



# Adolescent metabolic and bariatric surgery: what does the data show?

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## What is childhood obesity?

Obesity amongst children and young adults has progressively increased over the past decade in the United States. Based on the most recent National Health Statistics Report by the Centers for Disease Control and Prevention (CDC), obesity prevalence increased with age (highest in ages 12–19) and was similar in prevalence for boys and girls. Overall, the prevalence of obesity was 19.7%, spanning about 14 million children (1). For defining obesity in adolescents, the CDC recommends utilizing a relative body mass index (BMI) measurement. Overweight is defined with a BMI greater than 85th percentile. Obesity is separated into three classes: class I obesity is a BMI greater than the 95th percentile, class II (severe) obesity is a BMI greater than 120% of the 95th percentile, and class III (markedly severe) obesity is a BMI >140% of the 95th percentile (2,3) based on historic controls.

The concern for childhood obesity is heightened by the greater association of class II and III obesity with greater cardiovascular and metabolic disorders including hypertension, diabetes, hyperlipidemia, and nonalcoholic fatty liver disease (4). Current studies predict that approximately half of current children will be obese by the age of 35 years with increased risk with age of obesity and severity of obesity. Further concern with obesity in childhood is the concern for an increased risk of long-term obesity and subsequent complications including premature death into adulthood (5). Beyond the physical consequences, childhood obesity also leads to psychosocial ramifications with increased rates of depressive symptoms,

low self-esteem, self-harm, and social isolation (6).

## What are the medical options?

While there are medical options for weight loss for obese adolescents, the data surrounding such programs is minimal for long-term benefits. These programs can consist of exercise programs, behavioral modification programs, and nutritional teaching programs. Some of these programs involve family members for a comprehensive support system-based model to encourage long-term change for the adolescent and the family. However effective these programs have on BMI change and metabolic outcomes like insulin resistance, the follow up period for these programs are usually short and their effects are limited to a brief period of about 1–2 years (7–9).

In addition to exercise and behavioral modification programs, there are some new medications that have come onto the market for obesity treatment. The majority of these medications, however, are only Food and Drug Administration (FDA) approved for adults or studied in adults (10). The primary medications studied for use in pediatric obesity include sibutramine (now off the market for cardiovascular issues), orlistat, phentermine, metformin, and exenatide (the latter two not FDA approved). Orlistat, a lipase inhibitor blocking fat absorption, has shown modest weight loss in obese children, but it is associated with increased oily stooling and fecal urgency, making it a less desirable option for many adolescents. Phentermine, a sympathomimetic that acts on the central nervous system

as an appetite suppressant, is approved for children older than 16 for weight loss with small to moderate effects, but side effects include increased anxiety, tremors, and elevated blood pressure. Metformin, a medication often used for glycemic control in diabetics, has been seen to have moderate weight loss in adolescents but is not FDA approved for this purpose. Exenatide, a glucagon-like peptide-1 (GLP-1) receptor agonist used for glycemic control in diabetics, is now coming into use for weight loss management in adults. While studies show reduction in BMI in adolescents, it is not yet fully approved by the FDA and side effects are still not favorable with moderate gastrointestinal side effects (nausea and vomiting) (10,11).

### What are the surgical options?

Considering medical options are a good adjunct but not often a long-term option for the treatment of adolescent obesity, the role of surgical options for adolescent obesity is important (11). The initial bariatric surgical outcomes in adolescents were published in the 1970s. In the 1970–1980s, bariatric operations were more frequently starting to be offered for adolescents. The initial operations offered to adolescents were the jejunioileal bypass and the biliopancreatic diversion, and the initial results from the operations were favorable with 30% weight reduction, improved quality of life, and improvement in diabetes and hyperlipidemia. However, these procedures were forgone due to higher risk of nutritional deficiencies, hepatorenal disorders, and overall malabsorption related complications. Refinement of the biliopancreatic diversion with the duodenal switch is an operation that is still being offered in certain cases for severe obesity. The vertical banded gastroplasty was another operation that was offered to adolescents in the 1980–1990s but the long-term weight loss was minimal and did the benefits were felt to not outweigh the post-surgical complications (12,13).

Widespread use of bariatric surgery on adolescents did not gain popularity until the early 2000s. Between 1997–2003, the frequency of bariatric surgery for adolescents increased 3- to 5-fold. Initial recommendations for bariatric surgery in adolescents include failure of weight loss attempts for 6 months, class II obesity with comorbidities (diabetes, sleep apnea, fatty liver disease, pseudotumor cerebri, cardiovascular disease, quality of life), and class III obesity (13,14). Along with these criteria, careful consideration must be evaluated specifically for adolescents to consider the psychosocial, physical, behavioral, and emotional factors

that affect adolescents and their families with bariatric surgery (12,15,16).

The major operations that are offered to adolescents at this time include the Roux-en-Y gastric bypass (RYGB), laparoscopic adjustable gastric band (LAGB), and the vertical sleeve gastrectomy (VSG). In the early 2000s, RYGB was dominant as the most performed procedure for adolescent bariatric surgery, encompassing about 90% of cases in 2003 (16,17). Lapband then gained popularity in the mid-2000's. However, in recent years, VSG has started gaining popularity with lower 30-day risk-adjusted serious morbidity and mortality compared to RYGB. By 2014, VSG was the most popular procedure dominating 58% of cases compared to 37% RYGB in adults (18). RYGB is shown to have the most drastic weight loss in the first year at 31%, but stabilized to similar differences with VSG by around 5 years. LAGB, while a simpler technique with low morbidity rates, has recently lost favor with the less drastic changes in weight loss and higher reoperation rates compared to VSG and RYGB. The trend in adolescents highly favor VSG as this procedure grew from only 13% of cases from 2005–2009 to 83% of cases in 2014–2015 (19).

Newer studies are slowly coming out also for endoscopic and device therapies (e.g., intragastric balloons) for use in adolescents. While rare significant complications have been and moderate weight loss has been seen with these therapies, further research is necessary to determine long term and comparative outcomes to already established bariatric interventions (20,21).

### What are the risks and outcomes?

There are still several unique factors and risks to consider when deciding on bariatric surgery on adolescents. One positive aspect to consider is that with an earlier intervention, adolescent patients would possibly have a lower disease burden and operative risks in comparison to adult patients when obesity related co-morbidities are more developed (15). The largest prospective trial investigating adolescent bariatric surgery is the Teen Longitudinal Assessment of Bariatric Surgery or Teen-LABS. This study investigated 5 centers and enrolled 242 adolescents undergoing bariatric surgery from 2007–2012 with an average age of 17 years of age and BMI of 53 kg/m<sup>2</sup>. This prospective study evaluating data from three years post bariatric surgery in adolescents yielded critical insight on the benefits of bariatric surgery for adolescents and set a baseline group for comparison

on future projects. Of note, there was a mean percent weight loss of 27% in the entire group within 3 years. Comorbidities like hypertension, dyslipidemia, and diabetes were drastically reduced or in remission in adolescents by 3 years. The need for reoperations was still low in 3 years with only 13% of patients needing additional intraabdominal procedures, but the majority of those cases consisted of needing a subsequent cholecystectomy (22).

In a later study utilizing the Teen-LABS cohort versus adults who were obese as adolescents but had RYGB as an adult, there was overall similar weight loss in both groups, but more variability in maintenance, abdominal reoperations, and nutritional deficiencies for the adolescent Teen-LABS surgical patients. Following along the Teen-LABS cohort compared to nonoperative medically managed patients, there was also an improvement in hemoglobin A1c levels, blood pressure, dyslipidemia, and abnormal kidney function in the surgically managed adolescents versus the medically managed adolescents. Thus, overall bariatric surgery in adolescents has shown a positive improvement in medical comorbidities and weight loss (22).

Nutritional deficiencies have been a topic of concern for both adult and adolescent bariatric patients, but the concern is amplified in developing adolescents (12). Adolescents have lower compliance rates of patients for medical care or follow-up. Without supplementation, patients can have a lack of absorption of key vitamins and minerals leading to peripheral neuropathy, weakness, abnormal menses, and osteoporosis (12,15,22). In the Teen-LABS patients, after 3 years, 57% had low ferritin levels, 35% had lower B12 levels, and 16% had lower vitamin A levels. At times this could be secondary to factors outside of the adolescent's control, such as issues with family dynamics, thus intensive preoperative evaluation is critical for these patients.

Another factor to consider for adolescents is the process of informed consent. A team mindset is necessary for success for adolescents as disagreements in the process between the adolescent, the family and the medical care team can lead to poor patient outcomes or misaligned expectations. The question of whether an adolescent truly has full informed consent or assent as an independent person with decision-making capabilities should be addressed prior to any operation, and any level of coercion by the family or medical team could be detrimental (15).

### Who does it?

Bariatric surgery for adults and adolescents is seen as a

positive option for the on-going obesity epidemic in the United States. The factors beyond the operating room including social and psychological support are critical in bariatric patients, but the necessity of such support is exponential for adolescent patients. While there is no major study comparing surgical outcomes in adolescents who get bariatric surgery with or without a multidisciplinary team, the argument to approach adolescent bariatric surgery with a multidisciplinary team is becoming more standard of care (15). These factors are institutionally specific due to the differing resource availability. These teams should include the surgeon, a pediatrician or other pediatric medical advisor, mental health specialist, dietician, physical therapist, social worker, bariatric coordinator, the patient's family, and the patient themselves. In the US, these team members must be included to get accreditation via the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP). Of note, on initial evaluation of adolescent patients, the mental health specialist must be trained and credentialed in pediatric and adolescent care to perform the behavioral assessment. Additionally, the volume of cases for accreditation as an adolescent center must meet a minimum of 15 stapling procedures per year without a certified bariatric surgeon or less than 15 stapling procedures if a certified bariatric co-surgeon is present. While setting up such a team and meeting requirements can be difficult initially, a multidisciplinary team approach in specialized adolescent centers will aid in coordinating patient selection, preoperative care, and postoperative care for the ultimate success of the adolescent in their weight loss journey (23-25).

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