Surgery for Obesity and Related Diseases 14 (2018) 882–901

SURGERY FOR OBESITY AND RELATED DISEASES

Review article

ASMBS pediatric metabolic and bariatric surgery guidelines, 2018

Janey S.A. Pratt, M.D., F.A.C.S., F.A.S.M.B.S.[a,*], Allen Browne, M.D., F.A.C.S., F.A.A.P.[b], Nancy T. Browne, M.S., P.P.C.N.P.-B.C., C.B.N., F.A.A.N.P.[c], Matias Bruzoni, M.D., F.A.C.S.[a], Megan Cohen, Ph.D.[d], Ashish Desai, M.D., F.R.C.S, F.E.B.P.S., M.Ch. (Paed) (India)[e], Thomas Inge, M.D., Ph.D.[f], Bradley C. Linden, M.D., F.A.C.S., F.A.A.P., F.A.S.M.B.S.[g], Samer G. Mattar, M.D., F.A.C.S., F.R.C.S., F.A.S.M.B.S.[h], Marc Michalsky, M.D., F.A.C.S., F.A.A.P.[i], David Podkameni, M.D., F.A.C.S.[j], Kirk W. Reichard, M.B.A., M.D., F.A.C.S., F.A.A.P.[d], Fatima Cody Stanford, M.P.H., M.P.A., M.D., F.A.A.P., F.A.C.P., F.T.O.S.[k], Meg H. Zeller, Ph.D.[l], Jeffrey Zitsman, M.D., F.A.C.S., F.A.A.P.[m]

[a]*Lucille Packard Children's Hospital and Stanford University School of Medicine Stanford, California*
[b]*Diplomate American Board of Obesity Medicine Falmouth, Maine*
[c]*WOW Pediatric Weight Management Clinic, EMMC, Orono, Maine*
[d]*Nemours/Alfred I. DuPont Hospital for Children Wilmington, Delaware*
[e]*King's College Hospital, London, United Kingdom*
[f]*University of Colorado, Denver and Children's Hospital of Colorado Aurora, Colorado*
[g]*Pediatric Surgical Associates and Allina Health Minneapolis, Minnesota*
[h]*Swedish Weight Loss Services Swedish Medical Center Seattle, Washington*
[i]*Nationwide Children's Hospital and The Ohio State University Columbus, Ohio*
[j]*Banner Gateway Medical Center and University of Arizona Phoenix, Arizona*
[k]*Diplomate American Board of Obesity Medicine Massachusetts General Hospital and Harvard Medical School Boston, Massachusetts*
[l]*Cincinnati Children's Hospital Medical Center Cincinnati, Ohio*
[m]*Morgan Stanley Children's Hospital of NY Presbyterian and Columbia University Medical Center New York, New York*

Received March 21, 2018; accepted March 21, 2018

Abstract The American Society for Metabolic and Bariatric Surgery Pediatric Committee updated their evidence-based guidelines published in 2012, performing a comprehensive literature search (2009–2017) with 1387 articles and other supporting evidence through February 2018. The significant increase in data supporting the use of metabolic and bariatric surgery (MBS) in adolescents since 2012 strengthens these guidelines from prior reports. Obesity is recognized as a disease; treatment of severe obesity requires a life-long multidisciplinary approach with combinations of lifestyle changes, nutrition, medications, and MBS. We recommend using modern definitions of severe obesity in children with the Centers for Disease Control and Prevention age- and sex-matched growth charts defining class II obesity as 120% of the 95th percentile and class III obesity as 140% of the 95th percentile. Adolescents with class II obesity and a co-morbidity (listed in the guidelines), or with class III obesity should be considered for MBS. Adolescents with cognitive disabilities, a history of mental illness or eating disorders that are treated, immature bone growth, or low Tanner stage should not be denied treatment. MBS is safe and effective in adolescents; given the higher risk of adult obesity that develops

This manuscript was created by a subset of the Pediatric committee of the ASMBS with support of relevant additional experts where needed. It was reviewed and approved by the ASMBS Pediatric, Clinical Issues and Executive Committees as well as the general ASMBS membership before publication. It was also endorsed by the Society of American Gastrointestinal and Endoscopic Surgeons, SAGES.

*Correspondence: Janey S.A. Pratt, M.D., F.A.C.S., F.A.S.M.B.S, 300 Pasteur Drive, Always Bldg. M116, Stanford, CA, 94305.
E-mail: jsapratt@stanford.edu

https://doi.org/10.1016/j.soard.2018.03.019
1550-7289/© 2018 Published by Elsevier Inc. on behalf of American Society for Metabolic and Bariatric Surgery.

in childhood, MBS should not be withheld from adolescents when severe co-morbidities, such as depressed health-related quality of life score, type 2 diabetes, obstructive sleep apnea, and nonalcoholic steatohepatitis exist. Early intervention can reduce the risk of persistent obesity as well as end organ damage from long standing co-morbidities. (Surg Obes Relat Dis 2018;14:882–901.) © 2018 Published by Elsevier Inc. on behalf of American Society for Metabolic and Bariatric Surgery.

Keywords: Pediatric; Adolescent; Bariatric surgery; Metabolic and bariatric surgery; Weight loss surgery; Type 2 diabetes; Guidelines; Childhood obesity; Adolescent obesity; Guidelines for adolescent bariatric surgery; Morbid obesity

Overall rates of childhood obesity have tripled since the 1980s, the prevalence of obesity in adolescents has quadrupled [1,2]. Approximately 18.5% of youth in the United States meet the criteria of obesity (i.e., body mass index [BMI] percentile ≥95th for age and sex) while 8.5% of those 12 to 19 are categorized as severely obese (BMI ≥120% of the 95th percentile), representing approximately 4.5 million children [1,2]. Furthermore, severe obesity is currently known to be the fastest growing subcategory of obesity in adolescents [3].

Obesity is a multifactorial disease like cancer, caused by a combination of genetics, environment, and metabolic programming [4]. Unlike cancer, significant stigmatization is associated with obesity. Patients who suffer from this disease are often perceived as being responsible for their disease [5]. Studies show that healthcare professionals amongst others exhibit implicit bias against patients with obesity [6–8]. Education about the genetic and metabolic underpinning of obesity may decrease this bias [9,10].

In 2013, obesity was recognized by the American Medical Association as a disease, which opened the door to increased research in the field. Since the publication of the most recent American Society for Metabolic and Bariatric Surgery (ASMBS) best practice guidelines related to metabolic and bariatric surgery (MBS) in the pediatric population in 2012, there has been a significant increase in published reports of MBS being used to treat severe obesity in patients <19 years of age as well as reports of co-morbidity resolution with these operations [11,12]. There have also been a number of prospective studies examining long-term outcomes, cost-effectiveness, and improvement in weight-related quality of life [13–16].

Recently reported 3-year outcomes data from the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study, a prospective multiinstitutional observational study of 242 adolescents undergoing MBS, marked a turning point in the treatment of severe obesity in children [17]. While prevention remains the mainstay of obesity policy, in children who develop severe obesity, it has become clear that MBS is a safe and effective treatment for these children and should be considered more readily by primary care physicians. This consensus-driven paradigm is further supported in the context of disappointing outcomes related to the application of nonsurgical treatment modalities alone (i.e., diet, exercise, and behavior modification). The treatment of severe obesity in adolescents clearly requires a multidisciplinary approach where MBS should not be consigned to the treatment of last resort. Rather, when considered appropriate and within the clinical best practice guidelines, MBS should be readily offered to adolescents with obesity to effectively reverse co-morbidities and achieve overall wellness [18–23].

The rapidly expanding body of data related to adolescent MBS outcomes has rendered the most recent Best Practice Guidelines from the ASMBS (2012) to be outdated [24]. The aim of this current report, therefore, is to reevaluate and update recommendations based on contemporary publications. Through this updated communication, we hope to continue to provide guidelines for patients, their families, and physicians for referring and choosing MBS in the adolescent population. Our aim is also to remove the stigma against obesity and the surgical treatment of childhood obesity and educate pediatric physicians and providers about the need for early referral of patients suffering from severe obesity to a MBS program.

Overview of recommendation: Metabolic and bariatric surgery is a proven, effective treatment for severe obesity disease in adolescents and should be considered standard of care. Pediatricians and primary care providers should recognize that children with severe obesity require tertiary care and refer early to a MBS center with advanced treatments and support.

Methods and procedures

An extensive literature search using Pubmed was performed examining publications from January 2009 thru October 2017. Search terms included: weight loss surgery (WLS) and pediatrics, adolescents, gastric bypass, sleeve gastrectomy, laparoscopic adjustable band, and extreme obesity. There were 1387 abstracts reviewed and categorized into each topic discussed below (i.e., diabetes, pregnancy, choice of surgery, etc.). These smaller libraries, which varied in size from 3 to 137 articles each, were shared with each author who added additional references through the date of publication to support their section. Wherever possible, adolescent-specific data were used; however, 497 of the articles retrieved did not include adolescent data, and were used where adolescent data was not available. The articles included meta-analyses, randomized controlled trials, cohort studies, case reports, and prior systematic reviews with expert opinions.

Obesity disease-related co-morbidities and outcomes

Cardiovascular disease

A large body of literature links the disease of obesity, and in particular severe obesity, with the associated development of numerous cardiovascular disease (CVD) risk factors, the progression of frank cardiovascular pathophysiology, and functional abnormalities leading to premature mortality in adults. There is a dose-dependent increase in mortality from CVD in adults who suffer from obesity established during childhood. When children have a BMI >95th percentile, their risk of CVD mortality is increased 3 to 5 times at age 50 years [24]. There are now a handful of contemporary reports that have sought to directly address the potential improvements in baseline cardiovascular health after surgically induced weight loss [3,26]. As with other obesity-related co-morbid illnesses that have been extensively documented in the adult population, numerous researchers report evidence of the pathologic impact of severe obesity on the adolescent population being considered for metabolic and bariatric surgical intervention (i.e., hypertension [HTN], diastolic dysfunction and elevated cardiac work load, etc.) [27–29]. In combination with the existence of numerous markers of generalized cardiometabolic dysfunction (i.e., dyslipidemia, HTN, abnormal glucose metabolism, type 2 diabetes [T2D], and elevated levels of high sensitivity C-Reactive Protein [hs-CRP]) as well as recent evidence showing the high propensity for children with severe obesity to become adults with severe obesity, several recent studies support the use of MBS earlier in life [30–32].

In addition to a number of retrospective and single-centered studies showing unexpectedly high prevalence of dyslipidemia, HTN, insulin resistance, and T2D among teenagers presenting for MBS, a number of larger ongoing prospective studies have confirmed both baseline risk as well as longitudinal changes after MBS. In separate recent reports by Teeple et al. [30] and Inge et al. [32], both groups of investigators showed significant improvements in nearly all measures of CVD risk factors by 2 years after MBS. Furthermore, both studies showed significant “early” improvement as evidenced by marked improvement in most variables by 12 months after MBS. These data are further supported by more recent prospective studies examining the overall safety and efficacy of MBS in adolescents; where, significant benefits in cardiometabolic risk have been observed [17,33]. In a prospective analysis of 81 adolescents undergoing MBS at a single institution, Olbers et al. [34] showed significant improvement in a number of cardiometabolic risk factors in conjunction with significant reduction in excess weight. In particular, complete resolution of elevated serum insulin level (observed in 70% of patients before undergoing MBS) as well as marked improvements in several additional markers of cardiovascular health (lipid panels, systolic and diastolic blood pressure, hs-CRP, and hemoglobin A1C [HbA1C]) suggest the possibility of clinically relevant improvements in future morbidity and mortality rates as a result of such therapeutic intervention.

Most recently, the Teen-LABS research consortium, an ongoing National Institutes of Health–funded prospective observational study of 242 adolescent patients undergoing MBS, showed similarly high prevalence of cardiovascular-related risk [13]. Recently published longitudinal outcomes from the same study cohort demonstrate significant improvement in the overall prevalence of cardiovascular risk factors after surgically induced weight loss in addition to a notable decrease in multiplicity of associated risk factors [35]. In addition to the overall changes observed in risk prevalence, accompanying analysis identified several predictors of cardiovascular risk reduction during the postoperative study time period. Specifically, increased weight loss, female sex, and younger age at time of surgery predicted an increased likelihood of normalization of certain measured risk factors. While improvements in dyslipidemia, elevated blood pressure, glucose metabolism, and systemic inflammation (hs-CRP) in association with increasing weight loss are not altogether unexpected, results showing that younger participants were more likely to experience improvements in dyslipidemia and elevated hs-CRP levels compared with older patients is novel. Furthermore, females were more likely than males to experience significant improvements in blood pressure raising the possibility of ongoing refinement in the timing of surgical intervention [35].

Overview of cardiovascular disease: Adolescents with severe obesity have significant risk factors for CVD, including, hyperlipidemia, elevated inflammatory markers, HTN, and insulin resistance. MBS significantly improves these risk factors, and therefore would be expected to decrease morbidity and mortality from CVD long term. CVD risk factors should be considered a strong indicator for MBS.

Type 2 diabetes

Like the disease of obesity, T2D is a chronic, recalcitrant disease that has seen an increase in prevalence worldwide over the past 3 decades [13,17,34,36,37]. These parallel epidemics (obesity and T2D) pose a challenge to all healthcare providers [38,39]. Moreover, childhood obesity is not only linked to an increased incidence of T2D but can also be a predictor of an increased rate of death from cardiovascular events [37]. Adolescents with T2D show a decline in beta-cell function in the pancreas that is 4 times faster than that seen in adults [40]. End organ injury, especially kidney disease, occurs earlier in adolescents than adults and fails to respond to medical therapies for childhood-onset T2D [41]. In addition, HTN, CVD, retinopathy, depression, and neuropsychiatric co-morbidities are all associated with T2D and worsen over time. When children develop T2D at age 10, they can expect a risk of co-morbidities by age 15 (16%–39% microalbuminuria; 35%–46% HTN; 66% high triglycerides; 62% low high-density lipoproteins; 14% retinopathy; and 8% neuropathy). T2D is usually preceded by insulin resistance for several years; we should therefore include insulin resistance as an indication for MBS. Children with insulin resistance can have twice the fasting insulin levels of adults with the same BMI [42].

Only 2 medications, metformin and insulin, are currently Food and Drug Administration (FDA) approved in the United States for the treatment of T2D in adolescents. The TODAY study is the only large, randomized study that evaluated the treatment of T2D in adolescents [43]. This study looked at nearly 700 youth (12- to 16-years old) randomized to 3 treatment groups with metformin alone, metformin and rosiglitazone (a thiazolidinedione), or metformin in conjunction with lifestyle counseling. Outcomes after a median treatment time of 11.5 months showed failure, defined as HbA1C > 8% over 6 months, in 51.7% with metformin alone, 38.6% with metformin and rosiglitazone, and 46.6% in metformin plus lifestyle intervention. Weight loss was minimal at 2 years with any of the treatments. The severe adverse event rate associated with the study was 19% overall.

Despite the increase in obesity and T2D and the lack of effective medical therapies, most primary care providers view MBS with skepticism [44]. More recently however, an emerging body of evidence shows favorable outcomes related to adolescent MBS coupled with a multidisciplinary team model and very low rates of morbidity [14,45–48]. Additionally, both vertical sleeve gastrectomy (VSG) and Roux-en-Y gastric bypass (RYGB) adolescent MBS offer comparable results on short-term remission or partial remission of T2D [45,49–51].

In adults, several randomized controlled trials of maximal medical treatment compared with surgical treatment for T2D have shown superiority of surgical treatment [52–54]. Recent consensus in adults has led to the recommendation that MBS be considered as a primary treatment for T2D in adults. A recent analysis compared the outcome of 30 adolescents with T2D enrolled in the Teen-LABS study with a matched group of 63 individuals enrolled in the TODAY trial. Over a 2-year period of follow-up, mean HbA1C declined from 6.8% to 5.5% in Teen-LABS and increased from 6.4% to 7.8% in TODAY, while compared with baseline, BMI decreased 29% in Teen-LABS and increased by 3.7% in TODAY. Compared with medical management, surgical treatment of adolescents with severe obesity and T2D resulted in superior glycemic control, reduced weight, and improvement of other co-morbidities of T2D in youth [55]. Given the poor outcomes of medical treatment of T2D in adolescents as well as the significant risk of co-morbidity progression, MBS should be considered early in the prevention and treatment of T2D in children, especially those who fail medical therapy.

A recent study by Khidir et al. [56], demonstrates at 5 years after MBS in adolescents there was 100% resolution of insulin resistance compared with 96% in adults. Also at 5 years, 87% of adolescents and 59% of adults were off all medications for T2D. This is similar to findings in Teen-LABS at 3 years showing remission of prediabetes in 76% and T2D in 95% of adolescents [17]. Clearly MBS is an excellent treatment for and has been shown to provide prevention of T2D in the adolescent population.

Overview of Type 2 diabetes: Childhood-onset T2D fails medical therapy in >50% of cases and has a poor outcome with respect to end organ damage and early mortality. Insulin resistance in adolescents is more severe than in adults. Both the RYGB and VSG produce remission of insulin resistance and T2D in at least 90% of adolescents and should be considered as a primary therapy for children with T2D and severe obesity. Childhood-onset T2D and insulin resistance should be considered strong indications for MBS.

Obstructive sleep apnea

Up to one third of children and adolescents with obesity may have obstructive sleep apnea (OSA) [57]. The severity seems to increase with age, and children with OSA experience increased morbidity and mortality independent of other risk factors [58–60]. The prevalence of OSA is even greater among adolescents presenting for MBS, ranging from 46% to 70% [32,60,61]. Recent data demonstrate substantial improvement and/or resolution after MBS in adolescents, consistent with the outcomes in adults, with no increased morbidity or mortality [62,63]. Thus, OSA (e.g., apnea-hypopnea index >5) is a strong indication for performing MBS earlier.

Overview of obstructive sleep apnea: OSA has been shown to cause significantly decreased health-related quality of life (HRQoL) with increased risk of morbidity and mortality in adolescents. MBS in adolescents results in significant improvement or resolution of OSA. Thus, OSA should be considered a strong indication for MBS.

Nonalcoholic fatty liver disease (NAFLD) and steatohepatitis (NASH)

Nonalcoholic fatty liver disease (NAFLD) is a generic term for a wide spectrum of disease that ranges from fatty liver to advanced fibrosis and cirrhosis to hepatocellular cancer and end-stage liver failure. A study of childhood and adolescent liver epidemiology showed NAFLD in 9.6% of children between age 2 and 19 years [64]. However, Xanthakos et al. [65] evaluated the prevalence of NAFLD in children undergoing MBS in the Teen-LABS population. Of 165 patients who underwent liver biopsy at time of surgery, NAFLD was present in 59% patients with 24%

borderline NASH and 10% showing definite nonalcoholic steatohepatitis (NASH) [65,66].

Treatment of obesity is the mainstream of management of NAFLD. Manco et al. showed that VSG is more effective than lifestyle intervention for reducing NASH and liver fibrosis in adolescents with obesity [50]. One of the largest studies in 109 adult patients with biopsy proven NASH and/or fibrosis showed 85% resolution of NASH and 34% improvement in fibrosis 1 year after MBS [67]. Hence, MBS should be recommended in patients with NAFLD.

Overview of nonalcoholic fatty liver disease (NAFLD) and steatohepatitis (NASH): NAFLD may be present in at least 59% of adolescent patients referred for MBS. Given complete resolution of NASH in approximately 85% of patients who undergo VSG or RYGB, NAFLD should be considered a strong indication for MBS in adolescents with severe obesity.

Idiopathic intracranial hypertension

Idiopathic intracranial hypertension (IIH) is defined as elevated intracranial pressure without clinical, radiologic, or laboratory evidence of a cause. IIH can lead to permanent visual impairment or blindness. IIH is also known as pseudotumor cerebri, benign intracranial hypertension, and pseudotumor cerebri syndrome. The overall incidence of IIH in the United States is 1 per 100,000 people, but increases to 15 to 19 per 100,000 in women between 20- and 44-years old with obesity [68]. There is a strong association between childhood obesity and increased risk of pediatric IIH [69]. The incidence of IIH in youth with obesity is lower in prepubertal children than in adolescents [68,69].

The diagnosis of IIH is challenging in children [70]. Preserving vision and controlling symptoms are the goals of therapy. There are no randomized controlled trials in children; therapeutic decisions are based on adult experience.

Response to all therapies is variable. Ventricular/lumbar peritoneal shunts have been used to lower intracranial pressure, preserve vision, and relieve other symptoms [71,72]. There are published case reports of success with weight loss after RYGB [73–75]. Loss of as little as 6% of weight has been noted to reduce intracranial pressure [76].

IIH is a known co-morbidity of obesity in adults and in children. Children with obesity need to be monitored for IIH. One study in adults showed an incidence of 2.8% with abnormalities on nonmydriatic fundus photographs and a 0.6% incidence of asymptomatic optic disc edema in 606 patients with obesity [77]. When IIH is discovered, a progressive treatment algorithm proceeding from medical to surgical therapies should be applied.

Overview of idiopathic intracranial hypertension: Adolescents who suffer from severe obesity and have failed medical management of IIH should be considered for MBS. There is little published data, however expert opinion supports MBS as effective and safe in treating IIH associated with severe obesity.

Orthopedic disease

There are pediatric orthopedic complications of obesity that are not seen in adults or described in the adult literature. Blount's disease (tibia vara) and slipped capital femoral epiphysis (SCFE) are diseases associated with childhood obesity. There are some case reports demonstrating resolution of Blount's disease after MBS [78–80]. Recent data from Teen-LABS indicates that MBS improved functional mobility and reduced walking-related musculoskeletal pain [81]. In light of the fact that children with Blount's disease may continue to gain weight after orthopedic repair of the associated deformities [82], leading to recurrence and possible need for further surgeries, it follows that MBS should be considered within the clinical treatment armamentarium of this subpopulation and in fact, may warrant consideration before related orthopedic interventions are carried out [83].

Patients with a BMI $>$95th percentile for age are at higher risk of developing bilateral SCFE. A recent large study in the United Kingdom showed that in children $<$16 with SCFE, there was a 2 standard deviation elevation in BMI over those without the disease [84]. While the orthopedic literature recognizes the risk of bilateral SCFE to be as high as 80% in those who present with unilateral disease and they also recognize that a BMI $>$95th percentile is one of the risk factors, they have failed to consider MBS as a treatment option [85]. Based on case reports and expert opinion, when a patient with obesity presents for repair of stable SCFE that can be delayed, then MBS should be considered before orthopedic surgery. Furthermore, if a patient has undergone repair of 1 hip, MBS should be considered to possibly prevent bilateral disease.

Overview of orthopedic disease: Patients who suffer from severe obesity complicated by SCFE or Blount's disease should be considered for MBS to potentially improve outcomes surrounding orthopedic operations and to reduce the risk of developing bilateral or recurrent disease.

Gastroesophageal reflux disease

Gastroesophageal reflux disease (GERD) is commonly associated with obesity, thought to be, in part, caused by increase intraabdominal pressures. Several studies indicate that weight loss improves GERD. Nissen fundoplication was once thought to be less effective in patients with severe obesity [86]; however, more recent studies suggest that there may be little difference in outcomes based on weight [87]. That said, fundoplication surgery should not be performed in patients who are likely to require MBS in the future due to the significant increase in operative difficulty and complications associated with converting a fundoplication to a VSG or RYGB [88]. RYGB has been shown to be highly effective in treating GERD and should be the treatment of choice in patients with severe GERD and severe obesity unless contraindicated [89].

New-onset GERD may occur after VSG in approximately 30% to 60% with a high incidence of eosinophilic esophagitis noted on endoscopy [90,91]. Weight loss induced by VSG can also result in resolution of preexisting GERD. More research is needed to identify best surgical treatments for adolescents who suffer from obesity and GERD.

Overview of gastroesophageal reflux disease: GERD should be considered a strong indication for MBS in adolescents. RYGB is highly effective at treating GERD and should be considered the most effective treatment for patients with severe obesity and GERD. It is unclear if VSG may also be a reasonable approach to patients with GERD and obesity (as long as there is no evidence of Barrett's esophagus), as weight loss alone may resolve GERD in some of these patients. Fundoplication surgery should be avoided in patients who may require MBS in their lifetime.

Quality of Life

Adolescents with severe obesity report severe impairments in health- (HRQoL) and weight-related quality of life [92,93]. Most recent advances indicate severity of impairments were more notable for females, and for both sexes in the areas of weight-related physical comfort (e.g., fitting into public seating, bending over), body esteem (e.g., shame and avoidance of activities due to weight), and social life (e.g., weight-based teasing, social exclusion) [93]; moreover, the greater the severity of excess weight, the greater the quality of life impairment. Initial outcome reports demonstrate that, along with substantial and durable weight loss, adolescents report marked and sustained improvements in HRQoL and weight-related quality of life after RYGB, VSG, and adjustable gastric banding (AGB) across the first 3 postoperative years [17,94–97]. For RYGB, quality of life improvements recently were demonstrated beyond 5 years, as patients age into young adulthood [34,98].

Overview of quality of life: Adolescents with severe obesity report significant impairment in quality of life, with marked and sustained improvements in relation to surgically induced weight loss beyond 5 years. Therefore, reduced HRQoL should be considered a significant indication for MBS.

Mental health

There have been notable advances in our understanding of the mental health status of the adolescent patient. Our initial guidelines were informed by an early literature describing high rates of depressive symptoms in adolescents presenting at preoperative evaluations and in those who proceeded to surgery [99–103]. More contemporary multisite data [104] have reported rates of psychopathology in adolescents approved and undergoing MBS (RYGB, laparoscopic VSG, AGB) as no higher than national adolescent base rates (i.e., National Co-morbidity Study Adolescent Supplement) [105], yet lower than adolescents with severe obesity-seeking lifestyle intervention. While it is possible that psychosocial approval processes have grown more stringent over time, more likely, patients with less psychosocial impairment are now seeking/being referred for, and proceed, to MBS. For example, a recent single-site report demonstrated that noncompletion of the preoperative phase for an AGB trial was predicted by presentation of clinically significant psychopathology at intake [106].

Nonetheless, there is a subgroup of adolescents who do progress to MBS with mental health symptomatology that can be internalizing (≈1 in every 3 patients report depressive and anxiety symptoms) and/or externalizing (≈1 in every 8 patients report anger/disruptive behaviors) in nature [104]. Outcome data characterizing mental health domains after surgical intervention are more limited and short term in focus, but suggest general improvement in adolescent internalizing and externalizing behaviors at 1 and 2 years [94,95,97,101,107]. There is also a suggestion of a persistence of poor mental health for some patients at 2 years [108]. However, there is no initial evidence that preoperative or persistent psychopathology has impact on initial weight loss outcomes [95,108].

Adolescent guidelines to date have suggested that, in the absence of long-term outcome data and with the several exceptions (i.e., active substance use disorder, active psychosis, current suicidality), symptoms that are well managed and monitored by adjunctive providers should not be considered a contraindication for MBS. This continues to be true. Nonetheless, the presence and persistence of adolescent/young adult psychopathology, independent of MBS, is a known risk factor for other life challenges (i.e., employment, education, residential stability) [109] and is also a potential correlate to other known risks in this age group (i.e., substance use [109], suicidal behaviors [110]); risks already identified as clinical concerns in this population based on the adult MBS experience [111–113]. Thus, adolescents who undergo MBS with mental health concerns will benefit from provider discussions about their need for monitoring and care postoperatively to both promote positive mental health and reduce the potential for long-term negative consequences.

Overview of mental health: With the exception of active psychosis, suicidality, or substance abuse, mental health disorders are not a contraindication to MBS in adolescents. As with any subspecialty clinic, patients who present with mental health disorders should be carefully monitored after surgery to promote positive mental health and reduce the potential risk of further mental *health complications (i.e., new substance abuse or suicidality).*

High-risk social contexts

There are a number of contextual factors to be recognized and effectively managed in adolescent clinical care.

Family factors: Unlike adult patients, adolescent treatment appropriately involves caregivers. Our initial guidelines acknowledged the importance of family support, knowledge, and motivation to determine an adolescent's eligibility [114,115]. Based on the multigenerational nature of obesity, it is not surprising that the majority of adolescents under metabolic and bariatric care have a primary caregiver who has obesity, if not severe obesity [116]. Interestingly, approximately 1 in 4 adolescents have a primary caregiver who has undergone MBS themselves [116]. Rates of problematic family functioning are notable (i.e., 1 in every 2–3 families) with adolescents and caregivers reporting unhealthy communication, less interest/involvement with one another, and challenges in working together [116]. Initial evidence that these types of family factors impact short-term weight loss outcomes have been mixed. For example, AGB patients reporting higher family conflict experienced poorer weight loss outcomes at 1 year [95]. Yet, in the larger multisite sample of predominantly RYGB and VSG patients [116], none of the family contextual factors (family dysfunction, caregiver mental health, social support, caregiver BMI, caregiver history of MBS) were related to adolescent weight loss outcomes at 1 and 2 years [116]. Whether family factors have impact on other critical patient outcomes (i.e., perioperative safety, nutritional risks, psychosocial health) remains unknown.

Overview of family factors: Family dysfunction is not uncommon, yet there is not strong evidence suggesting it impacts adolescent weight loss after MBS, at least in the short term, and therefore should not be considered a contraindication to MBS in adolescents.

Child maltreatment: Our earliest guidelines [114,115] cautioned that a history of child maltreatment, and specifically sexual and physical abuse, might present a contraindication to adolescent MBS or interfere with treatment. Recent data indicate that approximately 29% of females and 12% of male adolescents with severe obesity in clinical weight management settings, including those undergoing MBS, report a history of child maltreatment (i.e., all forms of physical, emotional, and sexual abuse and/or neglect) [117]. Rates of physical and sexual abuse specifically for adolescents undergoing MBS were 7.3% and 8.3%, respectively. These rates are no higher than national adolescent base rates, but contrast with the adult literature that has child maltreatment rates as high as 66% [118]. There remains no adolescent empirical base to suggest a history of any form of child maltreatment would serve as a contraindication to MBS, with only 1 empirical study [95] suggesting involvement with family services (i.e., alleged abuse and/or neglect) was unrelated to 1-year weight loss after AGB. Furthermore, the adult literature to date indicates similar weight loss and health outcomes among maltreated and nonmaltreated patients [119–121]. With this in mind, across adolescent and adult patients, those with a child maltreatment history bring greater psychosocial impairment into the clinical setting [117,118,122]. As previously outlined by Zeller et al. [117], psychosocial providers in pediatric programs are uniquely positioned to assess a patient's maltreatment history and play a crucial role in facilitating appropriate referrals to adjunctive care. Providers may find the American Academy of Pediatrics trauma guide a helpful resource [123].

Overview of childhood maltreatment: Adolescents with a history of maltreatment may present with greater psychosocial challenges in general, but there are no data to suggest a history of child maltreatment is a contraindication for MBS.

Substance use behaviors: Since the publication of our previous guidelines, the adult MBS literature has documented problematic alcohol use behaviors (use, abuse) increase postoperatively in adult RYGB patients, with rates of alcohol use disorder estimated at 8% to 9% at 2 to 3 years postoperatively, including adults with no previous alcohol use disorder history [112,124]. Moreover, pharmacokinetic studies have demonstrated that RYGB patients, specifically, experience heightened alcohol sensitivity postoperatively with implications for clinical safety [125]. In response, recommendations for the assessment and management of alcohol use in adults after MBS have been published [126], with the most recent ASMBS adult clinical practice guidelines asserting, "following RYGB, high-risk groups should eliminate alcohol consumption" [127]. While the adolescent patients were not identified in these position statements, appropriate patient care at the program level was assumed.

It is well established that alcohol use behaviors typically have initial onset and increase from adolescence into young adulthood [128,129], launching some on a trajectory to abuse and dependence by adulthood [130,131]. Alcohol is also the most frequently used substance by adolescents in general [132], including those with severe obesity [133,134]. Moreover, adolescents drink differently than adults, typically consuming more drinks per occasion (i.e., binge drinking) [135].

Our current knowledge about the adolescent patient is based on recent multisite data from the Teen-LABS consortium [136]. A minority of adolescents ($<10\%$) reported having consumed any alcohol in the year before MBS with prevalence of any alcohol use increasing across the first 2 postoperative years (≈30% reported consuming alcohol during the second postoperative year). These rates of postoperative alcohol use were lower than national base rates for adolescents/young adults. Moreover, the increasing rate of those who consumed alcohol was also seen in a nonoperative comparison group of adolescents with severe obesity followed over the same course of time. Although fewer adolescents drank alcohol than normative base rates, a significant minority of those who drank alcohol did so in potentially dangerous ways. One in every 2 to 3 reported typically consuming of >3 drinks when drinking and ≥ 1 instance when they consumed >6 drinks in a single sitting. One in 4 reported having experienced alcohol-related harm. Finally, screening rates for alcohol use disorder, while comparable for RYGB, laparoscopic VSG, and nonoperative groups (≈9%), are comparable to adult postoperative rates at a similar time point [112,124]. As previously outlined [136], routine screening of alcohol use is imperative across all procedures. Conservative clinical care guidelines that strongly advocate abstinence, while appropriate, must also include information for this age group on harm reduction (i.e., lower consumption levels, how to avoid or manage situations related to alcohol-related harm) to mitigate clinical and safety risks.

Alcohol, as well as smoking and vaping of nicotine and nonsteroidal antiinflammatory drug use, are significant risk factors for ulcer formation after RYGB, accounting for 75% of ulcers found 1 study [137]. Adolescents with obesity were more likely to use both cigarettes and e-cigarettes than their normal weight peers [138]. According to the Centers for Disease Control and Prevention, the use of e-cigarettes or vaping is on the rise in adolescents; up to 16% of high school students compared with 9.3% who were smoking [139]. E-cigarettes are also being advertised to teens as a treatment for obesity [140]. Adolescents should be counseled regularly about the risk of smoking or vaping with nicotine after RYGB. There are no studies showing adverse outcomes associated with marijuana use at this time. We lack knowledge about other substance use behaviors but expect studies to be forthcoming.

Overview of substance use behaviors: Initial evidence suggests adolescents increase alcohol use after MBS, largely due to age-related trends. With this in mind, binge drinking and alcohol-related harm might signal increased risks for this patient population. All adolescent patients undergoing MBS should be routinely screened and counseled on the risks of alcohol misuse and abuse. Smoking or vaping with nicotine should be strongly discouraged after MBS, specifically RYGB.

Disordered eating

A recent meta-analysis indicated that approximately 1 in 4 children and adolescents with overweight or obesity report binge eating or loss of control eating (LOC) [141]. Disordered eating behaviors are not uncommon in adolescents with severe obesity considering or undergoing MBS [93,95] with LOC the most prevalent [142]. Recent data from the Teen-LABS consortium reported 26.9% adolescents met criteria for LOC compared with binge eating disorder (6.6%), night eating syndrome (5%), or bulimia nervosa (1%) before surgery [142]. Correlates of preoperative binge eating disorder and/or LOC include greater comorbid psychopathology and poorer weight-related quality of life [93,102,142], suggesting disordered eating may be a signal for other psychosocial burden. Unfortunately, our understanding of whether LOC or any other disordered eating behaviors change for adolescent patients after MBS or are related to adolescent weight loss outcomes is largely unknown. Fortunately, psychotherapeutic interventions, such as cognitive-behavioral therapy, family-based therapy, and executive skill building, as well as some pharmacotherapies, show effectiveness in reducing binge eating and LOC and improving weight loss outcomes [143,144].

There is initial evidence that for AGB specifically, preoperative LOC has been linked to poorer adherence to postoperative visits [145] as well as weight lost at 1 year [95]. Adult literature demonstrates that while disordered eating behaviors may decline after MBS (RYGB, AGB, VSG), patients who exhibit disordered eating postoperatively, and LOC specifically, have suboptimal weight loss outcomes [143,144,146,147]. Thus, patients who screen

Table 1
Indications and contraindications for adolescent metabolic and bariatric surgery (MBS)

Indications for adolescent MBS include
• BMI $\geq$35 kg/m^2 or 120% of the 95th percentile with clinically significant co-morbid conditions such as obstructive sleep apnea (AHI >5), T2D, IIH, NASH, Blount's disease, SCFE, GERD, or hypertension; or BMI $\geq$40 kg/m^2 or 140% of the 95th percentile (whichever is lower).
• A multidisciplinary team must also consider whether the patient and family have the ability and motivation to adhere to recommended treatments pre- and postoperatively, including consistent use of micronutrient supplements.
Contraindications for adolescent MBS include
• A medically correctable cause of obesity
• An ongoing substance abuse problem (within the preceding yr)
• A medical, psychiatric, psychosocial, or cognitive condition that prevents adherence to postoperative dietary and medication regimens.
• Current or planned pregnancy within 12 to 18 mo of the procedure

BMI = body mass index; AHI = apnea-hypopnia index; T2D = type 2 diabetes; IIH = idiopathic intracranial hypertension; NASH = nonalcoholic steatohepatitis; SCFE = slipped capital femoral epiphysis; GERD = gastroesophageal reflux disease.

positively for eating disordered behavior, both before and after MBS, should receive appropriate intervention. Ongoing support from behavioral health providers as part of an interdisciplinary medical team is recommended.

Overview of disordered eating: LOC eating is the most common type of disordered eating in the adolescent patient presenting for MBS (∼1 in 4 patients). LOC eating should be routinely assessed, treated, and closely monitored before and after MBS. However, given that it is treatable, LOC eating should not be considered a contraindication to MBS.

Decision making

Patient selection

While there may be children who should be considered for MBS before adolescence due to complications from obesity, we define adolescence here by the World Health Organization definition as a person who falls between the ages of 10 and 19 years of age [148].

In 2009, Flegal et al. [149] suggested the expression of severe obesity as a percentage >95th percentile; 120% of the 95th percentile of BMI for age was similar to unsmoothed 99th percentile. By 2012, Gulati et al. [150] had created new growth charts to augment Centers for Disease Control and Prevention growth charts, which allow clinicians to track and visualize BMI percentile values in children with severe obesity. These growth charts define a child/adolescent's BMI as a "percentage of the 95th percentile." In 2013, the American Heart Association recommended that severe obesity in children ≥2 years of age and adolescents be defined as a BMI ≥120% of the 95th percentile or an absolute BMI ≥35 kg/m^2, whichever is lower based on age and sex [3]. Furthermore, the American Heart Association recommends that this definition be used consistently in clinical and research settings. Most recently, Skinner and Skelton expanded the definition of severe obesity to include class I, II, and III obesity using the following American Heart Association criteria: obesity class I (≥95th percentile to <120% of the 95th percentile); obesity class II (≥120% to <140% of the 95th percentile) or a BMI ≥35 to ≤39 kg/m^2, whichever was lower; or obesity class III (≥140% of the 95th percentile) or BMI ≥40 kg/m^2, whichever was lower [151].

Indications for MBS in adolescents largely mirrors the recommendations for adults; however, there are co-morbidities that only affect adolescents and therefore require inclusion. In adults, the National Institutes of Health recommend consideration of MBS for individuals with BMI ≥40 kg/m^2. MBS is also indicated for adults with a BMI ≥35 kg/m^2 if the individual has significant current co-morbidities, including severe OSA, T2D, HTN, or NASH. In adolescents, we feel that it is important to look at the percentile BMI values especially in cases where severe medical conditions exist, affecting children's quality of life and/or wellbeing. MBS should be considered for patients with a BMI ≥120% of the 95th percentile with hyperlipidemia, HTN, T2D, insulin resistance, depressed HRQoL, GERD, OSA, NAFLD, orthopedic disease, IIH, or a BMI ≥140% of the 95th percentile. There are online tools available to help make these calculations [152].

There are no data to suggest that a youth's puberty status, as measured by Tanner staging, or linear growth, as measured by height, is adversely affected by MBS. In fact, 1 study by Alqahtani et al. [153] showed improved linear growth in children after VSG compared with matched controls. There is no reasonable argument to support limiting access to MBS based on bone age or Tanner stage. Indications and contraindications for adolescent MBS are included in Table 1.

Overview of patient selection: A BMI ≥120% of the 95th percentile with a co-morbidity or a BMI ≥140% of the 95th percentile should be used when determining weight cutoffs for adolescents to undergo MBS. Tanner stage and linear growth should not be used to determine readiness for adolescent MBS. Adolescents are defined by the World Health Organization's definition of 10- to 19-years old, but younger children who meet the other criteria could be considered when benefit outweighs risk.

Special cases

In cases of Prader-Willi Syndrome (PWS), hypothalamic obesity (HyOb), and other syndromic obesities, there are several small series as well as a meta-analysis in adolescents looking at the value of surgical therapies. As recently as 10 years ago, a critical analysis of MBS in adolescents with PWS suggested that outcomes were not as good as in children without syndromic obesity [154]. Alqahtani published a case-matched study of 24 children with PWS and those without, which confirmed outcomes of more weight regain after VSG in patients with PWS; however; the VSG was safe and effective showing a 5-year sustained BMI drop of 10 points [155]. Other small studies have shown excellent early weight loss with VSG in PWS patients [156,157].

The role of MBS in adolescents who have HyOb as a result of craniopharyngioma (CP) was reviewed in a meta-analysis by Bretault et al. [158]. The analysis looked at 21 adolescents and adults who underwent RYGB (6), VSG (8), AGB (6), and biliopancreatic diversion (BPD) (1) for HyOb from CP. Bretault et al. [158] concluded that the analysis demonstrated safety and efficacy of MBS procedures in patients with HyOb from CP for whom there is no other effective treatment available. Although outcomes were quite variable, the RYGB appeared to be more effective at maintaining long-term weight loss than the VSG or AGB in several other supporting studies [159,160]. A few very recent studies suggest that this may be related to the lack of postprandial glucagon-like peptide 1 secretion after CP; more research is needed [161,162].

Overview of special cases: Given the lack of other options in children with PWS, other syndromic obesity, or HyOb, MBS should be considered, especially when co-morbidities exist.

Informed consent

Informed consent for MBS on an adolescent <18 years requires consent by a parent or guardian and assent by the adolescent when possible. Both parent and adolescent must be informed of the risk and benefits of the surgery and the long-term outcomes expected. Some key facts to explain are as follows: (1) adolescents with severe obesity are at increased risk for adult obesity with increasing age and weight; (2) MBS is the most effective and durable treatment for severe obesity in adults and adolescents; however, lifestyle modification, exercise, and medications may be necessary to maintain long-term outcomes; (3) complications and risks of obesity outweigh the complications and risks of MBS in most adolescents; (4) lifelong vitamin level monitoring and supplemental vitamins are necessary after any metabolic and bariatric procedure [163]; (5) long-term there may be need for further surgery or procedures after MBS; (6) weight loss failure, weight regain, and return of or failure to resolve co-morbidities may occur; (7) follow-up and screening for complications specific to RYGB including ulcers and internal hernias and to VSG including GERD should be discussed; and (9) long-term unanticipated results may occur after MBS. It is important to assess both parent and adolescent understanding of these facts before proceeding.

We do not want to exclude patients with limited decision-making capacity who suffer from severe obesity and/or co-morbidities for which surgery is the only effective therapy. When there is not clear decision-making capacity, the care team should agree on what is most beneficent for the adolescent based on the adolescent's own obesity/co-morbidity risk, social, cognitive, and emotional condition and assist the adolescent and parent in gaining as clear an understanding as is possible [164–166]. It is important to demonstrate before MBS that the lifestyle changes required to succeed after surgery can be maintained by the child and caregiver. If the child is severely handicapped and fully dependent on the caregiver then an alternative caregiver should also be available should something happen to the first. In cases where the child cannot assent to the surgery, presentation before the local ethics board should be considered.

However, when there is decision-making capacity, one must be very careful when there is disagreement between parent(s) and the adolescent. Thorough evaluation of both parental and adolescent comprehension of obesity and MBS should be made. MBS should only be performed when both the parent consents and the adolescent assents to the procedure.

Overview of informed consent: When the adolescent is able to assent, then MBS should only be done if one can obtain assent as well as parental consent. When a child does not have the decisional capacity, but is able to demonstrate the ability to make lifestyle changes required by MBS with or without the assistance of a dedicated caregiver, then MBS should be considered. Both parents and the entire multidisciplinary team with consultation of the ethics committee, where appropriate, should agree that MBS is the best course of action for the adolescent.

Program requirements

Several studies support improvement in quality and safety through clinical accreditation [167,168]. The Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), offers review and accreditation for both freestanding pediatric programs and adult programs with adolescent teams. In their guidelines, program staffing is clearly delineated and our recommendation is to follow MBSAQIP guidelines. These guidelines currently require a pediatric or adolescent-trained medical physician as the "pediatric medical advisor" and a psychologist, psychiatrist, or otherwise adolescent-trained licensed counselor who can provide care as a "behavioral specialist." There is a requirement for a moderate volume metabolic and bariatric surgeon either adult or pediatric and a transition plan into an adult program. We would also strongly recommend a program coordinator as the process and requirements for insurance approval remain daunting.

The MBSAQIP facilities and equipment requirements lay out very clearly the need for larger beds, wheelchairs, x-ray equipment, and floor-mounted toilets. MBSAQIP also provides guidance for ensuring transition of care from pediatric to adult metabolic and bariatric programs. As with any chronic disease, transition of care is essential to sustained health and preventing complications. Even if a program does not plan for MBSAQIP accreditation, following these guidelines should assure the comfort and safety of pediatric patients undergoing MBS [169].

Overview of program requirements: We recommend that all adolescents with severe obesity be referred, early, to MBS programs that are established for adolescents and follow MBSAQIP program recommendations.

Treatments

Types of metabolic and bariatric surgery

In 2013, a meta-analysis was published that reviewed all case series of adolescent and pediatric patients undergoing MBS [11] and 637 adolescent patients were reported in 23 studies; by 2015, another meta-analysis only looking at studies of >10 patients found 37 studies with 2655 unique patients. These data, in addition to the recently published 3-year outcomes of Teen-LABS, a prospective observational study of 242 adolescents, and 2 long-term (>7 yr) outcome studies, provide enough data to definitively state that MBS in adolescents is at least as effective and safe as in the adult population. Today, the procedure of choice in adults worldwide is the VSG. This operation is also the most common operation performed in adolescents.

Adjustable gastric band. In 2001, the AGB was approved by the FDA in the United States [170] for adults and soon after was studied formally in adolescents. Paulus et al. [12] reviewed 18 studies with 607 patients who underwent AGB and reported a mean BMI loss of 11.6 kg/m^2. Complication rates reported by Paulus et al. [12] showed no deaths with a complication rate of 10.5% with 0 to 128 month follow-up and gastrointestinal complaints in 9.9%; reintervention rate was 14.7%. Even though the FDA-approved (LBA-001) multi-institutional industry trial (Allergan, Madison, New Jersey) was completed in 2013 in adolescents, to date no data have been published. The AGB is currently not FDA approved in patients <18 years of age who are not part of a trial.

There are more data internationally supporting use of the AGB in adolescents than there are in the United States. For example, Pena et al. [171] reported a prospective study on 21 adolescents undergoing AGB with a follow-up for 48 months, which showed a median BMI loss of 10 kg/m^2 (7–14.6). The study had 4 early minor and 12 late band or weight loss-related complications; no deaths were seen in this cohort. Reintervention rate was 42%, which includes the band removals. Given the high failure rate and increased need for reintervention [171], we do not feel the AGB should be the preferred weight loss procedure in adolescents.

Roux-en-Y gastric bypass. RYGB has been performed since the late 1960s and laparoscopically since the early 1990s. The Teen-LABS data updated in 2016 includes 161 adolescents who underwent RYGB with a 3-year follow-up [17]. In addition, Paulus et al. [12] evaluated 6 studies with 242 RYGB patients for BMI loss and 9 studies with 495 patients reviewed for complications. These studies showed a mean BMI loss of 15 kg/m^2 and 16.6 kg/m^2, respectively. The reintervention rates, including endoscopies with dilations, were 19% in the Teen-LABS study and 17% in Paulus et al [12] review. The 30-day complication rates were reported to be 9.3% from Inge [25] and 11% in the meta-analysis [12]. Resolution of co-morbidities and quality of life were recorded both as being significant.

There is a recent study from Sweden looking at 81 adolescents who underwent RYGB and 81 matched adolescent controls [34]. This study followed patients for 5 years and showed significant sustained BMI loss of 13 kg/m^2 compared with weight gain in controls. There was a 90% success rate of losing and maintaining at least 10% of total weight and a 25% reoperation rate. In the controls, there was a 25% rate of undergoing MBS.

The benefit from RYGB clearly outweighs the risk in most adolescents with severe obesity; however, any adolescent who is smoking or living with those who smoke is at a significantly higher risk of complications after RYGB surgery [172,173]. Caution should be used in adolescents who have significant issues with medication compliance, due to the dependence on vitamins after surgery [174]. Finally, in patients who suffer from severe GERD, RYGB is superior to the VSG for the treatment of reflux.

Vertical sleeve gastrectomy. VSG became recognized as a stand-alone procedure for weight loss with metabolic mechanisms in early 2000. Since the last recommendations, VSG has become the preferred choice for MBS in both adults and adolescents [17]. The BMI loss with VSG is reported to be 13 kg/m^2 in the Teen-LABS data and 14.1 kg/m^2 in the Paulus et al. [12] review. VSG is particularly attractive for the adolescent population due to the lower risk of complications than the RYGB. In the Paulus et al. [12] review, the 30-day complication rate was 2.7% and in the Teen-LABS data, it was 4.5%. The reintervention rate for VSG was 11% in the Teen-LABS study at 3 years and 1% in the Paulus et al. [12] study. There is a single-center study looking at 226 children and adolescents 3 years after VSG that found a 20 kg/m^2 drop in BMI [175]. VSG does have a slightly lower co-morbidity resolution rate compared with RYGB; however, given similar weight loss and a significantly lower complication rate, the VSG has become the most recommended operation in the adolescent population. We still lack significant long-term outcomes data on VSG and should remember that the RYGB remains a safe and effective operation with significant long-term outcomes data. Due to asymptomatic GERD occurring after VSG in adults, periodic postoperative screening could be considered after VSG in adolescents.

Biliopancreatic diversion with or without duodenal switch. There remains little data on adolescent patients undergoing BPD. While in adults this operation has shown the best weight loss and resolution of T2D and other co-morbidities, BPD still carries a high risk of protein calorie malnutrition and vitamin deficiencies, especially of the fat-soluble vitamins. In 2016, the Board of the Spanish Society for Obesity Surgery and Metabolic Diseases proposed a study of childhood obesity by using the Delphi method. This prospective study involved 60 experts from 9 national societies. In the specific questions on surgical technique, the experts agreed on the need to abandon BPD in adolescents because it leads to excessive operative morbidity and severe nutritional deficiencies [176]. While newer versions of BPD with duodenal switch and single anastomosis duodenal switch that leave a long (>300 cm) common channel may be reasonable alternatives, more studies will be needed. There would remain a need for strict dietary adherence; the most recent review of single anastomosis duodenal switch shows 34% of patients with macronutrient deficiencies [177]. Our committee remains in agreement that this operation should be reserved for adults in most cases. After VSG, BPD with duodenal switch, or single anastomosis duodenal switch could be done as a staged procedure for inadequate weight loss or weight regain once the adolescent reaches adulthood.

Overview of metabolic and bariatric surgery types: VSG and RYGB can be considered both safe and effective treatments for severe obesity in adolescents. When deciding which operation to use in adolescents, consideration of complications associated with vitamin deficiencies, durability, and reoperation must take high priority. The risk of reoperation is significantly higher in BPD and AGB than in the other 2 operations, making these less desirable choices.

Pharmaceuticals

Weight loss medications are useful in the treatment of children and adolescents with obesity [178,179], but there are only a few medications that have been formally evaluated in the population [180]. While there has been a recent increase in the number of medications approved for treatment of obesity in the adult population, only metformin and orlistat are routinely prescribed in the pediatric population [181]. In addition, despite the relatively low efficacy of orlistat in comparison to other weight loss medications, it is the only drug currently approved by the FDA for treatment of obesity in children and adolescents [182]. Studies that evaluate the long-term treatment of obesity in adults with pharmacotherapy as an adjunct to lifestyle intervention demonstrate greater mean weight loss and an increased likelihood of achieving clinically meaningful 1-year weight loss relative to placebo [183].

In a recent Cochrane systematic review, the efficacy of weight loss medications in 2484 children and adolescents was evaluated in 29 trials, 8 of which were ongoing. These trials included an evaluation of metformin (15 trials), sibutramine (6 trials), orlistat (4 trials), topiramate (2 trials), exenatide (2 trials), and 1 trial investigated the combination of metformin and fluoxetine [184]. In the interventions that were 12 to 48 weeks in length, there was a mean difference in BMI of -1.3 kg/m^2 (95% confidence interval -1.9 to -0.8; $P < .00001$). Despite these trials, there is limited information on the efficacy and safety of medication for weight loss in children [185]. Yet, weight loss medications show promise for treatment both as an adjunct to lifestyle and for persons with inadequate weight loss or weight regain after MBS [186].

Overview of pharmaceuticals: Medications have a useful role as adjunct therapy for the treatment of adolescents with severe obesity who undergo MBS. The medication choice, dosage, and timing will require further research in the adult and pediatric populations.

Emerging treatments

Four endoscopic bariatric therapies (EBT) have recently been approved by the FDA for use in adults with obesity. These include 2 intragastric balloons, 1 vagal stimulator, and 1 gastric aspiration device. These devices share the following common characteristics: (1) they are adjustable, (2) they are reversible, (3) they should only be used in the setting of a multidisciplinary pediatric team, and (4) their effect in terms of weight loss is less than that of MBS procedures. In adults with obesity, EBT are suggested as a bridge to MBS or as a tool for weight management for those in whom MBS is contraindicated. Adult studies have demonstrated a 10% to 20% weight loss with higher rates of weight regain than with MBS. EBT's have appeal but need careful study to avoid procedures that could make MBS difficult or impossible.

The role of alternative therapies and EBT in weight management for children and adolescents with obesity is unknown. There are few studies looking at outcomes using gastric pacers or EBT's in adolescents and children with obesity [187–189]. Currently, the endoscopic versions of current metabolic and bariatric surgical procedures are struggling with durability. The long-term durability and the physiologic consequences of these variations are unknown. FDA indications for these devices do not include adolescents. One intragastric balloon has FDA approval for ≥18 years and another for ≥22 years. The laparoscopically placed vagal nerve stimulator and the gastric aspiration device are approved for age ≥18 years.

There may be a role for the use of alternative therapies and EBT's when a MBS procedure must be delayed due to other health conditions or is not indicated (i.e., before orthopedic procedures or in patients with unfavorable anatomy for MBS). As with adults, these therapies could be used for weight management in those who find MBS unacceptable or inaccessible. As adjunct therapy for preoperative weight loss, EBT's have not been fully studied. The intragastric balloon, for example, has been shown to induce gastric wall thickening that could potentially affect surgical stapling; however, more studies are needed.

For procedures that involve significant small bowel resections we would recommend they be avoided in adolescents until adequate data are collected in adults to show at least equivalence to current metabolic and bariatric procedures.

Overview of alternative and endoscopic bariatric therapies: There may be a role for EBT in adolescents. More research is needed for routine use; however, EBT should not be denied based on age when MBS is not anatomically possible, and companies should be encouraged not to delay studies in adolescents with obesity once safety in adults is demonstrated.

Benefits and risks

Mortality data from adult studies

It is important to recognize that MBS has been shown, in adults, to decrease all-cause mortality compared with weight-matched controls [190]. The Swedish obesity patients were followed for 16 years in a study that enrolled >2000 MBS patients and >2000 case-matched controls. This study showed patients who underwent MBS had a hazard ratio of .76 for mortality compared with controls. Another group from McGill looked at 1000 surgery patients and 5000 case-matched controls. They found a sustained 67% weight loss and a reduced relative risk of death by 89% during the 5-year study. In addition, there were significant reductions in CVD, cancer, endocrine disorders, and psychiatric complications as well as long-term health costs [191].

While there are no studies that specifically look at adolescent mortality risk improvement after MBS, these studies suggest that patients with long-term exposure to obesity may be at the highest risk of early mortality, and thus early intervention would be expected to provide more significant protective health benefits.

Overview of mortality risk: Years of exposure to the obese state likely contributes to early mortality in patients with childhood onset obesity; therefore, early intervention may decrease mortality in adolescents undergoing MBS.

Reoperation

Reoperation can be necessary in patients who undergo a primary weight loss procedure for 2 primary reasons, a complication of the original procedure (i.e., band slipped, cholecystitis, internal hernia, leak, etc.), or failure to lose weight or resolve co-morbidities [192]. The first is discussed in the complications of surgery; however, the second merits some careful consideration. All MBS procedures do not work in all patients. The "failure rate" from MBS is not well defined and can vary from no weight loss to failure to lose > 50% of excess weight [193]. Reporting of "failure rate" is also very poor in the literature.

When considering a patient with inadequate weight loss from a procedure, one should first ask for evaluation by a dietician and a psychologist to assess for dietary indiscretion and/or disordered eating. If the patient's caloric intake is low and they underwent a RYGB or VSG before, then considering the addition of medications might be reasonable [186]. For patients who underwent an AGB or VSG, then an alternative procedure can be considered but it is important to frankly discuss the possibility that the patient is simply a "nonresponder" and may not lose weight even after conversion.

Overview of reoperation and revision surgery: When there is inadequate weight loss or failure of resolution of certain co-morbidities, then conversion of an AGB or VSG to a RYGB is recommended; however, it may be reasonable to try the addition of weight loss medications as well.

Nutritional risks

Non-adherence with medical regimens is particularly common among adolescents with chronic diseases [194]; MBS creates a potential for both macro- and micronutrient deficiency [195,196]. Reduced food volume (a feature of all procedures) may result in inadequate protein intake. The RYGB may sometimes limit fat absorption and as a consequence result in long-term hypovitaminosis of fat-soluble vitamins A, D, E, and K. Iron deficiency and low vitamin D levels are common in patients with the disease of obesity, particularly in females. Anemia is common after MBS and may relate to low levels of iron, folate, B6, or B12. Dieticians with expertise in MBS are best equipped to assess nutritional status, including screening for frank nutrient deficiencies

Thiamine (vitamin B1) deficiency presenting with Wernicke's encephalitis has been described previously with RYGB procedures in adolescents, especially those with poor intake and protracted emesis, but recently it has been observed after VSG as well [197]. Adolescence is a critical period for bone mass accumulation, with >50% of adult total bone mass achieved during this period; calcium and vitamin D are vital for the accrual of optimal bone mineral in the developing skeleton [198,199].

Preparation for MBS educates patients and families to the importance of taking vitamins and supplements regularly before MBS to reduce the risk of deficiencies after MBS. Preoperative nutritional assessment includes serum iron, folate, ferritin, and total iron-binding capacity (TIBC); thiamin (B1); vitamin B12; vitamin A and B6; calcium, Parathyroid Hormone, alkaline phosphatase, vitamin D, phosphorus, magnesium, and zinc. All except serum magnesium and zinc should be checked 2 months postsurgery and all should be checked at 6 months and then yearly thereafter. Individuals who have gastric resection or bypass also need serum levels of copper and selenium checked starting with the 6-month postsurgical visit. Vitamin A levels may also be monitored annually, especially in procedures with small intestine bypass [200]. Standard supplementation recommended for adolescents includes vitamin B1 preoperatively and for at least 6 months postoperatively, vitamin B12 sublingual, multivitamin with iron, and calcium citrate with vitamin D daily. See the ASMBS Nutritional guidelines for current recommendations and dosages [201].

Overview of nutritional risks: Adolescents are more likely to stop taking nutritional supplements. Therefore, annual follow-up with vitamin level monitoring is strongly recommended. All efforts should be made to help adolescents remember and become accustomed to taking supplements daily.

Pregnancy

Almost half of all patients who undergo MBS are, or will be, women of reproductive age. Up to 50% of women of reproductive age and 20% to 25% of pregnant women are overweight or obese at the first antenatal visit [202]. Women who have obesity display higher frequencies of morbidities and mortality, and their offspring show higher frequencies of stillbirth, neonatal death, congenital anomalies, and macrosomia [203]. Women with obesity are more often afflicted with gestational HTN and gestational diabetes. The linear relationship between obesity and diabetes entails an increase in the incidence of gestational diabetes of up to 3-fold with increasing BMI [204]. Obesity is a well-known associated risk factor for developing pregnancy-associated hypertensive disorders [205], entailing a 2- to 3-fold increased risk for HTN and preeclampsia in women with a BMI >30 kg/m^2 [206]. The incidence of pregnancy-associated HTN and preeclampsia increases proportionately with maternal BMI, ranging from 1.4% to 2.4% in women with normal weight and reaching 3.5% to 14.5% in women with severe obesity [204].

MBS renders dramatic improvement in these disease processes. Numerous studies have reported a reduction in the rate of gestational diabetes after MBS (0%–8.9% in pregnancies after MBS versus 1.6%–20.8% in the control group). Women who had MBS experience a higher birth rate compared with women with obesity who had not undergone MBS. In fact, in recent years, many studies report that women who became pregnant after MBS tend to deliver newborns with an overall lower weight and a higher rate of small-for-gestational-age infants (5.2-27.8%), in comparison to nonoperated women [207].

Many authors recommend a waiting period of at least 2 years after MBS to become pregnant. However, no high-quality evidence supports this recommendation. In recent years, several studies report that maternal and perinatal outcomes of pregnancies occurring earlier than 12 to 18 months after MBS were not inferior [208]. Smith et al. [209] observed that offspring born after maternal RYGB surgery exhibited increased insulin sensitivity and improved lipid profiles compared with offspring born before maternal MBS. These offspring also exhibited lower risk for obesity, even though many women were classified as obese when they conceived. This finding suggests that intrauterine environment may be even more relevant for pregnancies in women with previous MBS, because of its influence on epigenetics and subsequent development of obesity and other cardiovascular risk factors [210].

Overview of pregnancy: There is significant morbidity and mortality associated with pregnancy in women with obesity. Pregnancy after MBS confers a significant health benefit for both mother and infant; however, infants are likely to be small for gestational age and vitamin supplementation is imperative. Adolescent pregnancy carries its own risks and MBS can increase fertility. Therefore, all female MBS patients should be counseled on birth control surrounding MBS.

Discussion

This update of the 2012 guidelines represents a major shift in philosophy with the significant milestones made in the current understanding of obesity. The disease of obesity has become recognized as a metabolic disease controlled by genetic factors, with clear evidence that the physiologic control of weight is through neuroendocrine pathways that regulate body mass by affecting satiety, hunger, and metabolism. The recognition that weight is largely not under volitional control leads to a strong need to offer effective, sustainable, proven therapies to children with obesity.

There has also been a major shift in thinking about the use of medications, nutrition, behavioral training, physical therapy, and MBS together instead of separately. While timing of each of these interventions remains unclear, for patients suffering from severe obesity disease, most will require all of these therapies to attain a healthy weight and completely control weight related co-morbidities.

Summary of major changes in this guideline are as follows:

1. Vertical sleeve gastrectomy: VSG has become the most used and most recommended operation in adolescents with severe obesity for several reasons, near-equivalent weight loss to the RYGB in adolescents, fewer reoperations, better iron absorption, and near-equivalent effect on co-morbidities as RYGB in adolescents. However, given the more extensive long-term data available for RYGB, we can recommend the use of either RYGB or VSG in adolescents. Long-term outcomes of GERD after VSG are still not well understood.
2. Preoperative attempts at diet and exercise: there are no data that the number of weight loss attempts correlates with success after MBS. Compliance with a multidisciplinary preoperative program may improve outcomes after MBS but prior attempts at weight loss should be removed as a barrier to definitive treatment for obesity.
3. The use of the most up to date definitions of childhood obesity are as follows: (1) BMI cut offs of 35 kg/m^2 or 120% of the 95th percentile with a co-morbidity, or (2) BMI >40 kg/m^2 or 140% of the 95th percentile without a co-morbidity (whichever is less). Requiring adolescents with a BMI >40 to have a co-morbidity (as in the old guidelines) puts children at a significant disadvantage to attaining a healthy weight. Earlier surgical intervention (at a BMI <45 kg/m^2) can allow adolescents to reach a normal weight and avoid lifelong medication therapy and end organ damage from co-morbidities.
4. Certain co-morbidities should be considered in adolescents, specifically the psychosocial burden of obesity, the orthopedic diseases specific to children, GERD, and cardiac risk factors. Given the poor outcomes of medical therapies for T2D in children, these co-morbidities may

be considered an indication for MBS in younger adolescents or those with lower obesity percentiles.

5. Vitamin B deficiencies, especially B1 appear to be more common in adolescents both preoperatively and postoperatively; they should be screened for and treated. Prophylactic B1 for the first 6 months postoperatively is recommended as is education of patients and primary care providers on the signs and symptoms of common deficiencies.
6. The use of emerging technologies in adolescents should be considered when standard procedures are unavailable or anatomically inappropriate, but when done in adolescents they must be used in the setting of an age appropriate multidisciplinary team that treats obesity and under an institutional review board–approved trial. Companies should be encouraged to fund trials of new devices in adolescents at least as soon as a device is FDA approved in adults.
7. Developmental delay, autism spectrum, or syndromic obesity should not be a contraindication to MBS. Each patient and caregiver team will need to be assessed for ability to make dietary and lifestyle changes required for surgery. Multidisciplinary teams should agree on the specific needs and abilities of the given patient and caregiver and these should be considered on a case-by-case basis with the assistance of the hospital ethics committee where appropriate.
8. Because MBS results in better weight loss and resolution of co-morbidities in adolescents at lower BMI's with fewer co-morbidities, referrals should occur early, as soon as a child is recognized to suffer from severe obesity disease (BMI >120% of the 95th percentile or BMI of 35). Prior weight loss attempts, Tanner stage, and bone age should not be considered when referring patients to a MBS program.
9. Unstable family environments, eating disorders, mental illness, or prior trauma should not be considered contraindications for MBS in adolescents; however, these should be optimized and treated where possible before and surrounding any surgical intervention for obesity.
10. Routine screening of alcohol use is imperative across all procedures. Conservative clinical care guidelines, which strongly advocate abstinence, while appropriate, must also include information for this age group on harm reduction (i.e., lower consumption levels, how to avoid or manage situations related to alcohol-related harm) to mitigate clinical and safety risks. Risks of nicotine should be discussed and smoking or vaping nicotine should be discouraged.
11. The recognition of obesity as a chronic disease that requires multimodal therapies justifies the treatment of such a disease in a multidisciplinary team that can provide surgical, pharmacologic, behavioral, nutritional, and activity interventions. Pharmacologic therapies as adjuncts to surgical therapies may provide improved outcomes long term in the pediatric population; more studies are needed.

Conclusions

Children who suffer from obesity are at a significant disadvantage if they are denied MBS. MBS is clearly one of the main obesity treatment modalities with the best-sustained weight loss and control of obesity-related co-morbidities. Data support the use of MBS in adolescents with severe obesity; either the VSG or the RYGB should be considered for adolescents with a BMI >35 or >120% of the 95th percentile and a co-morbidity or with a BMI >40 or >140% of the 95th percentile. Prior weight loss attempts, Tanner stage, and bone age should not be barriers to definitive treatment. Vitamin levels should be monitored before and after MBS with all attempts to maximize adherence with vitamin supplements long term. Multidisciplinary teams should stabilize and treat preexisting eating disorders, assure stable social support, assess and assist with nutrition and activity knowledge, and consider the addition of medications when appropriate. MBSAQIP guidelines should be followed when building an adolescent MBS program. It is the responsibility of the adolescent MBS program to have a transition plan in place for adolescents to transition to an adult MBS program for lifelong care.

Disclosures

T.I. is a consultant for Standard Bariatric. S.M. is a speaker for Gore and Mederi therapeutics. The remaining authors have no commercial associations that might be a conflict of interest in relation to this article.

References

[1] Skinner AC, Ravanbakht SN, Skelton JA, Perrin EM, Armstrong SC. Prevalence of obesity and severe obesity in US children, 1999-2016. Pediatrics. Epub 2018 Feb 26.
[2] Ogden CL, Carroll MD, Fryar CD, Flegal KM. Prevalence of obesity among adults and youth: United States, 2011-2014. NCHS Data Brief 2015;(219):1–8.
[3] Kelly AS, Barlow SE, Rao G, et al. Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches: a scientific statement from the American Heart Association. Circulation 2013;128(15):1689–712.
[4] Upadhyay J, Farr O, Perakakis N, Ghaly W, Mantzoros C. Obesity as a disease. Med Clin North Am 2018;102(1):13–33.
[5] Puhl RM, Heuer CA. The stigma of obesity: a review and update. Obesity (Silver Spring) 2009;17(5):941–64.
[6] Garcia JT, Amankwah EK, Hernandez RG. Assessment of weight bias among pediatric nurses and clinical support staff toward obese patients and their caregivers. J Pediatr Nurs 2016;31(4):e244–51.
[7] Phelan SM, Puhl RM, Burke SE, et al. The mixed impact of medical school on medical students' implicit and explicit weight bias. Med Educ 2015;49(10):983–92.

[8] Puhl R, Suh Y. Health consequences of weight stigma: implications for obesity prevention and treatment. Curr Obes Rep 2015;4(2):182–90.
[9] Wiese HJ, Wilson JF, Jones RA, Neises M. Obesity stigma reduction in medical students. Int J Obes Relat Metab Disord 1992;16(11):859–68.
[10] Kushner RF, Zeiss DM, Feinglass JM, Yelen M. An obesity educational intervention for medical students addressing weight bias and communication skills using standardized patients. BMC Med Educ 2014;14:53.
[11] Black JA, White B, Viner RM, Simmons RK. Bariatric surgery for obese children and adolescents: a systematic review and meta-analysis. Obes Rev 2013;14(8):634–44.
[12] Paulus GF, de Vaan LE, Verdam FJ, Bouvy ND, Ambergen TA, van Heurn LW. Bariatric surgery in morbidly obese adolescents: a systematic review and meta-analysis. Obes Surg 2015;25(5):860–78.
[13] Inge TH, Jenkins TM, Xanthakos SA, et al. Long-term outcomes of bariatric surgery in adolescents with severe obesity (FABS-5+): a prospective follow-up analysis. Lancet Diabetes Endocrinol 2017; 5(3):165–73.
[14] Vilallonga R, Himpens J, van de Vrande S. Long-term (7 years) follow-up of Roux-en-Y gastric bypass on obese adolescent patients (<18 years). Obes Facts 2016;9(2):91–100.
[15] Klebanoff MJ, Chhatwal J, Nudel JD, Corey KE, Kaplan LM, Hur C. Cost-effectiveness of bariatric surgery in adolescents with obesity. JAMA Surg 2017;152(2):136–41.
[16] White B, Doyle J, Colville S, Nicholls D, Viner RM, Christie D. Systematic review of psychological and social outcomes of adolescents undergoing bariatric surgery, and predictors of success. Clin Obes 2015;5(6):312–24.
[17] Inge TH, Courcoulas AP, Jenkins TM, et al. Weight loss and health status 3 years after bariatric surgery in adolescents. N Engl J Med 2016;374(2):113–23.
[18] van der Baan-Slootweg O, Benninga MA, Beelen A, et al. Inpatient treatment of children and adolescents with severe obesity in the Netherlands: a randomized clinical trial. JAMA Pediatr 2014; 168(9):807–14.
[19] Inge TH, Siegel RM, Xanthakos SA. Weight loss maintenance: a hard nut to crack. JAMA Pediatr 2014;168(9):796–7.
[20] Treadwell JR, Sun F, Schoelles K. Systematic review and meta-analysis of bariatric surgery for pediatric obesity. Ann Surg 2008;248(5):763–76.
[21] Marcus MD, Foster GD, El Ghormli L. Stability of relative weight category and cardiometabolic risk factors among moderately and severely obese middle school youth. Obesity (Silver Spring) 2014; 22(4):1118–25.
[22] Danielsson P, Kowalski J, Ekblom O, Marcus C. Response of severely obese children and adolescents to behavioral treatment. Arch Mediatr Adoesc Med 2012;166(12):1103–8.
[23] Zitsman JL, Digiorgi MF, Marr JR, Witt MA, Bessler M. Comparative outcomes of laparoscopic adjustable gastric banding in adolescents and adults. Surg Obes Relat Dis 2011;7(6):720–6.
[24] Michalsky M, Reichard K, Inge T, et al. ASMBS pediatric committee best practice guidelines. Surg Obes Relat Dis 2012;8(1):1–7.
[25] Twig G, Yaniv G, Levine H, et al. Body-mass index in 2.3 million adolescents and cardiovascular death in adulthood. N Engl J Med 2016;374(25):2430–40.
[26] Poirier P, Giles TD, Bray GA, et al. Obesity and cardiovascular disease: pathophysiology, evaluation, and effect of weight loss: an update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease from the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. Circulation 2006;113(6):898–918.
[27] Cuspidi C, Rescaldani M, Tadic M, Sala C, Grassi G. Effects of bariatric surgery on cardiac structure and function: a systematic review and meta-analysis. Am J Hypertens 2014;27(2):146–56.
[28] Ippisch HM, Inge TH, Daniels SR, et al. Reversibility of cardiac abnormalities in morbidly obese adolescents. J Am Cardiol 2008; 51(14):1342–8.
[29] Michalsky MP, Raman SV, Teich S, Schuster DP, Bauer JA. Cardiovascular recovery following bariatric surgery in extremely obese adolescents: preliminary results using cardiac magnetic resonance (CMR) imaging. J Pediatr Surg 2013;48(1):170–7.
[30] Teeple EA, Teich S, Schuster DP, Michalsky MP. Early metabolic improvement following bariatric surgery in morbidly obese adolescents. Pediatr Blood Cancer 2012;58(1):112–6.
[31] Inge TH, Miyano G, Bean J, et al. Reversal of type 2 diabetes mellitus and improvements in cardiovascular risk factors after surgical weight loss in adolescents. Pediatrics 2009;123 (1):214–22.
[32] Inge TH, Zeller MH, Jenkins TM, et al. Perioperative outcomes of adolescents undergoing bariatric surgery: the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study. JAMA Pediatr 2014;168(1):47–53.
[33] Olbers T, Gronowitz E, Werling M, et al. Two-year outcome of laparoscopic Roux-en-Y gastric bypass in adolescents with severe obesity: results from a Swedish nationwide study (AMOS). Int J Obes (Lond) 2012;36(11):1388–95.
[34] Olbers T, Beamish AJ, Gronowitz E, et al. Laparoscopic Roux-en-Y gastric bypass in adolescents with severe obesity (AMOS): a prospective, 5-year, Swedish nationwide study. Lancet Diabetes Endocrinol 2017;5(3):174–83.
[35] Michalsky MP, Inge TH, Jenkins TM, et al. Cardiovascular risk factors after adolescent bariatric surgery. Pediatrics 2018; 141(2):e20172485.
[36] Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. Int J Pediatr Obes 2006;1(1):11–25.
[37] Juonala M, Magnussen CG, Berenson GS, et al. Childhood adiposity, adult adiposity, and cardiovascular risk factors. N Engl J Med 2011;365(20):1876–85.
[38] Forslund A, Staaf J, Kullberg J, Ciba I, Dahlbom M, Bergsten P. Uppsala longitudinal study of childhood obesity: protocol description. Pediatrics 2014;133(2):e386–93.
[39] Juonala M, Sabin MA, Burgner D, et al. Increased body mass index in parent-child dyads predicts the offspring risk of meeting bariatric surgery criteria. J Clin Endocrinol Matab 2015;100(11):4257–63.
[40] Viner R, White B, Christie D. Type 2 diabetes in adolescents: a severe phenotype posing major clinical challenges and public health burden. Lancet 2017;389(10085):2252–60.
[41] Tryggestad JB, Willi SM. Complications and comorbidities of T2 DM in adolescents: findings from the TODAY clinical trial. J Diabetes Complications 2015;29(2):307–12.
[42] Arslanian S, Kim JY, Nasr A, et al. Insulin sensitivity across the lifespan from obese adolescents to obese adults with impaired glucose tolerance: who is worse off? Pediatr Diabetes 2018;19(2):205–11
[43] Zeitler P, Hirst K, Pyle L, et al. A clinical trial to maintain glycemic control in youth with type 2 diabetes. N Engl J Med 2012; 366(24):2247–56.
[44] Woolford SJ, Clark SJ, Gebremariam A, Davis MM, Freed GL. To cut or not to cut: physicians' perspectives on referring adolescents for bariatric surgery. Obes Surg 2010;20(7):937–42.
[45] Sjostrom L. Review of the key results from the Swedish Obese Subjects (SOS) trial - a prospective controlled intervention study of bariatric surgery. J Intern Med 2013;273(3):219–34.
[46] Michalsky MP, Kramer RE, Fullmer MA, et al. Developing criteria for pediatric/adolescent bariatric surgery programs. Pediatrics 2011; 128(Suppl 2):S65–70.
[47] Michalsky MP, Inge TH, Teich S, et al. Adolescent bariatric surgery program characteristics: the Teen Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study experience. Semin Pediatr Surg 2014;23(1):5–10.

[48] Maffazioli GD, Stanford FC, Campoverde Reyes KJ, et al. Comparing outcomes of two types of bariatric surgery in an adolescent obese population: Roux-en-Y gastric bypass vs. sleeve gastrectomy. Front Pediatr 2016;4:78.
[49] Ejaz A, Patel P, Gonzalez-Heredia R, Holterman M, Elli EF, Kanard R. Laparoscopic sleeve gastrectomy as first-line surgical treatment for morbid obesity among adolescents. J Pediatr Surg 2017;54(4):544–8.
[50] Manco M, Mosca A, De Peppo F, et al. The benefit of sleeve gastrectomy in obese adolescents on nonalcoholic steatohepatitis and hepatic fibrosis. J Pediatr 2017;180:31–7.e32.
[51] Serrano OK, Zhang Y, Kintzer E, et al. Outcomes of bariatric surgery in the young: a single-institution experience caring for patients under 21 years old. Surg Endosc 2016;30(11):5015–22.
[52] Courcoulas AP, Belle SH, Neiberg RH, et al. Three-year outcomes of bariatric surgery vs lifestyle intervention for type 2 diabetes mellitus treatment: a randomized clinical trial. JAMA Surg 2015; 150(10):931–40.
[53] Schauer PR, Bhatt DL, Kirwan JP, et al. Bariatric surgery versus intensive medical therapy for diabetes–3-year outcomes. N Engl J Med 2014;370(21):2002–13.
[54] Rubino F, Nathan DM, Eckel RH, et al. Metabolic surgery in the treatment algorithm for type 2 diabetes: a joint statement by international diabetes organizations. Diabetes Care 2016;39(6):861–77.
[55] Inge TH, Laffel LM, Jenkins TM, et al. Comparison of surgical and medical therapy for type 2 diabetes in severely obese adolescents. JAMA Pediatr 2018;172(5):452–60.
[56] Khidir N, El-Matbouly MA, Sargsyan D, Al-Kuwari M, Bashah M, Gagner M. Five-year outcomes of laparoscopic sleeve gastrectomy: a comparison between adults and adolescents. Obes Surg. Epub 2018 Feb 11.
[57] Verhulst SL, Van Gaal L, De Backer W, Desager K. The prevalence, anatomical correlates and treatment of sleep-disordered breathing in obese children and adolescents. Sleep Med Rev 2008; 12(5):339–46.
[58] Kohler MJ, van den Heuvel CJ. Is there a clear link between overweight/obesity and sleep disordered breathing in children? Sleep Med Rev 2008;12(5):347–61; discussion 363–44.
[59] Jennum P, Ibsen R, Kjellberg J. Morbidity and mortality in children with obstructive sleep apnoea: a controlled national study. Thorax 2013;68(10):949–54.
[60] Koeck ES, Barefoot LC, Hamrick M, Owens JA, Qureshi FG, Nadler EP. Predicting sleep apnea in morbidly obese adolescents undergoing bariatric surgery. Surg Endosc 2014;28(4):1146–52.
[61] Ishman S, Heubi C, Jenkins T, Michalsky M, Simakajornboon N, Inge T. OSA screening with the pediatric sleep questionnaire for adolescents undergoing bariatric surgery in teen-LABS. Obesity (Silver Spring) 2016;24(11):2392–8.
[62] Kalra M, Inge T, Garcia V, et al. Obstructive sleep apnea in extremely overweight adolescents undergoing bariatric surgery. Obes Res 2005;13(7):1175–9.
[63] Amin R, Simakajornboon N, Szczesniak R, Inge T. Early improvement in obstructive sleep apnea and increase in orexin levels after bariatric surgery in adolescents and young adults. Surg Obes Relat Dis 2017;13(1):95–100.
[64] Duncan M, Zong W, Biank VF, Hageman JR. Nonalcoholic fatty liver disease in pediatrics. Pediatr Ann 2016;45(2):e54–8.
[65] Xanthakos SA, Jenkins TM, Kleiner DE, et al. High prevalence of nonalcoholic fatty liver disease in adolescents undergoing bariatric surgery. Gastroenterology 2015;149(3):623–34.e628.
[66] Younossi ZM, Loomba R, Rinella ME, et al. Current and future therapeutic regimens for non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH). Hepatology. Epub 2017 Dec 9.
[67] Lassailly G, Caiazzo R, Buob D, et al. Bariatric surgery reduces features of nonalcoholic steatohepatitis in morbidly obese patients. Gastroenterology 2015;149(2):379–88; quiz e315–76.
[68] Andrews LE, Liu GT, Ko MW. Idiopathic intracranial hypertension and obesity. Horm Res Paediatr 2014;81(4):217–25.
[69] Brara SM, Koebnick C, Porter AH, Langer-Gould A. Pediatric idiopathic intracranial hypertension and extreme childhood obesity. J Pediatr 2012;161(4):602–7.
[70] Friedman DI, Liu GT, Digre KB. Revised diagnostic criteria for the pseudotumor cerebri syndrome in adults and children. Neurology 2013;81(13):1159–65.
[71] Marton E, Feletti A, Mazzucco GM, Longatti P. Pseudotumor cerebri in pediatric age: role of obesity in the management of neurological impairments. Nutr Neurosci 2008;11(1):25–31.
[72] Rekate HL, Wallace D. Lumboperitoneal shunts in children. Pediatr Neurosci 2003;38(1):41–6.
[73] Chandra V, Dutta S, Albanese CT, Shepard E, Farrales-Nguyen S, Morton J. Clinical resolution of severely symptomatic pseudotumor cerebri after gastric bypass in an adolescent. Surg Obes Relat Dis 2007;3(2):198–200.
[74] Leslie DB, Kellogg TA, Boutelle KN, et al. Preserved vision without growth retardation after laparoscopic Roux-en-Y gastric bypass in a morbidly obese child with pseudotumor cerebri: 36-month follow-up. J Pediatr Surg 2008;43(7):e27–30.
[75] Graber JJ, Racela R, Henry K. Cerebellar tonsillar herniation after weight loss in a patient with idiopathic intracranial hypertension. Headache 2010;50(1):146–8.
[76] Rubin RC, Henderson ES, Ommaya AK, Walker MD, Rall DP. The production of cerebrospinal fluid in man and its modification by acetazolamide. J Neurosurg 1966;25(4):430–6.
[77] Krispel CM, Keltner JL, Smith W, Chu DG, Ali MR. Undiagnosed papilledema in a morbidly obese patient population: a prospective study. J Neuroophthalmol 2011;31(4):310–5.
[78] Baltasar A, Serra C, Bou R, Bengochea M, Andreo L. Sleeve gastrectomy in a 10-year-old child. Obes Surg 2008;18(6):733–6.
[79] Mohaidly MA, Suliman A, Malawi H. Laparoscopic sleeve gastrectomy for a two-and half year old morbidly obese child. Int J Surg Case Rep 2013;4(11):1057–60.
[80] Inge TH, Xanthakos S. Sleeve gastrectomy for childhood morbid obesity: why not? Obes Surg 2010;20(1):118–20
[81] Ryder JR, Edwards NM, Gupta R, et al. Changes in functional mobility and musculoskeletal pain after bariatric surgery in teens with severe obesity: Teen-Longitudinal Assessment of Bariatric Surgery (LABS) Study. JAMA Pediatr 2016;170(9):871–7.
[82] Sabharwal S, Zhao C, Sakamoto SM, McClemens E. Do children with Blount disease have lower body mass index after lower limb realignment? J Pediatr Orthop 2014;34(2):213–8
[83] Lisenda L, Simmons D, Firth GB, Ramguthy Y, Kebashni T, Robertson AJ. Vitamin D status in Blount disease. J Pediatr Orthop 2016;36(5):e59–62.
[84] Perry DC, Metcalfe D, Costa ML, Van Staa T. A nationwide cohort study of slipped capital femoral epiphysis. Arch Dis Child 2017; 102(12):1132–6.
[85] Roaten J, Spence DD. Complications related to the treatment of slipped capital femoral epiphysis. Orthop Clin North Am 2016; 47(2):405–13.
[86] Perez AR, Moncure AC, Rattner DW. Obesity adversely affects the outcome of antireflux operations. Surg Endosc 2001;15(9):986–9.
[87] Luketina RR, Koch OO, Kohler G, Antoniou SA, Emmanuel K, Pointner R. Obesity does not affect the outcome of laparoscopic antireflux surgery. Surg Endosc 2015;29(6):1327–33.
[88] Ibele A, Garren M, Gould J. The impact of previous fundoplication on laparoscopic gastric bypass outcomes: a case-control evaluation. Surg Endosc 2012;26(1):177–81.

[89] Patti MG. An evidence-based approach to the treatment of gastroesophageal reflux disease. JAMA Surg 2016;151(1):73–8.
[90] Viscido G, Gorodner V, Signorini F, Navarro L, Obeide L, Moser F. Laparoscopic sleeve gastrectomy: endoscopic findings and gastroesophageal reflux symptoms at 18-month follow-up. J Laparoendosc Adv Surg Tech A 2018;28(1):71–7.
[91] Kowalewski PK, Olszewski R, Waledziak MS, et al. Long-term outcomes of laparoscopic sleeve gastrectomy-a single-center, retrospective study. Obes Surg 2018;28(1):130–4.
[92] Modi AC, Loux TJ, Bell SK, Harmon CM, Inge TH, Zeller MH. Weight-specific health-related quality of life in adolescents with extreme obesity. Obesity 2008;16(10):2266–71.
[93] Zeller MH, Inge TH, Modi AC, et al. Severe obesity and comorbid condition impact on the weight-related quality of life of the adolescent patient. J Pediatr 2015;166(3):651–9, e654.
[94] Zeller MH, Reiter-Purtill J, Ratcliff MB, Inge TH, Noll JG. Two-year trends in psychosocial functioning after adolescent Roux-en-Y gastric bypass. Surg Obes Relat Dis 2011;7(6):727–32.
[95] Sysko R, Devlin MJ, Hildebrandt TB, Brewer SK, Zitsman JL, Walsh BT. Psychological outcomes and predictors of initial weight loss outcomes among severely obese adolescents receiving laparoscopic adjustable gastric banding. J Clin Psych 2012;73(10):1351–7.
[96] O'Brien PE, Sawyer SM, Laurie C, et al. Laparoscopic adjustable gastric banding in severely obese adolescents: a randomized trial. JAMA 2010;303(6):519–36.
[97] Schmitt F, Riquin E, Beaumesnil M, et al. Laparoscopic adjustable gastric banding in adolescents: results at two years including psychosocial aspects. J Pediatr Surg 2016;51(3):403–8.
[98] Zeller MH, Pendery EC, Reiter-Purtill J, et al. From adolescence to young adulthood: trajectories of psychosocial health following Roux-en-Y gastric bypass. Surg Obes Relat Dis 2017;13(7):1196–203.
[99] Zeller MH, Roehrig HR, Modi AC, Daniels SR, Inge TH. Health-related quality of life and depressive symptoms in adolescents with extreme obesity presenting for bariatric surgery. Pediatrics 2006;117(4):1155–61.
[100] Kim RJ, Langer JM, Baker AW, Fitter DE, Williams NN, Sarwer DB. Psychosocial status in adolescents undergoing bariatric surgery. Obes Surg 2008;18(1):27–33.
[101] Zeller MH, Modi AC, Noll JG, Long JD, Inge TH. Psychosocial functioning improves following adolescent bariatric surgery. Obesity 2009;17(5):885–90.
[102] Sysko R, Zakarin EB, Devlin MJ, Bush J, Walsh BT. A latent class analysis of psychiatric symptoms among 125 adolescents in a bariatric surgery program. Int J Pediatr Obes 2011;6(3–4):289–97.
[103] Jarvholm K, Olbers T, Marcus C, et al. Short-term psychological outcomes in severely obese adolescents after bariatric surgery. Obesity (Silver Spring) 2012;20(2):318–23.
[104] Rofey DL, Zeller MH, Brode C, et al. A multisite view of psychosocial risks in patients presenting for bariatric surgery. Obesity (Silver Spring) 2015;23(6):1218–25.
[105] Kessler RC AS, Costello EJ, Georgiades K, et al. Prevalence, persistence, and sociodemographic correlates of DSM-IV disorders in the National Comorbidity Survey Replication Adolescent Supplement. Arch Gen Psychiatry 2012;69(4):372–80.
[106] Cohen MJ, Curran JL, Phan TT, Reichard K, Datto GA. Psychological contributors to noncompletion of an adolescent preoperative bariatric surgery program. Surg Obes Relat Dis 2017;13(1):58–64.
[107] Jarvholm K, Karlsson J, Olbers T, et al. Two-year trends in psychological outcomes after gastric bypass in adolescents with severe. obesity. Obesity (Silver Spring) 2015;23(10):1966–72.
[108] Jarvholm K, Karlsson J, Olbers T, et al. Characteristics of adolescents with poor mental health after bariatric surgery. Surg Obes Relat Dis 2016;12(4):882–90.
[109] Substance abuse and mental health services administration, center for behavioral health statistics and quality. (May 6, 2014). *The CBHSQ report: Serious mental health challenges among older adolescents and young adults*. Rockville, MD
[110] Nock MK, Green JG, Hwang I, et al. Prevalence, correlates, and treatment of lifetime suicidal behavior among adolescents: results from the National Comorbidity Survey Replication Adolescent Supplement. JAMA Psych 2013;70(3):300–10.
[111] Mitchell JE, Crosby R, de Zwaan M, et al. Possible risk factors for increased suicide following bariatric surgery. Obesity 2013;21(4):665–72.
[112] King WC, Chen J, Mitchell JE, et al. Prevalence of alcohol use disorders before and after bariatric surgery. JAMA 2012;307(23):2516–25.
[113] Backman O, Stockeld D, Rasmussen F, Naslund E, Marsk R. Alcohol and substance abuse, depression and suicide attempts after Roux-en-Y gastric bypass surgery. Br J Surg 2016;103(10):1336–42.
[114] Apovian CM, Baker C, Ludwig DS, et al. Best practice guidelines in pediatric/adolescent weight loss surgery. Obes Res 2005;13(2):274–82.
[115] Pratt JS, Lenders CM, Dionne EA, et al. Best practice updates for pediatric/adolescent weight loss surgery. Obesity (Silver Spring) 2009;17(5):901–10.
[116] Zeller MH, Hunsaker S, Mikhail C, et al. Family factors that characterize adolescents with severe obesity and their role in weight loss surgery outcomes. Obesity (Silver Spring) 2016;24(12):2562–9.
[117] Zeller MH, Noll JG, Sarwer DB, et al. Child maltreatment and the adolescent patient with severe obesity: implications for clinical care. J Pediatr Psychol 2015;40(7):640–8.
[118] Wildes JE, Kalarchian MA, Marcus MD, Levine MD, Courcoulas A. Childhood maltreatment and psychiatric morbidity in bariatric surgery candidates. Obes Surg 2008;18(3):306–13.
[119] Steinig J, Wagner B, Shang E, Dolemeyer R, Kersting A. Sexual abuse in bariatric surgery candidates: impact on weight loss after surgery: a systematic review. Obes Rev 2012;13(10):892–901.
[120] Clark MM, Hanna BK, Mai JL, et al. Sexual abuse survivors and psychiatric hospitalization after bariatric surgery. Obes Surg 2007;17(4):465–9.
[121] Grilo CM, White MA, Masheb RM, Rothschild BS, Burke-Martindale CH. Relation of childhood sexual abuse and other forms of maltreatment to 12-month postoperative outcomes in extremely obese gastric bypass patients. Obes Surg 2006;16(4):454–60.
[122] Grilo CM, Masheb RM, Brody M, Toth C, Burke-Martindale CH, Rothschild BS. Childhood maltreatment in extremely obese male and female bariatric surgery candidates. Obes Res 2005;13(1):123–30.
[123] Trauma guide [homepage on the Internet]. Itasca: National Academy of Pediatrics, c2018. [updated 2018]. Avalable from: https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/healthy-foster-care-america/Pages/Trauma-Guide.aspx. [Accessed March 15, 2018].
[124] Mitchell JE, Steffen K, Engel S, et al. Addictive disorders after Roux-en-Y gastric bypass. Surg Obes Relat Dis 2015;11(4):897–905.
[125] Blackburn AN, Hajnal A, Leggio L. The gut in the brain: the effects of bariatric surgery on alcohol consumption. Addict Biol 2017;22(6):1540–53.
[126] Heinberg L, Ashton K, Coughlin J. Alcohol and bariatric surgery: review and suggested recommendations for assessment and management. Surg Obes Relat Dis 2012;8(3):357–63.
[127] Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient–2013 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery. Surg Obes Relat Dis 2013;9(2):159–91.

[128] Johnston LD, O'Malley PM, Bachman JG, Schulenberg JE. Monitoring the Future National Results of Drug Use: 2012 Overview, Key Findings on Adolescent Drug Use. Ann Arbor: The University of Michigan, 2013.
[129] Chen P, Jacobson KC. Developmental trajectories of substance use from early adolescence to young adulthood: gender and racial/ethnic differences. J Adolesc Health 2012;50(2):154–63.
[130] Behrendt S, Wittchen HU, Hofler M, Lieb R, Beesdo K. Transitions from first substance use to substance use disorders in adolescence: is early onset associated with a rapid escalation? Drug Alcohol Depend 2009;99(1–3):68–78
[131] Hu MC, Griesler PC, Schaffran C, Wall MM, Kandel DB. Trajectories of criteria of nicotine dependence from adolescence to early adulthood. Drug Alcohol Depend 2012;125(3):283–9.
[132] Patrick ME, Schulenberg JE, Martz ME, Maggs JL, O'Malley PM, Johnston LD. Extreme binge drinking among 12 th-grade students in the United States: prevalence and predictors. JAMA Pediatr 2013;167(11):1019–25.
[133] Ratcliff MB, Jenkins TM, Reiter-Purtill J, Noll JG, Zeller MH. Risk-taking behaviors of adolescents with extreme obesity: normative or not? Pediatrics 2011;127(5):827–34
[134] Zeller MH, Becnel J, Reiter-Purtill J, Peugh J, Wu YP. Associations among excess weight status and tobacco, alcohol, and illicit drug use in a large national sample of early adolescent youth. Prev Sci 2016;17(4):483–92.
[135] Patrick ME, Schulenberg JE. Prevalence and predictors of adolescent alcohol use and binge drinking in the United States. Alcohol Res 2013;35(2):193–200.
[136] Zeller MH, Washington GA, Mitchell JE, et al. Alcohol use risk in adolescents 2 years after bariatric surgery. Surg Obes Relat Dis 2016;13(1):85–94.
[137] Scheffel O, Daskalakis M, Weiner RA. Two important criteria for reducing the risk of postoperative ulcers at the gastrojejunostomy site after gastric bypass: patient compliance and type of gastric bypass. Obes Facts 2011;4(Suppl 1):39–41.
[138] Delk J, Creamer MR, Perry CL, Harrell MB. Weight status and cigarette and electronic cigarette use in adolescents. Am J Prev Med 2018;54(1):e31–5.
[139] Singh T, Arrazola, Corey CG, et al. Tobacco use among middle and high school students–United States, 2011–2015. MMWR Morb Mortal Wkly Rep 2016;65(14):361–7.
[140] Verhaegen A, Van Gaal L. Do E-cigarettes induce weight changes and increase cardiometabolic risk? A signal for the future. Obes Rev 2017;18(10):1136–46.
[141] He J, Cai Z, Fan X. Prevalence of binge and loss of control eating among children and adolescents with overweight and obesity: an exploratory meta-analysis. Int J Eating Dis 2017;50(2):91–103.
[142] Utzinger LM, Gowey MA, Zeller M, et al. Loss of control eating and eating disorders in adolescents before bariatric surgery. Int J Eating Dis 2016;49(10):947–52.
[143] Kalarchian MA, King WC, Devlin MJ, et al. Psychiatric disorders and weight change in a prospective study of bariatric surgery patients: a 3-year follow-up. Psychosom Med 2016;78(3):373–81.
[144] Mitchell JE, Christian NJ, Flum DR, et al. Postoperative behavioral variables and weight change 3 years after bariatric surgery. JAMA Surg 2016;151(8):752–7.
[145] Sysko R, Hildebrandt TB, Kaplan S, Brewer SK, Zitsman JL, Devlin MJ. Predictors and correlates of follow-up visit adherence among adolescents receiving laparoscopic adjustable gastric banding. Surg Obes Relat Dis 2014;10(5):914–20.
[146] Devlin MJ, King WC, Kalarchian MA, et al. Eating pathology and experience and weight loss in a prospective study of bariatric surgery patients: 3-year follow-up. Int J Eating Dis 2016;49(12):1058–67.
[147] Ivezaj V, Kessler EE, Lydecker JA, Barnes RD, White MA, Grilo CM. Loss-of-control eating following sleeve gastrectomy surgery. Surg Obes Relat Dis 2017;13(3):392–8.
[148] Adolescent health [homepage on the Internet]. Geneva: World Health Organization, cc2018. [updated 2018]. Available from: http://www.who.int/topics/adolescent_health/en/. [Accessed March 15, 2018].
[149] Flegal KM, Wei R, Ogden CL, Freedman DS, Johnson CL, Curtin LR. Characterizing extreme values of body mass index-for-age by using the 2000 Centers for Disease Control and Prevention growth charts. Am J Clin Nutr 2009;90(5):1314–20.
[150] Gulati AK, Kaplan DW, Daniels SR. Clinical tracking of severely obese children: a new growth chart. Pediatrics 2012;130(6):1136–40.
[151] Skinner AC, Skelton JA. Prevalence and trends in obesity and severe obesity among children in the United States, 1999-2012. JAMA Pediatr 2014;168(6):561–6.
[152] Clinical tools for pediatric providers [homepage on the Internet]. City: PediTools; c2012-18 [updated 2018]. Available from: https://peditools.org/growthpedi/index.php. [Accessed March 15, 2018].
[153] Alqahtani A, Elahmedi M, Qahtani AR. Laparoscopic sleeve gastrectomy in children younger than 14 years: refuting the concerns. Ann Surg 2016;263(2):312–9.
[154] Scheimann AO, Butler MG, Gourash L, Cuffari C, Klish W. Critical analysis of bariatric procedures in Prader-Willi syndrome. J Pediatr Gastroenterol Nutr 2008;46(1):80–3.
[155] Alqahtani AR, Elahmedi MO, Al Qahtani AR, Lee J, Butler MG. Laparoscopic sleeve gastrectomy in children and adolescents with Prader-Willi syndrome: a matched-control study. Surg Obes Relat Dis 2016;12(1):100–10.
[156] Fong AK, Wong SK, Lam CC, Ng EK. Ghrelin level and weight loss after laparoscopic sleeve gastrectomy and gastric mini-bypass for Prader-Willi syndrome in Chinese. Obes Surg 2012;22(11):1742–5.
[157] Inge TH. A new look at weight loss surgery for children and adolescents with Prader-Willi syndrome. Surg Obes Relat Dis 2016;12(1):110–2.
[158] Bretault M, Boillot A, Muzard L, et al. Clinical review: bariatric surgery following treatment for craniopharyngioma: a systematic review and individual-level data meta-analysis. J Clin Enocrinol Metab 2013;98(6):2239–46.
[159] Wijnen M, Olsson DS, van den Heuvel-Eibrink MM, et al. Efficacy and safety of bariatric surgery for craniopharyngioma-related hypothalamic obesity: a matched case-control study with 2 years of follow-up. Int J Obes 2017;41(2):210–6.
[160] Weismann D, Pelka T, Bender G, et al. Bariatric surgery for morbid obesity in craniopharyngioma. Clin Endocrinol 2013;78(3):385–90.
[161] Bretault M, Laroche S, Lacorte JM, et al. Postprandial GLP-1 secretion after bariatric surgery in three cases of severe obesity related to craniopharyngiomas. Obes Surg 2016;26(5):1133–7.
[162] Castro-Dufourny I, Carrasco R, Pascual JM. Hypothalamic obesity after craniopharyngioma surgery: treatment with a long acting glucagon like peptide 1 derivated. Endocrinil Diabetes Nutr 2017;64(3):182–4.
[163] Schneider NM, Tully CB, Washington GA, Price KL. Information needs among adolescent bariatric surgery patients and their caregivers. Surg Obes Relat Dis 2016;12(4):876–81.
[164] Hofmann B. Bariatric surgery for obese children and adolescents: a review of the moral challenges. BMC Med Ethics 2013;14:18.
[165] Bolt IL, van Summeren MJ. Competence assessment in minors, illustrated by the case of bariatric surgery for morbidly obese children. Best Pract Res Clin Gastroenterol 2014;28(2):293–302.
[166] Caniano DA. Ethical issues in pediatric bariatric surgery. Semin Pediatr Surg 2009;18(3):186–92.
[167] Nguyen NT, Nguyen B, Nguyen VQ, Ziogas A, Hohmann S, Stamos MJ. Outcomes of bariatric surgery performed at accredited vs nonaccredited centers. J Am Coll Surg 2012;215(4):467–74.

[168] Gebhart A, Young M, Phelan M, Nguyen NT. Impact of accreditation in bariatric surgery. Surg Obes Relat Dis 2014;10(5):767–73.
[169] Metabolic and Bariatric Surgery Accreditation And Quality Improvement Program [hopmepage on the Internet]. Chicago: American College of Surgeons, 2018. [updated 2018]. Available from: https://www.facs.org/quality-programs/mbsaqip. [Accessed March 15, 2018].
[170] BioEnterics Corporation, assignee. United States patent P000008. LAP-BAND Adjustable Gastric Banding (LAGB) System 2001 Jun 5. United States patent P000008.
[171] Pena AS, Delko T, Couper R, et al. Laparoscopic adjustable gastric banding in australian adolescents: should it be done? Obes Surg 2017;27(7):1667–73
[172] Coblijn UK, Goucham AB, Lagarde SM, Kuiken SD, van Wagensveld BA. Development of ulcer disease after Roux-en-Y gastric bypass, incidence, risk factors, and patient presentation: a systematic review. Obes Surg 2014;24(2):299–309.
[173] Weiss AC, Parina R, Horgan S, Talamini M, Chang DC, Sandler B. Quality and safety in obesity surgery-15 years of Roux-en-Y gastric bypass outcomes from a longitudinal database. Surg Obes Relat Dis 2016;12(1):33–40.
[174] Modi AC, Zeller MH, Xanthakos SA, Jenkins TM, Inge TH. Adherence to vitamin supplementation following adolescent bariatric surgery. Obesity (Silver Spring) 2013;21(3):E190–5.
[175] Alqahtani AR, Elahmedi MO, Al Qahtani A. Co-morbidity resolution in morbidly obese children and adolescents undergoing sleeve gastrectomy. Surg Obes Relat Dis 2014;10(5):842–50.
[176] Vilallonga R, Moreno Villares JM, Yeste Fernandez D, et al. Initial approach to childhood obesity in Spain. A multisociety expert panel assessment. Obes Surg 2017;27(4):997–1006.
[177] Shoar S, Poliakin L, Rubenstein R, Saber AA. Single anastomosis duodeno-ileal switch (SADIS): a systematic review of efficacy and safety. Obes Surg 2018;28(1):104–13.
[178] Greydanus DE, Bricker LA, Feucht C. Pharmacotherapy for obese adolescents. Pediatr Clin North Am 2011;58(1):139–53, xi.
[179] Matson KL, Fallon RM. Treatment of obesity in children and adolescents. J Pediatr Pharmacol Ther 2012;17(1):45–57.
[180] Kelly AS, Fox CK, Rudser KD, Gross AC, Ryder JR. Pediatric obesity pharmacotherapy: current state of the field, review of the literature and clinical trial considerations. Int J Obes (Lond) 2016; 40(7):1043–50.
[181] White B, Jamieson L, Clifford S, et al. Adolescent experiences of anti-obesity drugs. Clin Obes 2015;5(3):116–26.
[182] Rogovik AL, Goldman RD. Pharmacologic treatment of pediatric obesity. Can Fam Physician 2011;57(2):195–7.
[183] Yanovski SZ, Yanovski JA. Long-term drug treatment for obesity: a systematic and clinical review. JAMA 2014;311(1):74–86.
[184] Mead E, Atkinson G, Richter B, et al. Drug interventions for the treatment of obesity in children and adolescents. Cochrane Database Syst Rev 2016;11:Cd012436.
[185] Kumar S, Kelly AS. Review of childhood obesity: from epidemiology, etiology, and comorbidities to clinical assessment and treatment. Mayo Clin Proc 2017;92(2):51–65.
[186] Stanford FC, Alfaris N, Gomez G, et al. The utility of weight loss medications after bariatric surgery for weight regain or inadequate weight loss: a multi-center study. Surg Obes Relat Dis 2017;13(3):491–500.
[187] Reece LJ, Sachdev P, Copeland RJ, Thomson M, Wales JK, Wright NP. Intra-gastric balloon as an adjunct to lifestyle support in severely obese adolescents; impact on weight, physical activity, cardiorespiratory fitness and psychosocial well-being. Int J Obes 2017;41(4):591–7.
[188] Swidnicka-Siergiejko A, Wroblewski E, Andrzej D. Endoscopic treatment of obesity. Can J Gasterolenterol 2011;25(11):627–33.
[189] De Peppo F, Caccamo R, Adorisio O, et al. The Obalon swallowable intragastric balloon in pediatric and adolescent morbid obesity. Endosc Int Open 2017;5(1):E59–63.
[190] Sjostrom L, Narbro K, Sjostrom CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med 2007;357(8):741–52.
[191] Christou NV, Sampalis JS, Liberman M, et al. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. Ann Surg 2004;240(3):416–23; discussion 423–4.
[192] Gill RS, Birch DW, Shi X, Sharma AM, Karmali S. Sleeve gastrectomy and type 2 diabetes mellitus: a systematic review. Surg Obes Relat Dis 2010;6(6):707–13.
[193] Christou NV, Look D, Maclean LD. Weight gain after short- and long-limb gastric bypass in patients followed for longer than 10 years. Ann Surg 2006;244(5):734–40.
[194] Rianthavorn P, Ettenger RB. Medication non-adherence in the adolescent renal transplant recipient: a clinician's viewpoint. Pediatr Transplant 2005;9(3):398–407.
[195] Xanthakos SA, Inge TH. Nutritional consequences of bariatric surgery. Curr Opin Clin Nutr Metab Care 2006;9(4):489–96.
[196] Alvarez-Leite JI. Nutrient deficiencies secondary to bariatric surgery. Curr Opin Clin Nutr Metab Care 2004;7(5):569–75.
[197] Armstrong-Javors A, Pratt J, Kharasch S. Wernicke encephalopathy in adolescents after bariatric surgery: case report and review. Pediatrics 2016;138(6).
[198] Harkness LS, Bonny AE. Calcium and vitamin D status in the adolescent: key roles for bone, body weight, glucose tolerance, and estrogen biosynthesis. J Pediatr Adolesc Gynecol 2005;18(5):305–11.
[199] Harkness LS, Cromer BA. Vitamin D deficiency in adolescent females. J Adolesc Health 2005;37(1):75.
[200] Nogueira I, Hrovat K. Adolescent bariatric surgery: review on nutrition considerations. Nutr Clin Pract 2014;29(6):740–6.
[201] Parrott J, Frank L, Rabena R, Craggs-Dino L, Isom KA, Greiman L. American Society for Metabolic and Bariatric Surgery integrated health nutritional guidelines for the surgical weight loss patient 2016 update: micronutrients. Surg Obes Relat Dis 2017;13(5):727–41.
[202] Harper A. Reducing morbidity and mortality among pregnant obese. Best Pract Res Clin Obstet Gynaecol 2015;29(3):427–37.
[203] Lawlor DA, Relton C, Sattar N, Nelson SM. Maternal adiposity–a determinant of perinatal and offspring outcomes? Nat Rev Endocrinol 2012;8(11):679–88
[204] Gonzalez I, Lecube A, Rubio MA, Garcia-Luna PP. Pregnancy after bariatric surgery: improving outcomes for mother and child. Int J Womens Health 2016;8:721–9.
[205] Khan FH, Shaw L, Zhang W, et al. Fibroblast growth factor 21 correlates with weight loss after vertical sleeve gastrectomy in adolescents. Obesity (Silver Spring) 2016;24(11):2377–83.
[206] American College of Obstetricians and Gynecologists. ACOG Committee opinion no. 549: obesity in pregnancy. Obstet Gynecol 2013;121(1):213–7.
[207] Johansson K, Cnattingius S, Naslund I, et al. Outcomes of pregnancy after bariatric surgery. N Engl J Med 2015;372(9):814–24.
[208] Sheiner E, Edri A, Balaban E, Levi I, Aricha-Tamir B. Pregnancy outcome of patients who conceive during or after the first year following bariatric surgery. Am J Obstet Gynecol 2011;204(1):50.e51–6.
[209] Smith J, Cianflone K, Biron S, et al. Effects of maternal surgical weight loss in mothers on intergenerational transmission of obesity. J Clin Endocrinol Metab 2009;94(11):4275–83.
[210] Barisione M, Carlini F, Gradaschi R, Camerini G, Adami GF. Body weight at developmental age in siblings born to mothers before and after surgically induced weight loss. Surg Obes Relat Dis 2012; 8(4):387–91.