Obesity in children: bariatric surgery

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ABSTRACT
INTRODUCTION: The prevalence of childhood obesity in the UK and in many countries worldwide remains high. Behavioural interventions to modify lifestyle, such as diet and physical activity, usually form part of weight management strategies for obese children. Whether or not surgical interventions are effective and safe in treating childhood obesity is unclear. METHODS AND OUTCOMES: We conducted a systematic overview, aiming to answer the following clinical question: What are the effects of surgical interventions for the treatment of childhood obesity? We searched Medline, Embase, The Cochrane Library, and other important databases up to August 2014 (BMJ Clinical Evidence reviews are updated periodically; please check our website for the most up-to-date version of this overview). RESULTS: At this update, after deduplication and removal of conference abstracts, 67 records were screened for inclusion in the overview. Appraisal of titles and abstracts led to the exclusion of 19 studies and the further review of 48 full publications. Of the 48 full articles evaluated, two systematic reviews were included at this update. CONCLUSIONS: In this systematic overview, we categorised the efficacy for two comparisons based on information about the effectiveness and safety of bariatric surgery versus no intervention and different types of bariatric surgery versus each other.

QUESTIONS
What are the effects of surgical interventions for the treatment of childhood obesity? 4

INTERVENTIONS
OBESITY IN CHILDREN: SURGICAL INTERVENTIONS
Unknown effectiveness
Bariatric surgery versus no treatment usual care, or waiting list control 4
Different types of bariatric surgery versus each other 5
To be covered in future updates
Pharmacological interventions for the treatment of childhood obesity

Key points

• Obesity is the result of long-term energy imbalances, where daily energy intake exceeds daily energy expenditure. Obesity in children is associated with physical as well as psychosocial problems. Long-term adverse health consequences of childhood obesity may include increased risk for chronic disease conditions, including cancer and cardiovascular and metabolic diseases in adulthood. Most obese children stay obese as adults.

• Obesity is increasing among children and adolescents, with 16% of boys and 15% of girls in the UK aged 2 to 15 years being obese in 2013. The prevalence of severe obesity is unclear and depends on the classification used to define this condition. However, it has been estimated to be 1% to 4% of children aged 4 to 5 years and 10 to 11 years in the UK in 2011–2012, and up to 8% of children aged 2 to 9 years in the US.

• We don’t know how effective and safe bariatric surgery is versus no intervention, or different types of bariatric surgery are versus each other, in treating obesity in children, particularly in children with severe obesity, as we found no relevant RCTs. Surgical expertise, specialist care, the target population (i.e., children), and some uncertainties on adverse consequences of bariatric surgery in the long-term are some of the barriers that may have limited the number of RCTs conducted to evaluate the effectiveness and safety of surgical interventions to treat morbid obesity in children.

• Future RCTs may require multi-centre collaboration to assess both short-term and long-term follow-up. Findings from existing, well-characterised prospective cohorts of children who underwent bariatric surgery should be relevant, particularly in informing how RCTs should be designed in the future. Future RCTs should also address questions on effectiveness and safety of the different surgical interventions for obesity in children, including the increasingly used technique of laparoscopic sleeve gastrectomy.

Clinical context

GENERAL BACKGROUND
The prevalence of overweight children and childhood obesity remains high in the UK and in many countries worldwide. Lifestyle interventions form part of the main strategy to treat childhood obesity; however, the impact of these interventions is limited, particularly in morbidly obese children. There is a growing interest in the use of surgical interventions in the treatment and management of obesity in paediatric patients, but evidence for the benefits and harms of surgical interventions is unclear, and the cost-effectiveness of this intervention is unknown.
FOCUS OF THE REVIEW
The main purpose of this overview is to seek evidence from RCTs to assess physical, psychosocial, and quality-of-life outcomes of bariatric surgery in childhood obesity as compared to appropriate control (no intervention, usual care, or waiting list control), or of different types of bariatric surgery compared with each other.

COMMENTS ON EVIDENCE
Two systematic reviews met our criteria. However, these reviews included mostly non-RCTs and studies without appropriate comparison groups. Some of the barriers that may have limited the number of RCTs conducted to evaluate the effectiveness and safety of surgical interventions to treat morbid obesity in children include: surgical expertise, specialist care, the target population (i.e., children), and some uncertainties on adverse consequences of bariatric surgery in the long term.

SEARCH AND APPRAISAL SUMMARY
The update literature search for this review was carried out from the date of the last search, January 2010, to August 2014. For more information on the electronic databases searched and criteria applied during assessment of studies for potential relevance to the overview, please see the Methods section. After deduplication and removal of conference abstracts, 67 records were screened for inclusion in the overview. Appraisal of titles and abstracts led to the exclusion of 19 studies and the further review of 48 full publications. Of the 48 full articles evaluated, two systematic reviews were included at this update.

ADDITIONAL INFORMATION
Lifestyle interventions, usually delivered through behavioural programmes, may be effective in reducing excess weight in obese children, but these interventions may have limited impact in children with severe obesity. Even if weight loss is achieved through lifestyle modification, the magnitude of the effect is small and severely obese children remain obese. The indication and patient selection criteria for bariatric surgery remain poorly defined, but the target patient group in paediatric populations is likely to be limited to older children with severe obesity (e.g., adolescents). Bariatric surgery may be offered as a treatment option for morbidly obese children, but is usually reserved for exceptional circumstances in settings where this treatment is available and accessible. There is growing interest in the use of bariatric surgery as a treatment option for obesity among paediatric patients, but the evidence for the effectiveness and safety of such surgical intervention is unclear.

DEFINITION
Obesity is a chronic condition characterised by an excess of body fat that presents a risk to health. Body mass index (BMI), calculated as weight (in kilograms) divided by squared height (in metres), is a crude yet simple and widely used measure in the identification of overweight and obesity as it is highly correlated with body fat. In young children and adolescents, BMI varies with age and sex. It typically rises during the first months after birth, falls after the first year, and rises again around the sixth year of life and into adolescence. Thus, a child’s BMI is usually compared to age- and sex-specific BMI of a reference population to obtain the BMI percentile of the child relative to that population. A BMI above the 95th percentile is variably defined as obese, which generally indicates a need for intervention. A small subgroup of obese children are considered to have severe obesity (also described as extreme or morbid obesity), but there is no standard definition to identify this group, and their classification is largely based on the very extreme end of the BMI percentile distribution, or the BMI percentile distribution equivalent to the adult BMI of 35 kg/m² or higher (class II and III obesity).

INCIDENCE/ PREVALENCE
The prevalence of obesity (generally, BMI >95th percentile) has been increasing among children and adolescents. In the UK in 2013, it was estimated that 16% of boys and 15% of girls aged 2 to 15 years were obese, an increase from 11% of boys and 12% of girls in 1995, but a decrease from 18% to 19% of both boys and girls from when the prevalence peaked in 2004 and 2005. This pattern suggested an increasing prevalence of obesity until the mid-2000s, when the prevalence seemed to have plateaued. Among children followed for more than 9 years from age 5, 12% became obese when they reached age 14 years, with an incidence rate of 26.5 per 1000 person-years among non-obese at baseline. The proportion of extremely obese children varies with the classification used. In the National Child Measurement Programme in England in 2011 to 2012, around 2% of children 4 to 5 years old and 3% to 4% of those 10 to 11 years old had severe obesity, based on classifying severe obesity as equal to or above the 99.6th percentile on the UK 1990 growth chart; or 1% to 2% of children 4 to 5 years old and 1% of those 10 to 11 years old when using the International Obesity Task Force classification. The prevalence of severe obesity among 4- to 5-year-olds hardly changed between 2006–2007 and 2011–2012, but there was a marked increase over the same period among 10- to 11-year-olds. In the US, little has changed in the prevalence of overweight children, but the proportions of obese, as well as severely obese,
children continued to rise between 1999–2000 and 2011–2012. In 2011–2012, up to 8% of children in the US aged 2 to 19 years may be considered to be severely obese. `11 `[15]

**AETIOLOGY/RISK FACTORS**

Obesity is the result of disproportionate energy consumption outweighing energy expenditure. `18` The genetic basis of obesity has been well investigated, `19` `20` and genetic factors are likely to play an important role in the aetiology of severe obesity. `21` However, the increase in obesity prevalence in the past few decades is less likely to be explained by changes in the human gene pool, and more likely to be related to environmental changes that promote excessive food intake and discourage physical activity (increasing sedentariness); `22` `23` `24` and changes to other distal factors that may influence diet and physical activity, including parental education, social deprivation, infant feeding patterns, and intrauterine exposures. `11` `25` Physical activity levels have decreased over the years. Only 36% of children and adolescents in the US meet the recommended levels of physical activity. `26` Among British children aged 5 to 15 years in 2012, only 21% of boys and 16% of girls met the minimum physical activity level required to achieve health benefits, down from 28% of boys and 19% of girls in 2008. `27` Less commonly, obesity may also be induced by drugs (e.g., high-dose glucocorticoids), neuroendocrine disorders (e.g., Cushing’s syndrome), or inherited disorders (e.g., Down’s syndrome and Prader-Willi syndrome). `11`

**PROGNOSIS**

Most obese children will become obese adolescents. Obese children at age 5 years are four times more likely to become obese at age 14 years than non-obese children. `17` In longitudinal studies, most obese children and adolescents are also most likely to become obese adults as compared to non-obese children. `28` `29` Consequently, the obese children who remain obese in adulthood develop adverse morbidity and mortality outcomes later in life, including hypertension, dyslipidaemia, diabetes, cardiovascular disease, sleep apnoea, osteoarthritis, and some cancers. `11` `30` `31` The long-term adverse health risks associated with childhood obesity are potentially modifiable. The effect of childhood obesity on adult health outcomes is generally linked to the development of a high adult BMI among obese children later in life. `29` The associated risks are reduced if these children achieve normal weight when they reach adulthood. `30` Perhaps a less recognised but important short-term comorbidity of overweight/obesity, particularly in adolescent children, is functional impairment in several psychosocial domains, including social marginalisation, low self-esteem, and impaired quality of life. `11` `37` `38` `39` `40`

**AIMS OF INTERVENTION**

To achieve reduction in BMI and BMI percentile, and to prevent the morbidity and mortality associated with obesity, without undue adverse effects.

**OUTCOMES**

Change in overweight proxy measures assessed in studies included mean weight loss (kg), change in BMI (kg/m²), change in BMI z score, change in BMI percentile, change in percentage overweight, obesity or severe obesity, and change in other adiposity indicators (waist circumference, hip circumference, waist-hip ratio, total fat mass, percentage fat mass); quality of life; secondary disease outcome any change in diabetes (diagnosis of diabetes, change in treatment for diabetes, change in fasting insulin or glucose levels), hypertension (diagnosis of hypertension, change in treatment for hypertension, change in blood pressure), dyslipidaemia (diagnosis of dyslipidaemia, change in treatment of dyslipidaemia, change in total or LDL-cholesterol); adverse effects.

**METHODS**

Search strategy BMJ Clinical Evidence search and appraisal August 2014. Databases used to identify studies for this systematic review include: Medline 1966 to August 2014, Embase 1980 to August 2014, The Cochrane Database of Systematic Reviews 2014, issue 3 (1966 to date of issue), the Database of Abstracts of Reviews of Effects (DARE), and the Health Technology Assessment (HTA) database. Inclusion criteria Study design criteria for inclusion in this systematic overview were systematic reviews and RCTs published in English and containing 10 or more individuals (at least 5 people per study arm), of whom more than 60% were followed up. RCTs could be open or blinded. Minimum length of follow-up was 12 weeks. We included studies in overweight and obese children (aged 18 years and younger), including children with a BMI above the 85th percentile for age and sex. We included RCTs and systematic reviews of RCTs where harms of an included intervention were assessed, applying the same study design criteria for inclusion as we did for benefits. BMJ Clinical Evidence does not necessarily report every study found (e.g., every systematic review). Rather, we report the most recent, relevant and comprehensive studies identified through an agreed process involving our evidence team, editorial team, and expert contributors. Evidence evaluation A systematic literature search was conducted by the evidence team, who then assessed titles and abstracts, and finally selected articles for full text appraisal against inclusion and exclusion criteria agreed a priori with our expert contributors. In consultation with the expert contributors, studies were selected for inclusion and all data relevant to this overview extracted into the benefits and harms section of the overview. In addition, information that did not meet our predefined criteria for inclusion in the benefits and harms section, may have been reported in the ‘Further information
QUESTION
What are the effects of surgical interventions for the treatment of childhood obesity?

OPTION
BARIATRIC SURGERY VERSUS NO TREATMENT, USUAL CARE, OR WAITING LIST CONTROL

- We found no direct information from RCTs on the effects of bariatric surgery versus no treatment, usual care, or waiting list controls for obesity in children.

- Although bariatric surgery could potentially result in substantial weight loss among severely obese adolescents, evidence from well designed studies, particularly from RCTs, is limited. Uncertainties remain regarding clinical indications, identification of the relevant age group, cost, ethics, post-operative complications, and the short- and long-term benefits and harms of surgical procedures in this population.

Benefits and harms
Bariatric surgery versus no treatment, usual care, or waiting list control:

We found two systematic reviews (search dates 2010; and 2013) evaluating the effects of bariatric surgery for obesity in children. The reviews included mostly non-RCTs, and did not identify any RCT comparing bariatric surgery with no treatment, usual care, or waiting list control. We found no additional or subsequent RCTs.

Comment:
Findings from the review of mostly non-RCTs suggest that surgical intervention in the treatment of severe obesity could lead to a substantial amount of weight loss. However, the actual magnitude of weight loss is unclear. In one RCT, laparoscopic adjustable gastric banding resulted in substantial weight loss when compared to an intensive lifestyle intervention, suggesting that, if the comparison group was given usual or conventional care for obese children, the magnitude of the effect could have been potentially greater in this study. However, the evidence for the effectiveness and safety of surgical interventions for the treatment of paediatric obesity remains poor. Uncertainties remain, particularly in relation to indications, patient selection criteria, post-operative complications, and beneficial and harmful outcomes beyond weight loss in the short and long term. How long is ‘long term’ to assess benefits and harms associated with surgical interventions for obesity in paediatric populations needs further elucidation considering that, depending on the age at surgical intervention, a 24-month follow-up would still mean assessing outcomes during childhood for some patients. There are registered RCTs (e.g., ClinicalTrials.gov identifiers NCT01700738 and NCT02378259), but the status of these trials is unclear as they are probably not actively recruiting patients into the study.

Surgical expertise, specialist care, the target population (i.e., children), and some uncertainties on adverse consequences of bariatric surgery in the long-term are some of the barriers that may have limited the number of RCTs conducted to evaluate the effectiveness and safety of surgical interven-
tions to treat morbid obesity in children. Future RCTs may require multi-centre collaboration to assess both short-term and long-term follow-up. Findings from existing, well-characterised prospective cohorts of children who underwent bariatric surgery should be relevant, particularly in informing how RCTs should be designed in the future. Future RCTs should also address questions regarding the effectiveness and safety of the different surgical interventions for obesity in children, including the increasingly used technique of laparoscopic sleeve gastrectomy.

Clinical guide
Surgical treatment strategies for paediatric obesity are complex and may only be used in exceptional circumstances. Unlike in adults, there are several considerations that are specific to paediatric populations, including potential effects on growth and development, having a longer lifespan than adults to experience benefits and harms, and issues of consent. However, factors such as the local healthcare system and availability of specialist services are key considerations for surgical interventions for childhood obesity. As in adults, the magnitude of weight loss after bariatric surgery is likely to be substantial and could lead to improvements in cardiovascular and metabolic risk profile, at least in the short term. However, this treatment strategy for obesity is likely to be limited to severe obesity in paediatric patients who have reached appropriate chronological age and/or developmental stage, and only after other conventional weight management approaches have been explored. In addition, the absolute long-term benefits and harms of surgical treatment in this population are currently poorly described and quantified.

**OPTION DIFFERENT TYPES OF BARIATRIC SURGERY VERSUS EACH OTHER**

- We found no direct information from RCTs on the effects of different types of bariatric surgery for obesity in children.
- There are different bariatric surgery techniques that have been used to treat severe obesity in adolescence. One of the key considerations to the technique of choice is the reversibility or permanence of the procedure on the intestinal tract. We found no RCTs comparing the effectiveness between surgical techniques or evaluating the benefits and harms of the different bariatric surgery techniques.

**Benefits and harms**

**Different types of bariatric surgery versus each other:**

We found no systematic review or RCTs comparing different types of bariatric surgery with each other in children that met our inclusion criteria.

**Comment:**

As in adults, laparoscopic adjustable gastric banding and the Roux-en-Y gastric bypass are two of the most commonly used procedures for surgical intervention in children with severe obesity, although laparoscopic sleeve gastrectomy has been increasingly used in some medical centres. However, there are no RCTs comparing the effectiveness of different surgical techniques in treating severe obesity. Observations from mostly non-RCTs suggest substantial reduction in BMI using the three surgical techniques, with the biggest reductions in BMI seen after Roux-en-Y gastric bypass procedures. However, the evidence has been based on studies without appropriate comparison groups and with heterogeneity in the patient selection criteria, definition of severe obesity, and sample size. One of the key considerations for the procedure of choice is the reversibility or permanence of the procedure on the intestinal tract. However, the use of adjustable gastric banding in people under 18 years of age is currently not approved by the FDA and is usually performed ‘off-label’.

**GLOSSARY**

**Z score** The z score reveals how many units of the standard deviation a case is above or below the mean.

**SUBSTANTIVE CHANGES**

**Bariatric surgery versus no treatment, usual care, or waiting list control** Option restructured. Two systematic reviews added. Categorised as ‘unknown effectiveness’.

**Different types of bariatric surgery versus each other** Option restructured. No new evidence. Categorised as ‘unknown effectiveness’.
REFERENCES


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