., Asperger and ADHD) were retrieved from the Swedish National Patient Register and the Swedish Prescribed Drug Register.

Ethnic descent was classified as Nordic—individuals born in Nordic countries (Sweden, Finland, Denmark, Norway, and Iceland) with 1 or 2 parents born in the Nordics; and nonNordic—individuals born outside the Nordics or born in the Nordics with 2 parents born outside the Nordics. Data were retrieved from the Swedish Total Population Register.

Family socioeconomic status (SES) was based on parental level of education, income, and occupational status in the year their child turned 15 years, as described previously [25]. Data were retrieved from the Swedish Longitudinal Integration Database for Health Insurance and Labour Market Studies. SES was categorized into 4 levels: low SES (0–1.5 points), medium-low SES (2–3 points), medium-high SES (3.5–4.5 points), and high SES (5–6 points).

Cardiometabolic diseases were identified for all individuals in the Swedish Prescribed Drug Register according to the use of antidiabetic (ATC A10 B), lipid-lowering (ATC C10), blood pressure lowering (ATC C02, C03, C09, C07 AB, C07 AG, C07 F), and/or weight loss (ATC A08 AB01 [Orlistat]) medications. The overall prevalence of each individual disease and its association with bariatric surgery was assessed. Parental cardiometabolic disease was similarly assessed.

Statistical analyses

Descriptive statistics are presented as median and IQR or proportions. Differences between groups were determined using the Wilcoxon or χ^2 test. The cumulative incidence of bariatric surgery was calculated using the product limit estimator, i.e., the Kaplan-Meier function. Both unadjusted and adjusted Cox proportional hazard regression were used to estimate hazard ratios (HR) which are presented with 95% confidence intervals (CI) and *P* values. Covariates in these analyses included sex, ethnic descent, SES, age and BMI SDS at treatment initiation, unless otherwise stated. SAS Statistical software (version 9.4 Cary, NC, USA) was used for all analyses. A *P* value <.05 was considered statistically significant.

Results

In total, 6502 individuals (45% females) from the childhood obesity cohort were included, with a median age at follow-up of 21.7 years (IQR 5.2, range 18.0–38.8). At childhood obesity treatment initiation, the median (IQR) BMI SDS was 2.9 (0.6) and age was 13.5 (4.0) years. The median time in treatment was 2.8 (2.7) years. The mean (SD) time from obesity treatment initiation in childhood to study follow-up was 9.1 (4.0) years. Detailed characteristics are presented in Table 1.

Main outcome

The proportion of individuals who underwent bariatric surgery in early adulthood was 8.2% (n = 534) with a median age at time of surgery of 20.9 (IQR 4.19) years, more than half (52.3%) undergoing bariatric surgery before 21 years of age. The estimated cumulative incidence of bariatric surgery at 30 years of age was 21.5% (95%CI 19.3–24.2), Fig. 1. The proportion of individuals who underwent bariatric surgery was similar across age-groups, 1.2–2% (*P* = .9623), Fig. 2.

Table 1
Descriptive characteristics of the childhood obesity cohort

	Childhood obesity cohort (N = 6502)
Sex, female (%)	45.29
Nordic descent (%)	72.33
Age at treatment initiation (median (IQR), yr)	13.46 (4.01)
BMI SDS at treatment initiation (median (IQR))	2.87 (.60)
Bmi at treatment initiation (median (IQR))	31.48 (6.77)
Time in treatment (median (IQR), yr)	2.81 (2.74)
Age at follow-up (median (IQR), yr)	21.63 (5.16)
Bariatric surgery (n, %)	534 (8.21%)
Age at surgery (median (IQR), yr)	20.86 (4.19)
Neurodevelopmental condition (%)	18.66
Socioeconomic status	N = 6456
Low (%)	23.65
Medium-low (%)	36.88
Medium-high (%)	29.96
High (%)	9.50

IQR = interquartile range; BMI = body mass index; SDS = standard deviation score, according to IOTF [18].

Predictors of bariatric surgery in the childhood obesity cohort (Table 2)

The strongest predictive factors for bariatric surgery in early adulthood were female sex (HR = 3.02, 95%CI: 2.51–3.64) and high BMI SDS at treatment initiation (HR = 3.59 per unit, 95%CI: 2.99–4.31). Additionally, age at treatment initiation (HR = 1.06 per yr, 95%CI: 1.03–1.10) and nonNordic origin (HR = 1.23, 95%CI: 1.01–1.50) were associated with bariatric surgery in adjusted analyses, whereas neurodevelopmental conditions and SES were not.

Treatment response in childhood as a predictor of bariatric surgery

A good response to childhood obesity treatment was associated with a lower likelihood of bariatric surgery compared with no response (HR = .49, 95%CI: .37–.66). Similarly, a poor response was associated with a greater likelihood of bariatric surgery (HR = 1.94, 95%CI: 1.50–2.50) compared with no response. Treatment dropout was associated with a lower likelihood of bariatric surgery (HR = .72, 95%CI: .58–.89). However, when BMI SDS at the end of treatment was included as a covariate (available for n = 4936), treatment response was no longer associated with bariatric surgery (data not shown).

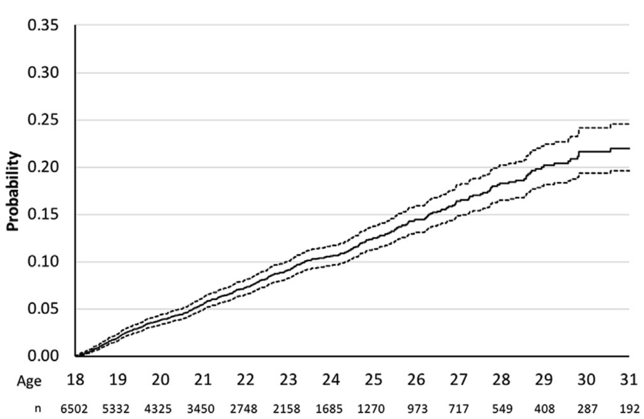

Fig. 1. Kaplan-Meier illustration of bariatric surgery in the childhood obesity cohort (mean estimated cumulative incidendce with 95%CI).

Weight status at the last clinical visit

During pediatric behavioral obesity treatment, 14.3% (n = 930) reduced their BMI SDS and were no longer classified as having obesity at last clinical visit. In total, 1.7% (n = 108) reached a normal weight, and 12.6% (n = 822) were defined as having overweight. Bariatric surgery was not performed in any individual with normal weight at the end of pediatric behavioral obesity treatment, and was performed in 1.6% (n = 13) of those with overweight at pediatric treatment end. The remaining 85.7% had obesity at the end of pediatric treatment, of whom 9.4% (n = 521) underwent bariatric surgery ($P < .0001$).

BMI at the last clinical visit

In the subset of participants with BMI data available between 15 to 18 years of age (n = 4157), the last measured BMI was 30–35 kg/m^2 in 35.3% (n = 1469), 35–40 kg/m^2 in 27.0% (n = 1121) and $\geq$40 kg/m^2 in 20.4% (n = 847), with corresponding bariatric surgery frequencies of 5.2% (n = 77), 13.7% (n = 154) and 23.9% (n = 202) ($P <$ .0001).

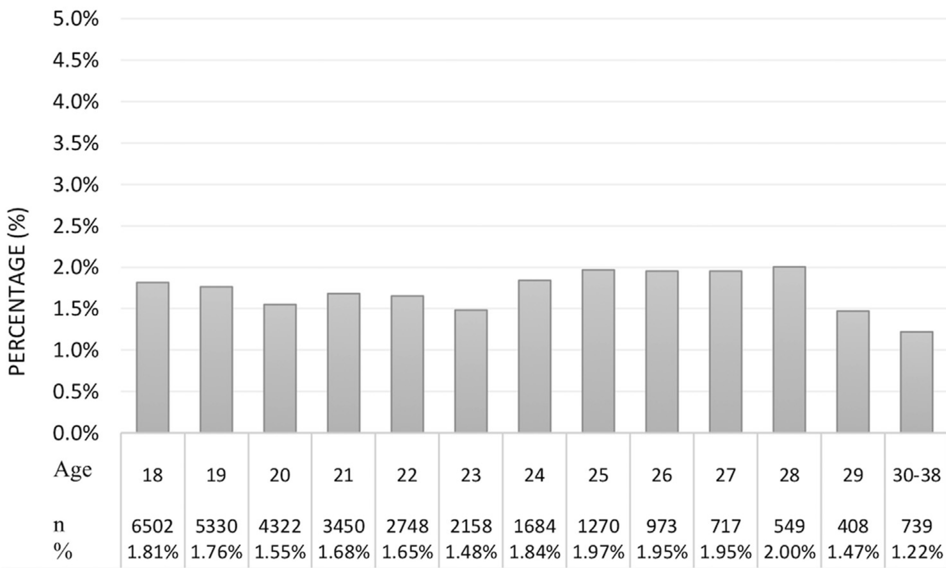

Fig. 2. Percentage of adults in the childhood obesity cohort undergoing bariatric surgery per age, $P = .9623$.

Cardiometabolic disease

When investigating the possible association of obesity-related co-morbidities to bariatric surgery, we found that 17.4% were pharmacologically treated for cardiometabolic disease at some point (females 22.6% versus males 13.0%, $P < .0001$). Dispensed prescribed drugs included: antidiabetic (7.8%), lipid-lowering (1.4%), blood pressure lowering (6.3%; excluding nonselective beta-blockers) and weight loss (4.0%; orlistat). Pharmacologic treatment of cardiometabolic disease was positively correlated with bariatric surgery; 31.7% (n = 169) of individuals undergoing

Table 2
Factors associated with bariatric surgery in the childhood obesity cohort, hazard ratio

	Model 1 unadjusted n = 6502			Model 2 mutually adjusted n = 6456			Model 3 adjusted n = 6456		
	HR	95% CI	*P* value	HR	95% CI	*P* value			
Female versus male	2.68	2.23–3.23	<.0001	3.02	2.51–3.64	<.0001			
NonNordic versus Nordic	1.14	.95–1.38	.1688	1.23	1.01–1.50	.039			
BMI SDS at treatment initiation	3.08	2.59–3.65	<.0001	3.59	2.99–4.31	<.0001			
Age at treatment initiation, yr	1.07	1.04–1.11	<.0001	1.06	1.03–1.10	.0002			
Neurodevelopmental condition*	.93	.73–1.17	.52	1.05	.83–1.33	.70			
SES n = 6456 (ref = low)									
Medium-low	.83	.68–1.02	.071	0.94	.77–1.15	.55			
Medium-high	.62	.49–.78	<.0001	.82	.64–1.05	.12			
High	.44	.28–.69	.0003	.66	.42–1.04	.075			
Treatment response (ref = “no response”)									
Good response (≤ -.25 BMI SDS)	.46	.35–.60	<.0001				.49	.365–.66	<.0001
Poor response (≥ +.25 BMI SDS)	1.45	1.12–1.87	.0042				1.94	1.50–2.50	<.0001
Dropouts†	.84	.69–1.03	.096				.72	.58– .89	.0021
BMI SDS at end of treatment‡	3.76	3.16–4.47	<.0001				3.75	2.84–4.95	<.0001
Own cardiometabolic disease	1.81	1.51–2.17	<.0001				1.27	1.05–1.53	.012
Parental cardiometabolic disease	1.40	1.12–1.75	.0030				1.22	0.98–1.53	.079
Paternal cardiometabolic disease	1.30	1.09–1.55	.0031				1.25	1.04–1.49	.015
Maternal cardiometabolic disease	1.21	1.02–1.44	.0286				1.05	0.88–1.25	.60

HR = hazard ratio; CI = confidence interval; BMI = body mass index; SDS = standard deviation score (IOTF); SES = socioeconomic status.

Model 2: Sex, migration background, SES, age, and BMI SDS at treatment initiation were mutually adjusted. Reduced n due to lack of SES data in 46 cases. Model 3: Each investigated variable was adjusted for sex, migration background, SES, age and BMI SDS at treatment initiation. Reduced n due to lack of SES data in 46 cases.

* Attention deficit hyperactivity disorder (ADHD), Asperger.

† No clinical follow-up after first registered visit or with <1 yr between first and last measure of BMI.

‡ Subsample of n = 4936.

bariatric surgery receiving pharmacologic treatment, compared with 16.1% (n = 959) of individuals not undergoing bariatric surgery ($P < .0001$, Table 2). The use of orlistat was found to be the only specific drug associated with bariatric surgery in the adjusted model (HR = 1.74, 95%CI: 1.34–2.25). No association was identified between either metabolic disease or deranged blood chemistry (FG, A1 C, TC, TG, LDL, HDL or ALT) during pediatric behavioral obesity treatment and bariatric surgery in early adulthood (data not shown).

Overall, parental pharmacologic treatment for cardiometabolic disease was identified in 49.7% of fathers and in 48.4% of mothers, with an overlap of 26.4% in both parents. Pharmacologic treatment was more frequent in parents of individuals that underwent bariatric surgery, 61.4% in fathers and 55.8% in mothers, compared with parents whose offspring did not undergo bariatric surgery, 47.8% and 45.6%, respectively ($P < .0001$). Parental pharmacologic treatment for cardiometabolic disease was associated with bariatric surgery in offspring in the unadjusted but not the adjusted model. However, paternal cardiometabolic disease remained a significant predictor for offspring bariatric surgery (HR = 1.25, 95%CI: 1.04–1.49).

Discussion

In this prospective cohort study of individuals who underwent pediatric behavioral obesity treatment, we estimated that 21.5% will have undergone bariatric surgery by age 30. Of those who underwent bariatric surgery, 52.3% did so before 21 years of age. Factors predicting bariatric surgery included female sex, high BMI SDS at both the start and end of treatment, as well as participants' and their parents' pharmacologic treatment for cardiometabolic disease. This indicates that treatment of childhood obesity with lifestyle behavioral modification [17] fails to provide long-term protection against severe obesity and related co-morbidities in many individuals, and that many proceed with bariatric surgery in early adulthood. This is in agreement with our previous findings regarding the effect of behavioral treatment on blood pressure [26]. However, the effect of pediatric behavioral obesity treatment had a dose-response relationship with adult bariatric surgery. Obesity remission during obesity treatment in childhood was protective from later bariatric surgery, and a very small proportion of those that reached overweight during treatment in childhood subsequently underwent bariatric surgery in adulthood (1.6%). This implies that when pediatric obesity treatment results in obesity remission, it provides lasting results. A deteriorating metabolic health in individuals with obesity incurs cost (both on the individual and society) and impaired health-related quality of life (QOL). Therefore these results can be important for physicians as well as policymakers in understanding the burdens and consequences of the progression of obesity from childhood to adulthood.

While only 45% of children treated for obesity were female, almost 70% of those undergoing bariatric surgery were women. This female predominance among bariatric surgery recipients mirrors existing reports [27]. Although the development of co-morbidities was also more common in females, the sex disparity in bariatric surgery recipients remains a concern from a public health perspective, as there is no reason to believe that the low number of males in the bariatric surgery group reflects the clinical need.

As expected, there was a strong association between the degree of obesity, measured as BMI SDS in childhood and adolescence, and bariatric surgery in early adulthood. We found that both higher BMI SDS at treatment initiation and poor treatment response were associated with an increased likelihood of bariatric surgery, and contrary, a good response reduced the likelihood of bariatric surgery. However, when BMI SDS from the last clinical visit was considered, the absolute degree of obesity at the end of treatment was a superior predictor of later bariatric surgery, regardless of treatment response.

A meta-analysis from Simmonds et al. demonstrated untreated adolescent obesity to be highly likely (80%) to persist into adulthood [3]. Our results show that a majority (85.7%) of children's obesity persisted to adulthood or the last clinical visit, despite organized treatment in formal behavioral-based obesity programs.

Pharmacologic treatment for cardiometabolic disease in adulthood was associated with bariatric surgery. However, there was no association between childhood cardiometabolic or blood chemistry abnormalities and bariatric surgery, implying that it is cardiometabolic health deterioration over time that increases the likelihood of bariatric surgery, rather than that present during childhood, in concurrence with previous observations [28]. In contrast, the use of antidiabetic drugs (7.8%) in early adulthood was not associated with bariatric surgery. This is concerning as young-onset type 2 diabetes (T2D) is an aggressive disease with increased risk of severe complications and high mortality [29]. Since bariatric surgery has proven effective for the remission and amelioration of young-onset T2D [30], this may indicate an underutilization of bariatric surgery in this particular sub-group, even within the wider context of a widespread underutilization of bariatric surgery, as highlighted among 14–25 year olds with obesity in the United States [31].

We did not identify an association between bariatric surgery and SES, which may imply that within the Swedish healthcare system, bariatric surgery is equally available for everyone who fulfills the surgical criteria, as suggested by a previous study [32]. In the present study, individuals with a nonNordic origin were slightly more likely to undergo bariatric surgery, which may be related to hereditary factors.

The present study confirms that pediatric behavioral obesity treatment has a high risk of being unsuccessful, alongside a high likelihood of developing cardiometabolic co-morbidities and undergoing bariatric surgery during the early years of adulthood. Hence, our results imply a clinical need for intensification of adolescent obesity treatment to reduce the burden of obesity. It has been demonstrated that very frequent clinical visits, as many as 25–50 per year, are required for lifestyle interventions to achieve good effect [33]. This is rarely possible to achieve. Thus, combination therapies and the inclusion of both pharmacologic treatment and bariatric surgery should be considered more frequently for adolescents and should be formally integrated in pediatric obesity treatment pathways, in line with ASMBS guidelines [15] and the AAP policy statement [16].

This study has several strengths and limitations. The study included prospectively compiled data from over 6500 patients who were followed from pediatric behavioral obesity treatment into adulthood by combining data extracted from several Swedish national registries, all of which have outstanding coverage and completeness, resulting in insignificant loss to follow-up. A limitation is the absence of data on adult BMI. There has been notable variation in the volume of bariatric surgery performed in Sweden over the study period, which is likely to have influenced the prospect of individuals undergoing surgery. The present study is comprised of a clinical sample from Sweden, which may impair the generalizability, as it is possible that children who have received pediatric behavioral obesity treatment may be more informed and knowledgeable about the availability of bariatric surgery, potentially increasing their likelihood of undergoing bariatric surgery. Another impact on generalizability is that Swedish healthcare is government funded and subsidized making our results of bariatric surgery prevalence less translatable to countries with different healthcare systems. By contrast, characteristics such as cardiometabolic disease are likely to be similar regardless of healthcare organizational setting. Future studies should aim at investigating interactions that are of clinical importance, such as age and treatment response.

Conclusion

One in 5 individuals treated for pediatric obesity was estimated to undergo bariatric surgery between 18 and 30 years of age. Unsuccessful treatment in childhood, female sex and obesity-related co-morbidity were associated with bariatric surgery and a majority underwent surgery under the age of 21, reflecting that the age criteria for surgery is likely to have withheld the most effective obesity treatment from these adolescents. A third of the individuals were receiving pharmacologic treatment for obesity-related co-morbidities before undergoing surgery, implying a rapid deterioration of metabolic health during adolescence and early adulthood. These results indicate that for many, pediatric behavioral obesity treatment is insufficient in reducing obesity and preventing obesity-related co-morbidity. Hence, a need for intensified and more effective treatment of adolescents with severe obesity seems warranted. This may include more rigorous behavioral support and pharmacologic treatment, but also more frequent use of bariatric surgery. We advocate a move toward multimodal combination therapies, seeking to combine the various available treatment modalities to achieve additive or even synergistic effects.

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Disclosures

The authors have no commercial associations that might be a conflict of interest in relation to this article.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.1016/j.soard.2020.09.017.

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