



Evidence Review:

Obesity surgery for children with severe complex obesity

NHS England

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1. Introduction

The prevalence of childhood obesity has been increasing over the last few decades, and in 2011, 3 in 10 children aged 2-15 years were found to be overweight or obese in the UK (NICE CG189, 2014). Childhood obesity is associated with co-morbid conditions, commonly: hypertension; obstructive sleep apnoea; insulin resistance; metabolic syndrome; non-alcoholic fatty liver disease; and dyslipidaemia. The cost of obesity to society was estimated in 2007 to be £16 billion, and if rates continue to rise could reach up to £50 billion in 2050 (NICE CG189, 2014).

Obesity in children is currently managed predominately with lifestyle interventions, focusing on behavioural and dietary modifications, with evidence of short term success (Cochrane Review, 2009). Pharmacotherapy is less commonly used in adolescent patients: Cochrane review (2009) showed both orlistat and sibutramine in children greater than 12 years to be beneficial in reducing weight at 6 months.

NHS England commissions obesity surgery for appropriate, selected adults with severe and complex obesity that have not responded to all other non-invasive therapies (Complex and specialised obesity surgery NHSCB/A05/P/a). Some severely obese adolescents with significant and severe obesity-related comorbidities such as hypertension, fatty liver disease or uncontrolled diabetes, who have failed specialist multi-component, intensive, non-invasive weight management programmes, may be benefit from a surgical approach.

Currently there is no evidence based care pathway in utilising obesity surgery in the paediatric/adolescent population. Primarily three types of obesity surgery are being commonly performed in the paediatric/adolescent population: laparoscopic Roux-en Y gastric bypass (RYGB); laparoscopic adjustable gastric banding (LAGB); and more recently sleeve gastrectomy (LSG).

2. Summary of results

What is the clinical effectiveness of obesity surgery in children and adolescents?
Is there any evidence for long term efficacy (more than 1 year? more than 5 years?)?

Overall, in the current literature there is evidence of clinical effectiveness for obesity surgery in adolescents (following skeletal maturity - Tanner Stage 4 and above), predominately from non-RCT studies (level 2 and 3 studies), with limited evidence about long term efficacy. There are limited studies on performing obesity surgery in younger children (level 3). There is insufficient evidence on selection criteria, indications, postoperative complications and long-term adverse effects of surgery. Although included in the literature search strategy, no evidence relating to duodenal switch procedures in adolescents could be found. The search strategy did not specifically include rare syndromes predisposing to adolescent obesity, but some pertinent information was found in the wider literature.

One RCT (level 1) by O'Brien et al, 2010 has been identified in the current literature, which evaluated laparoscopic adjustable gastric banding (LAGB) with intensive lifestyle intervention (dietary and behavioural modification) in 50 obese adolescents aged 14-18. They found that LAGB resulted in substantial weight loss at two years, with a mean reduction of 34.6kg versus 3kg in the lifestyle group. They also observed improvements in health related quality of life. Twenty-eight percent of adolescents did require revision surgery (removal or replacement of the band or replacement of the access port), a rate consistent with adult studies.

A recent meta-analysis (level -1) by Paulus et al (2015) examined change in BMI one year post operatively, and reported on health related indices. The analysis included 23 studies (level 2/3), and found the mean BMI loss was -13.5kg/m², the greatest loss in the RYGB group (-17.2kg/m²) and smallest in the LAGB group (-10.5kg/m²). These findings were consistent with another meta-analysis that evaluated 37 studies (Black et al, 2013) (level -1), and found the mean BMI loss was greatest in the RYGB group (-16.6kg/m²), followed by LSG with 14.1kg/m² and LAGB with -11kg/m². Pedroso et al (2015) (level -2) assessed LSG and LAGB in adolescent patients and at two year follow-up observed significant greater percentage excess weight loss in the LSG group compared to the LAGB group (70.9% vs 35.5% respectively P=0.004). The recently published Teen longitudinal Assessment of Bariatric surgery (Teen-LABS) study (Inge et al, 2015) showed that patients who underwent obesity surgery (RYGB and LSG) reported an overall decrease in mean weight of 27% and mean BMI decrease of 28% (BMI decreased from baseline from 53kg/m² to 38kg/m²) at 3 years post operatively. The mean weight loss of those patients who underwent RYGB was 28% compared to 26% in the LSG group at three years. The study observed that at three

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years 26% of patients were no longer obese. At 3 years 2% of patients who underwent gastric bypass and 4% of those who underwent sleeve gastrectomy exceeded baseline weight.

Paulus et al (2015) noted the overall poor quality of documentation of complications, with the majority of complications in the RYGB group involving nutrient deficiencies, hernia and wound infection. In LAGB the key complications were pouch dilatation, band slippage and port complications. Complications were rarely reported in LSG. Pedroso et al (2015) observed that at 5 years the complication rate in the LAGB group was 23.4%, which included bowel obstruction, port leakage and band displacement. Follow-up at two years in the LSG group reported minimal overall complications. However, there was one death 12 days post LSG, as a result of mesenteric venous thrombosis. The Teen Longitudinal Assessment of Bariatric surgery (Teen-LABS) (n=242) (level 3), which is an ongoing prospective study, evaluated outcomes within 30 days postoperatively (Inge et al, 2014). No mortality was recorded, 7.9% experienced major complications, 5% perioperative complications including one splenic injury, early reoperation for intestinal obstruction, bleeding or suspected gastrointestinal leak. 14.9% had minor complications including urinary tract infections, abdominal and gastrointestinal complaints including dehydration. The Teen-LAB study at 3 years post operatively (Inge et al 2015) found 13% of patients had undergone one or more intra-abdominal procedure. Inge et al also evaluated micronutrients, and found low ferritin levels were evident in 57% of patients (P<0.001), 16% of patients who undergone RYGB (P=0.008) and 8% of all patient being VitB12 deficient, at three years post-surgery. Case series of 345 patients Lennez et al (2014) reported intraoperative complications rate of 0%-2.6%, and postoperative complications (18 months follow-up) rate of 9.1% to 2.5%. In this case series they found no difference in rates of complications at 18 months amongst the three surgical procedures (LSG, LAGB and RYGB). Long-term high quality studies are required to evaluate the risk of different obesity surgical procedures in children and adolescents.

In studies reporting co-morbidities a variability in both the assessment and methodology is evident. There is level 2/3 evidence of improvement and resolution of co-morbidities. Paulus et al (2015) found that over 50% of the RYGB and LGB reported resolution in associated co-morbidities, including hypertension, sleep apnoea, insulin resistance and dyslipidaemia. Black et al (2013) reported, 11/18 LAGB studies observed complete resolution of hypertension in 22-100% of studies, dyslipidaemia in 50% and 100% of diabetic cases after surgery. In RYGB 8/13 reported an improvement, and in LSG 4/5 studies reported resolution of co-morbidities in 75-100% of studies evaluating hypertension, 56-100% of dyslipidaemia and 50-93% of those with diabetes. Inge et al (2015) observed (level 3) an improvement in insulin sensitivity and β cell function, and metabolic improvements even with obesity persisting at one year follow-up.

Psychosocial and mental health is increasingly becoming an important parameter requiring evaluation pre and post obesity surgery. A systematic review consisting of 12 adolescent studies (Herget et al, 2014) (level 2+) reported depressive symptoms ranging from 15 to 70%, anxiety symptoms 15-33% and eating disorders in 48-70%, prior to surgery. A large case series by Sysko et al (2012) reported a significant improvement in depressive symptoms (P<0.001) at 15 months. A systematic review evaluating 10 studies (Hilstrom et al, 2015 (level 2+)) observed an overall improvement in psychosocial outcomes post operatively. Herget et al (2014) found studies varied in evaluation in time points and no clear documentation of pharmacotherapy pre and post-surgery. Studies have observed short term improvements in psychosocial parameters, however studies have also reported a persistence of symptoms post operatively. Zeller et al (2011) observed an increased tendency of depressive symptoms at 18-24 months postoperatively, and Orsorio et al (2011) observed 21.4% of patients were still suffering from clinical depressive symptoms. Overall studies (level2/3) have reported improvement in quality of life parameters, physical, self-esteem domains from baseline following obesity surgery, further high level evidence is required to further evaluate the psychosocial impact upon adolescents/children pre and post-surgery.

Cost effectiveness

There is lack of studies evaluating cost effectiveness of obesity surgery in children and adolescents. Aikenhead et al (2011) in a systematic review identified three studies on LAGB in adolescent, that showed net cost saving per disability adjusted life year was \$AU4,400 (£2,092) (level 2+). Bairdain et al (2015) (level 3) evaluated cost-effectiveness (n=11) and estimated that obesity surgery was not cost effective in the first three years, but cost effective after that \$80,065 (£52,925) QALY in year four and \$36,570 (23,515) QALY in year seven (threshold of \$100,000/QALY). This small study failed to include obesity specific comorbidities, and additionally the US findings may not be entirely applicable to the UK population cohort.

What is the evidence for selection criteria and previous weight management strategies?

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There is no empirical evidence of a standardised care pathway, including selection criteria. The majority of the western world follows consensus guidance, including that obesity surgery should be performed on adolescents following a multidisciplinary evaluation. Obese adolescents ($\geq 40\text{kg/m}^2$ or $\geq 35\text{kg/m}^2$ with at least one obesity associated co-morbidity) that have achieved skeletal maturation (linear growth), following failure of lifestyle interventions should be considered. There is a variation and documentation in the studies in type, intensity and duration of lifestyle intervention prior to obesity surgery. The majority of obesity surgery appeared to be performed in a multidisciplinary environment. The majority of studies have excluded syndromic patients, those with severe medical or psychiatric problems and those who have disease related aetiology for obesity.

Patient participation prior to surgery provides an opportunity to evaluate behaviour and motivation. Fenning et al (2015) pilot study (n=15) (level 3) involved two phases, firstly a 3 month preoperative program, consisting of medical examination, psychological measures, self-monitoring, physical activity, cognitive behaviour orientated therapy and psychosocial educational training, and phase two surgical phase. Phase I assessed adherence to program, parental involvement and weight loss preoperatively. They found both weight and BMI decreased over the three months, mean loss -3.14kg/m^2 and majority of patients followed the program. Interestingly, they observed poor parental participation. Compliance post operatively requires further evaluation.

Although the majority of surgery has been undertaken in non-syndromic adolescent, a recent study by Mohaidly et al (2013) (Level 3) performed LSG on an obese 2.5 year old, and at 2 years the patient had a 27% weight loss with normalisation of BMI from 41kg/m^2 to 24kg/m^2 . The authors did raise concern on parental compliance with instructions and poor attendance at follow-up. Growth, developmental and nutritional details were not included in the study. Alqahtani et al (2015) (level -2) performed LSG on 24 patients with Prader Willi Syndrome (PWS) with a mean age of 10.7 years, observed at 5 years significant weight reduction, with rate of growth not significant between the PWS group and matched non-PWS group.

In summary, the available evidence indicates that any of these three procedures in adolescents lead to greater short-term (1-3 years) weight loss and improvements in HRQOL, psychological outcomes and comorbidities than non-invasive management alone, although there is little longer term follow-up evidence available at present. There was little evidence to indicate that one type of procedure was superior or inferior to another, and the adverse effects of obesity surgery in general are not well documented. The collection of longitudinal evidence on the short and long-term effects of obesity surgery in children, including endocrinological and metabolic effects, raises the importance of robust mechanisms to assess longer term outcomes and to ensure patients are in a position to give informed consent for the procedure.

3. Research questions

1. What is the clinical effectiveness of obesity surgery in children and adolescents?
 - 1.1 Is there any evidence for long term efficacy (more than 1 year? more than 5 years?)?
2. What is the evidence for selection criteria and previous weight management strategies?

4. Methodology

A review of published, peer reviewed literature has been undertaken based on the research questions set out in Section 3 and a search strategy agreed with the lead clinician and public health lead for this policy area. This has involved a PubMed search and search of the Cochrane database for systematic reviews, in addition to review of any existing NICE or SIGN guidance. The evidence review has been independently quality assured.

An audit trail has been maintained of papers excluded from the review on the basis of the inclusion and exclusion criteria agreed within the search strategy. The full list has been made available to the clinicians developing the policy where requested.

5. Results

A detailed breakdown of the evidence is included in the Appendix.

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Appendix One

Grade	Study design and intervention			Outcomes					Reference	Other		
Level of evidence	Study design	Study size	Intervention	Category	Primary Outcome	Primary Result	Secondary Outcome	Secondary Result	Reference	Complications noted	Benefits noted	Comments
1-	Systematic + Meta Analysis	Total 637 patients (median baseline line 24 pts, with range of 10-108)	Patient underwent the following types of procedure: i) Roux-en-Y gastric bypass (RYGB), total number of 8 studies (n=256). ii) Adjustable gastric banding (AGB), 11 studies (n=271). iii) Sleeve gastrectomy (SG), 3 studies (n=90) iv)Bilopancreatic 1 study diversion (BPD) v) Sanotoro III (novel surgical procedure), 1 study	Clinical effectiveness of the intervention	i) Meta-analyse change in body mass index (BMI) 1 year post surgery ii) Report complications, co-morbidity resolution and health related quality of life (HRQoL)	i) All studies reported decreases in BMI. At 12months post operatively the average weighted mean BMI difference from baseline to 1 year was -13.5kg/m2 (95% CI -15.1, -11.9). Strong evidence of heterogeneity I2=76.1% and P<0.001 (used random effects model). - At 1 year the mean BMI loss greatest in the RYGB group (-17.2kg/m2 (95% CI -20.1, -14.3), and smallest for AGB -10.5kg/m2 (95% CI -11.8, -9.1). Mean BMI loss after SG was -14.5kg/m2 (95% CI -17.3, 11.7). ii) complications: Authors noted due to documentation of complications in each study difficult to ascertain exact numbers. In general RYGB studies; nutrient deficiencies, hernias, wound infections, small bowel obstructions, cholelithiasis and ulcers. AGB overall reported less complications, included pouch dilation, port leakage and slippage. Rarely complications reported from SG. iii) Co-morbidity resolution: Authors comment data was of very poor quality and variability with regards to the co-morbidities examined. 5/8 RYGB studies reported resolution at one year of majority of cases of hypertension, sleep apnoea, type 2 diabetes and dyslipidaemia. 6/11 studies in AGB reported resolution, including insulin resistance resolution. In one "G study (Al Qahtani, n=55) reported moderate resolution of dyslipidaemia. HRQoL: six studies reported from three general HRQoL measures. Loux TJ et al, RYGB (n=33) study showed an increase in both mean Short Form-36 Physical Component score 34.7 (10.1) to 55.5(5.3); P<0.01, and the mean component score 40.6(13.5) to 54.8(8.4); P<0.01 at one year follow-up. Two LAGB studies observed both PedsQL and general health domain. Two further case studies observed improvement.	-	-	Paulus, Givan F.; de Vaan, Loes E. G.; Verdarm, Froukje J.; Bouvy, Nicole D.; Ambergen, Ton A. W.; van Heurn, L. W. Ernest, Bariatric surgery in morbidly obese adolescents: a systematic review and meta-analysis. <i>Obes Surg</i> 2015;25(5):860-878.	Refer to primary outcome	Yes	Population: Patients aged 5 - 23 years. Mean BMI 47.9kg/m2 (range 38.5 to 60.2kg/m2). Studies that were excluded: studies involving VBG, jejunoileal bypass, study populations defined by specific causes of obesity, non-sequential case series, and studies < 10 individuals. In non-RCTS only data from surgical groups was extracted Overall comments: Authors have noted that only one RCT included in the systematic review. Small trial, n=50 and 28% of non-surgical arm withdrew from study post randomisation, with potential bias. Five studies were prospective and the remainder were retrospective. The majority of studies were of low evidence, hence downgraded to -1
1-	Systematic + Meta Analysis	-	Patient underwent the following types of procedure: i) Roux-en-Y gastric bypass (RYGB), total number of 13 studies (5/13 prospective) ii) Laparoscopic Adjustable gastric banding (LAGB), 18 studies (7/18 prospective + one RCT) iii) Sleeve gastrectomy (SG) 7 studies (3/7 prospective). One LAGB and LSG study.	Clinical effectiveness of the intervention	To evaluate for each type of procedure LAGB, RYGB, LSG to determine i) Mean body mass index loss (meta-analysis) ii) Improvement of comorbidity iii) Quality of life iv) complications	i) Mean BMI loss after LAGB was 11.6kg/m2 (95% CI 9.8-14.4), after RYGB 16.6kg/m2 (95% CI 13.4-19.8) and after LSG 14.1kg/m2 (95% CI 10.9-17.5). ii) Comorbidities: In the LAGB studies 11/18 reported data on comorbidity resolution. 9 studies reported resolution of hypertension - range from 22.9 to 100%, 6/9 studies complete resolution, 8/9 reported resolution of dyslipidaemia in 50% of cases (range 0 to 100%). 6/7 studies reported diabetes prevalence with 100% resolution after surgery. 8/13 on RYGB reported improvement. Studies reporting on hypertension, (n=4) show 61 to 100% improvement, 6-62% of pts had dyslipidaemia and resolved in 56-100%. In 5/6 studies resolution of diabetes. 4/5 studies on LSG reported comorbidities, hypertension resolved in 75-100%, dyslipidaemia improved, resolution of 58-70% of patients and diabetes reported in 3/5 studies and resolved in 50-93.8% . iii)	-	-	Black, J. A.; White, B.; Viner, R. M.; Simmons, R. K.. Bariatric surgery for obese children and adolescents: a systematic review and meta-analysis. <i>Obes Rev</i> 2013;14(8):634-644.	Refer to primary outcome and two unrelated deaths were reported after 495 RYGB procedures, these deaths occurred 2 and 6 years after surgery.	Yes	Population: Obese patients undergoing bariatric surgery. Inclusion criteria: prospective clinical trials and observational studies. Studies included >10patients, mean follow-up >12months, age <18 at time of operation, majority of procedures <25years ago. Overall comments: The funnel plots show heterogeneity and likely increase risk of bias is as described by the authors, a result of lack of high quality prospective randomised controlled trials. Authors report variability in describing co-morbidities. In addition authors report the criteria for micronutrient and vitamin deficiencies were poorly described. In addition follow up to 24 months may not capture negative long term effects after bariatric surgery. Authors recognise that RYGB may be superior in terms of BMI loss but should be aware of

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Quality of Life : 4 studies in the LAGB reported upon quality of life. Holterman et al showed 75% of children with abnormal Peds-QL scores at baseline improved at 12 and 18mths after surgery. O'Brien et al in their RCT observed improvements in physical functioning, general health, self esteem, family activities and change in health with child health questionnaire after surgery. Silberhumer et al observed improvement using the BAROS and Moorehead-Ardelt Quality of life questionnaires after 35 months (although no changes 3-5 years after surgery. Yitzhak et al reported 72% improvement in social and self esteem and 93% improvement in physical activity (non-validated questionnaire). 2 studies on RYGB showed improvement in 7/8 health domains on short Form-36 health survey at 1 year and increased Peds-QL after 6months, but not after 12. In addition depression scores improved at 6 and 12 months after surgery. One study on LSG by Aldaqa et al assessed self-esteem (Rosenberg scale) and QoL at baseline and 1 year after LSG improved significantly. iv) Complications: 13 studies on LAGB reported complications (n=538). No deaths occurred. Perioperative complications: 0.8% patients reported intra-abdominal bleeding, conversion to laparotomy, 1.4% had a surgical site infection. Late complications (follow up period 0 to 138mths) 1.1% cases reported bowel obstruction and abdominal wall hernia, 10.5% (55/524) experienced band related complications and 9.9%(17/172) gastrointestinal complication. 14.7% (77) reinterventions, including 3 cholecystectomies, repositioning, removal and port revision. Vitamin deficiencies reporting was variable and poorly defined, with only 5/18 studies reporting deficiencies, oral iron, VitD, folic acid and zinc were prescribed to 0.5-36% of patients. In RYGB 9 studies summarises complications, total of 495 patients. Perioperative complications: 5.1% of patients had an anastomotic leak, bleeding or conversion, 6.2% reported infection at surgical site. Late complications: 20.2% of patients obstruction, internal herniation, ulcers and abdominal wall hernia. 9.3% reported GI complaints included nausea, vomiting, dumping and GERD. 9 patients in 5 studies (5.6%) had nutritional deficiencies or dehydration requiring hospitalisation. 6/13 studies observed vitamin deficiencies, 4-56% of patients used oral supplements for iron, VitA, VitB1, VitB12, VitD, folic acid and zinc deficiencies. 17.1% had reinterventions (57) including 7 cholecystectomy. 18 endoscopic procedures (balloon dilation for stricture of anastomosis), 13 surgery for GI obstruction, leak or fistula repair in six. Five LSG studies (272 patients) reported two perioperative complications (0.7%) and no mortality. 2% reported wound infection, late complications occurred in 1.2% patients. None of the studies reported deficiencies.

adverse events and reinterventions. Article downgraded in view of lack of RCTs

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1+	Systematic + Meta Analysis	5230 participant s	RCT of lifestyle (dietary, physical activity and/or behavioural therapy), drug and surgical interventions for treating obesity with or without the support of family members. Interventions specifically dealing with treatment of eating disorders, type 2 diabetes and participants with a secondary or syndromic cause of obesity were excluded. Lifestyle interventions: 12 studies on physical activity and sedentary behaviour, 6 studies on diet, 36 on behaviour orientated treatment programs. Drug interventions: In total 10 studies, focusing on metformin, orlistat and sibutramine.	Clinical effectiveness of the intervention	To assess the efficacy of lifestyle, drug and surgical interventions for treating obesity in childhood. Meta-analyses to determine reduction in overweight at 6 and 12 months follow up in i) lifestyle interventions involving children (<12 years) ii) life style intervention in adolescents >12yrs iii) Orlistat (120mg tds) iv) Sibutramine (10g or 15g daily)	i) At 6 months lifestyle interventions in children <12 yrs was found to reduce weight. 4 studies, n=301. The changes in BMI-SDS at 6months with a mean difference of -0.06 (95% CI -0.12, -0.01), I2=61%, total Z effect=2.18 (P=0.0024). Changes in BMI-SDS at 12 months in <12yr, 3 studies, n=264 mean difference -0.04 (-0.12, 0.04), I2=0%, Z effect 0.0 (P=0.36). ii) Life style intervention >12yrs, Changes in BMI-SDS at 6 months, 3 studies n=291, mean difference -0.14 (-0.17, -0.12), I2=93% Z=11.51 (P<0.00001). BMI changes at 6months >12yr, 4 studies, n=361, mean diff -3.04 (-3.14, -2.10), I2=98% Z=61.57 (P<0.00001). BMI-SDS changes at 12months >12yr, 2 studies, n=231, mean diff -0.14 (-0.18, -0.1), I2=93% Z=7.11 (P<0.00001). BMI changes at 12 months >12yr, 2 studies, n=231 mean diff -3.27 (-3.35, -3.17), I2=94% Z=6.01 (P<0.00001). iii) studies with Orlistat in children >12yrs of age and evaluation of absolute BMI at 6 months favours drug intervention, 2 studies, n=579, mean difference -0.76 (-1.07, -0.41), I2=0% Z=4.70 (P<0.00001). iv) 2 Studies with Sibutramine in children >12yrs and upon evaluation of absolute BMI at 6 months favour drugs, n=111, mean difference -1.66 (-1.89, -1.43), I2=79% Z=14.23 (P<0.00001)			Oude Luttikhuis, Hiltje; Baur, Louise; Jansen, Hanneke; Shrewsbury, Vanessa A.; O'Malley, Claire; Stolk, Ronald P.; Summerbell, Carolyn D.. Interventions for treating obesity in children. Cochrane Database Syst Rev 2009;0(1):CD001872.	side effects reported for drug interventions. In the Orlistat group predominately gastrointestinal tract symptoms including asymptomatic gallstones, fatty, oily stool evacuation, oily spotting, increased defecation(cramps) and abnormal doses of Vit A, D, E levels. In the sibutramine group cardiovascular side effects, hypertension and tachycardia.	Yes	Population: Selected trials including children, mean age <18. Overall comments: There is a high degree of heterogeneity within each intervention arm, with raises potential bias. The authors notes there is limited quality data to favour recommendation of one treatment program over another. They conclude high quality research that considers psychosocial determinants for behaviour changes, to improve clinician-family interaction and cost-effective programs for primary and community care is required.
2++	Systematic		i) Bariatric surgery versus no treatment, usual care and waiting list control ii) Different types of bariatric surgery versus each other	Clinical effectiveness of the intervention	What are the effects of surgical interventions for the treatment of childhood obesity?	i) 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. Review of predominately non-RCT suggest surgical intervention in severe obesity can lead to substantial weight loss. However the magnitude of weight loss is not clear. One RCT (O'Brien et al) showed that laparoscopic adjustable gastric banding resulted in substantial weight loss when compared to intensive lifestyle intervention. Lack of data on selection criteria, indications, post operative complications and harmful outcomes in the short and long term. ii) No RCTs comparing the effectiveness between surgical techniques or evaluating the benefits and harms of the different bariatric surgery techniques.			Canoy, Dexter; Yang, TienYu Owen. Obesity in children: bariatric surgery. BMJ Clin Evid 2015;2015(0):0.		Yes	Population: Obese children (18 yrs old and younger) undergoing bariatric surgery. Inclusion criteria for systematic overview, to include systematic reviews and RCT (>10 or more patients, with min of 12 months F/U). BMI >85th percentile for age and sex Overall comments: The authors note that the two systematic reviews are predominately observational studies and although bariatric surgery can result in substantial weight loss among severely obese adolescents there is very limited evidence from well designed studies particularly RCTs. They conclude there are uncertainties regarding clinical indications, identifications of age group, cost, ethics, post-operative complications, long term benefits and harms of surgical procedures in this population. Authors comments upon the importance of future multicentre RCTS focusing on effectiveness and safety of different surgical interventions for obesity in children, including laparoscopic sleeve gastrectomy which is being increasingly performed. they comment upon the procedure of choice in children should consider reversibility or permanence of procedure on the intestinal tract. Currently the FDA has not approved the use of adjustable gastric banding in people under 18years of age. Study downgraded as a lack of randomised control trials.

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1-	Systematic	50 patients	In RCT 25 patients underwent laparoscopic adjustable gastric banding.	Clinical effectiveness of the intervention compared to existing interventions	How effective is bariatric surgery in safely reducing weight in obese children and adolescents?	Search identified one RCT O'Brien et al 2010. At two years the average reduction in banding groups was 34.6kg and in lifestyle group 3kg. Change in body mass index unit in the gastric banding group was 12.7kg/m ² (95% CI 11.3 to 14.2) compared to 1.3kg/m ² (95% CI 0.4 to 2.9) in the lifestyle group, P<0.0001.	lifestyle changes	At two years gastric banding group performed better than lifestyle group in 2/8 health related quality of life concepts measured by child health questionnaire i) physical functioning score 94 vs 78 (norm 95), and change in health score 4.4 vs 3.6 respectively (norm 3.5)	Ellis, Louisa J.; Mead, Emma; Atkinson, Greg; Corpeleijn, Eva; Roberts, Katharine; Viner, Russell; Baur, Louise; Metzendorf, Maria-Inti; Richter, Bernd. Surgery for the treatment of obesity in children and adolescents. Cochrane Database Syst Rev 2015;6(0):CD011740.	48% (12/25) pts in the banding group reported side effects and 44% (11/25) in the control group. 28% of adolescent undergoing gastric banding required revisional surgery as a result of a complication from banding surgery	Yes	Population: Obese children undergoing bariatric surgery. Selection criteria: selected RCT of surgical interventions for treating obesity in children and adolescents, with a min of 6mths follow-up. Specifically dealt with treatment of eating disorders or type 2 diabetes or included participants with a secondary or syndromic cause of obesity were excluded. Pregnant females were also excluded. Age <18 yrs. In RCT 50 participants (25 in both intervention (average age 16.5yrs) and comparator group (16.6yrs)) Overall comments: Identified one small RCT, with no data reported for all cause mortality, behaviour change, participants views of the intervention and socioeconomic effects. The authors conclude there is insufficient evidence to make an informed judgement about surgery for the treatment of obesity in children and adolescents.
2+	Systematic	311 patients (322), 214pts (70% female), 97 pts (30% male)	Depression was measured using 3 tools i) Beck depression Inventory II (BDI-II), ii) original BDI, iii) Beck Youth Inventory (BYI). Quality of life was measured utilising 6 tools i) Paediatric Quality of Life Inventory (PedsQL), ii) Moorehead-Ardelt Quality of Life Questionnaire (MA QoLQII), iii) IWQOL-Kids, iv) Impact of weight on quality of life-lite (IWQOL-Lite), v) Medical Outcomes Study Short Form 36 (SF-36), vi) Child Health Questionnaire (CHQ-CF)	Clinical effectiveness of the intervention	To evaluate changes in depression among adolescents after bariatric surgery	i) Changes in Depression: Holterman et al (2007) in the ten 14-18 year old patients, 3 patients with clinical depression resolved within 9month follow-up. Jarvholm et al (2012) utilised the BDI-II and BDY scale and found (13-18yr) 27% (10/37) pts were highly depressed and 49% average rates of depression pre surgery and 11 months post surgery 11% were highly depressed, 68% average and another 11% reported more depressive symptoms. The third study by Zeller et al, 2009 evaluated n=31, 13-18yr olds and reported 9 females and 3 males had clinical rates of depression, and 12months after the number of depressed patients fell to 3 females and zero males. Study by Zeller, Reiter (2011), found 10/16, 14-17 yr olds were clinically depressed prior to surgery and 14months after surgery this was reduced to 2. Largest case review by Sysko et al (2012) used the BDI tool in 101 patients aged 14-17 yrs old and reported that depression rates at 15months follow-up post surgery significantly improved (P<0.001) (the authors did not quantify these results)	To evaluate changes in quality of life after bariatric surgery	ii) Changes in QOL: Holterman et al (2007) used PedsQL and found 8/10 adolescents reported being depressed when compared to health control. After surgery initial QOL scores improved (P<0.002) and 3/8 self reports and 5/10 parental reports had normalised QOL at 9 months. Sysko et al (2012) n=101, used PedsQL and found significant improvement at 15months post surgery (P<0.001), with parallel post-op changes between psychosocial variables and BMI, those who lost more weight, greater improvement in QOL. Interestingly Zeller et al (2009) found Peds QL score (n=13) in 13-18yr old patients improved significantly in physical health and psychosocial domains 6 months post surgery, however between 6-12 post surgery these changes started to decelerate and found to be non-significant. Another study by Zeller et al (2011) n=16 utilising PedsQL found 14-17yrs old to have lower scores when compared to non-overweight youth norms (n=16). After the first 6 months of surgery clinical improvement on Physical Health and Psychosocial scales, although no improvement at 24 months. In addition Zeller et al in both studies in 2009 and 2011 utilised the IWQOL and found significant improvements in both studies at 6 months, although at 12 to 24 post surgery no longer clinically meaningful. A study by Loux et al (2009) administered IWQOL-Lite (includes work and sexuality measurement instrument) in 12 to 16 participants aged 14-20 and found results after surgery were similar to 'normal' weight adults and significantly better than obese adolescents receiving therapy (P<0.0001). In addition Loux et al	Hillstrom, Kathryn A.; Graves, Joyce K.. A review of depression and quality of life outcomes in adolescents post bariatric surgery. J Child Adolesc Psychiatr Nurs 2015;28(1):50-59.	-	Yes	Population: Obese children undergoing bariatric surgery. To include articles that evaluated changes in quality of life outcomes pre and post bariatric patients. 4 studies measured only QOL, 2 studies weight related QOL + depression, 2 studies QOL+ depression, 1 QOL + weight related QOL and one study measured depression. Average age 16.63yrs (range 9 to 20 yrs) Overall comments: Numerous limitations, inclusion of studies with small sample size, variability of age of participants and diversity of instruments selected with no standardisation, length of time of follow-up. Patient age varied from young as 9 to 20 years old, potential selection bias. Lack of long term follow-up in all the studies. Overall the majority of studies found in the short term an improvement in psychosocial outcomes. Predominately low evidence studies downgraded to 2

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utilised the SF-36 scores and found the mean and normalised score improved significantly $P < 0.0001$. Silberhumer et al (2006) in a study of 50 patients, 9-19 year olds found the Moorhead-Ardelt QOL increased from 0.8 to ± 0.3 preoperatively to 2.1 ± 0.8 at 34.7 months postoperatively. In study by Silberhumer et al 2011, they followed the same patient cohort up to 138.3 months, with average follow-up to 85.9 months, found at mean of 5 years the score was 2.13 ± 0.8 , remained unchanged from that reported at 34.7 months. The RCT by O'Brien et al (2010) was also included in the review which utilised the CHQ-CF 50, the baseline scores for behavioural, emotional and physical limitation did not differ between study participants (control + intervention arm), and both groups started with six subscore below community norms. At follow-up both groups showed significant improvement in general health. The gastric banding group showed improvement in physical functioning, general health, self esteem, family activities and change in health compared with lifestyle group. 2 year post operatively the lifestyle group was lower in 4/6 domains and gastric bypass group 2/6 when compared to community norms. Although the gastric bypass group had significantly higher subscores for change in health and family activities than community means.

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2+	Systematic	-	Following tools were utilised to assess depressive symptoms: BDI, BDI-II. To assess anxiety disorders, semi-structured clinical interview, Beck Youth Inventory (BYI). Eating disorders assessed retrospectively for symptoms etc.	Clinical effectiveness of the intervention	To evaluate pre- and post operative depressive, anxiety and eating disorder symptoms of adolescent patients	i) Pre-bariatric surgery: Depressive disorder symptoms (4 studies) ranged from 15% to 70%, anxiety disorder symptoms reported (3 studies) 15-33% and eating disorders (2 studies) present among 48-70%. One study Sysko et al, 2011 evaluated the co-occurrence of mental disorders in adolescent patients and found 25% of all patients had depressive symptoms and high proportion suffering from binge eating episodes, bulimic episodes (73.1%) or night eating episodes (52.1%) ii) Effects of surgery on post-operative mental health status: Authors noted that all studies differed with regards to time point and did not report use of antidepressants. In studies evaluating depressive symptoms (5 studies) improvement of mean levels of depressive symptoms 6 and 9 months after surgery. However Zeller et al, 2011 observed an increase tendency with level of depressive symptoms at 18-24months. Overall post-operative depressive symptoms were higher in females. Holterman et al (2007), observed complete resolution of 10 patients 9 months after LAGB surgery. However the longest follow up study of 9 years after LAGB surgery by Osorio et al (2011) observed that 21.4% of all patients were still suffering from clinical depressive symptoms.	-	-	Hergert, Sabine; Rudolph, Almut; Hilbert, Anja; Blüher, Susann. Psychosocial status and mental health in adolescents before and after bariatric surgery: a systematic literature review. Obes Facts 2014;7(4):233-245.	-	Yes	Population: Adolescent patients 12.5yrs to <18 yrs. Average age 16.63yrs (range 9 to 20 yrs) Overall comments: Limited review, small studies, no clear analysis of sociodemographic and ethnic characteristics. Also the pre and post operative assessments of depressive, anxiety and eating disorder symptoms were inconsistent in studies. Also several studies were retrospective chart reviews. However in view of limitations of the review the authors do conclude that depressive disorder symptoms are likely to be present in adolescents. Highlight the importance of establishing valid and standardised clinical assessment procedures of psychopathology in adolescent bariatric surgery patients. Downgraded review to 2+
2+	Systematic	831 patients	Bariatric surgery: 13 studies examined gastric banding, eight studies on RYGB and 14 studies on other bariatric surgery: sleeve gastrectomies, vertical banded gastroplasty, biliopancreatic diversion or a combination of procedures	Clinical effectiveness of the intervention	To evaluate i) evidence on effectiveness of surgical interventions to treat obese children and adolescents ii) whether the surgical interventions are cost- effective	i) Effectiveness and complications: Gastric banding: 13 studies, n=407 patients, aged 9-19yrs. Four cohort studies, three retrospective studies, three case studies, two longitudinal trials + prospective RCT. Follow-up time 3 to 84mths. 12/13 studies mean BMI reductions from 8.5 to 43kg/m2 and one study gain of 2.2kg/m2. 12/13 studies reported on surgical complications and three reported none. Range of complications included band slippage in 2-13% in 5 studies, in 10% of patients due to psychological intolerance, 18% of vomiting, 10% band readjustment. ii) RYGB eight papers, two retrospective studies, one was longitudinal, five case studies, 80 patients, aged 12.7-19yrs. follow-up time fiver studies more than 1 year of follow-up. 8/8 studies reported mean BMI reductions ranging from 9 to 25kg/m2. All studies reported on postoperative complications, included dehydration, peristomal ulcer, intestinal leakage, wound infection, anastomotic stricture, nutritional deficiencies, acute gallstone pancreatitis, iron deficiency anaemia + bowel obstruction. In the 14 publications mean BMI reduction ranged from 9 to 24kg/m2. ii) Cost-effectiveness: 3 papers identified on cost-effectiveness of LAGB in adolescents all based on the ACE-Obesity project. Using cost data from a series of 28 LAGB patients extrapolated to the Australian adolescent population, estimated cost/surgery was \$AU31553, exclusive of future cost savings and net cost savings per disability-adjusted life year (DALY) was \$AU44400. Data from this project was shown to be cost-effective on basis of Incremental Cost-Effectiveness Ratio (ICER).	-	-	Aikenhead, A.; Knai, C.; Lobstein, T.. Effectiveness and cost-effectiveness of paediatric bariatric surgery. Clin Obes 2011;1(1):45992.	As per primary outcome	Yes	Population: Obese children (<19 years) undergoing bariatric surgery. Included studies with at least 1 year post operative follow-up. Overall comments: The systematic review recognised the lack of high evidence studies, majority of studies are underpowered, retrospective studies, with a significant degree of bias. The authors acknowledge the lack of long term data on safety, effectiveness and cost effectiveness. Study downgraded to 2

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2++	Systematic	sample size varied from 18 to 819 (median 111)	Included articles if they described an intervention trial that aimed to treat infants, children or adolescents that were overweight or obese in a primary care setting. Articles describing both randomised and non-randomised controlled intervention trials. Excluded articles if described primary prevention interventions or if majority of participants >18yrs of age. Patients had undergone surgery or if obesity was a result of pharmacotherapy or congenital disorder.	Clinical effectiveness of the intervention	The aim of the study was to answer the following 1) What does the existing literature report on effectiveness of intervention involving primary care in treatment of overweight or obese children? 2) What components of these intervention are associated with significant outcomes? Combined total of 30 different outcomes. i) Anthropometric (9 studies), ii) Behavioural changes (10), psychological (8) and one study incorporated all four domains	12/17 interventions involving primary reported significant effect in the first post intervention outcomes. Behaviour changes included healthy diet, activity and sedentary behaviour, with effecting behaviour change via a combination of counselling, education, written resources, support and motivation. 7 of these maintained effect between 6 months and 4 years after intervention. i) 8/17 studies 47% reported significant anthropometric changes ii) 3/9 studies (30%) reported significant metabolic outcomes. iii) 6/10 (60%) of studies that measured behaviour change reported significant changes. No significant psychosocial changes or adverse effects were recorded. Unable to perform meta-analysis due to heterogeneity of outcome measures.			Sargent, G. M.; Pilotto, L. S.; Baur, L. A. Components of primary care interventions to treat childhood overweight and obesity: a systematic review of effect. <i>Obes Rev</i> 2011;12(5):e219-235.		Yes	Population: Obese or overweight children aged 3-17 years old. Overall comments: Of the 17 studies, 11 intervention were principally delivered in primary care, effective outcomes were in settings with family practice (n=2), health centre (n=4), other primary care (n=3), school (n=2) and hospital outpatient clinic (n=1). Effective intervention arms involved between 1-114 contacts in a period of 3-12months. To affect behaviour change the majority of effective interventions reported employing combination of counselling or education (n=11), provision of written resources (n=11) and motivation or support (n=9). The targets used to be the most effective in the intervention arm was incorporating both healthy diet and activity into daily routine (n=5), decreasing sedentary behaviour (n=4), calorie restricted diet (n=4), attending physical activity sessions (n=4) and a healthier diet (n=3). The authors note that of the 12 effective interventions, 7 incorporated specific training for primary healthcare professionals. In this review the Methodological rigor score was 2-9 (max 10), 3 studies did not establish an effective control group and no in between group comparison. Only few articles scored highly for MR, which reflects the inadequate reporting and analysis in the majority of the studies. All interventions that reported significant behaviour changes were self reported, which may not always represent actual behaviour change. In view of heterogeneity of data and predominately low MR score, downgraded 2++
3	Cross-sectional	Utilised Healthcare cost and utilisation Project Kid's Inpatient database - captures inpatient hospital admissions for pts <21yrs	Obese adolescent who underwent bariatric surgery	Other	National population based bariatric procedure rate	The inpatient bariatric procedure rate increased from 0.8 per 100,000 in 2000 to 2.3 per 100,000 in 2003 (328 vs 987 procedures). There was no significant increases subsequently, in 2009 2.4 per 100,000 procedures (1009 procedures)	Trends in i) type ii) demographic iii) length of stay iv) hospital charges	i) By 2009 32.1% of all procedures adopted laparoscopic adjustable gastric banding and 67.6% laparoscopic Roux-en-Y gastric bypass. ii) Procedure performed predominately in adult hospital units (74.9%-85.2%) and urban location. Cohort predominately female (74-77.9%) and >17yrs of age (although performed in pts young as 12), with associated comorbidities increasing from 49.3% in 2003 to 58.6% in 2009, P=0.002 iii) over the observed time period hospital stage decreased by - 1 day P<0.001. iv) Although increasing number of patients were utilising medicaid, increased from 7.7% in 2003 to 17.2% in 2009 (P<0.001), in 2009 68.3% utilised private insurance. Adjusting for inflation in 2009 the mean hospital charge -\$35000	Kelleher, Deirdre C.; Merrill, Chaya T.; Cottrell, Linda T.; Nadler, Evan P.; Burd, Randall S. Recent national trends in the use of adolescent inpatient bariatric surgery: 2000 through 2009. <i>JAMA Pediatr</i> 2013;167(2):126-132.	Report low complication rates and no inpatient deaths.	Yes	Population: Obese adolescents, aged 10-19 years. Overall comments: Retrospective cross-sectional study, discharge data obtained from the Healthcare Cost and Utilisation Project Kid's Inpatient database. The authors conclude that inpatient bariatric procedures have plateaued since 2003. Authors comment that disparities in bariatric surgery may reflect the differences in socioeconomic status and regional demographics. Although larger proportion of adolescents with obesity come from a lower socioeconomic status, this is not reflected by the rate of bariatric procedures which is similar across both low income and high income area. Limitation of study is the utilisation of administrative data and does not include preoperative clinical data or post discharge outcomes, also no longitudinal data to determine rates of late complications.

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2-	cohort	24 patients with PWS (control group 72 patients)	Obese patients with PWS who underwent laparoscopic sleeve gastrectomy	Clinical effectiveness of the intervention	Study evaluates i) BMI/weight change ii) growth	i) BMI change in the PWS group upon follow-up in year 1,2,3,4 and 5 was -14.7 (n=22), -15.0 (n=18), -12.2 (n=13), -12.7 (n=11) and -10.7 (n=7) respectively, whilst in non-PWS group BMI change of -15.9 (n=67), -18(n=50), -18.4 (n=47), -18.9 (n=26) and -19 (n=20) respectively. No significant change between the two groups. ii) Growth: Mean height z score at 1 year post operatively was 0.5 with a mean change of height z score of -0.1, and was lowest at the third year postoperatively (over 5 years) and reached a nadir of -0.5, although at 5 years follow-up reached an average of 1.1 height z-score. Overall no significant difference when compared to non-PWS group. Authors report no significant decline in rate of growth in each group.	Evaluating resolution/remission of co-morbidities	All PWS patients had at least one co-morbidity, and 66.7% had 3 or more. 81.8% of comorbidities were in complete remission, with an improvement rate of 97%. No significant difference between both groups in the rate of co-morbidity resolution (P=0.73)	Alqahtani, Aayed R.; Elahmed, Mohamed O.; Al Qahtani, Awadh R.; Lee, Jaehoon; Butler, Merlin G.. Laparoscopic sleeve gastrectomy in children and adolescents with Prader-Willi syndrome: a matched-control study. Surg Obes Relat Dis 2015;0(0):0.	One patient with PWS readmitted 5 years after surgery with reoccurrence of OSA and heart failure. Authors report no mortality or major morbidity over the 5 year follow-up period. No other readmissions, no reoperations, postoperative leaks or other complications.	Yes	Population: Obese children with prader Willi syndrome (PWS). Mean preoperative BMI was 46.2 kg/m2 +/- 12.2 (range: 30.1-78.1) and with a mean height z score of 0.6 according to non-growth hormone treated PWS specific charts. All PWS patients had OSA (obstructive sleep apnoea), 62% had dyslipidaemia, 43% hypertension, 29% diabetes mellitus. Mean age 10.7yrs (19/24 pts<14yrs of age) Overall comments: All obese patients at centre undergo a standardised care pathway, that involves a multidisciplinary non surgical weight management program and includes close follow-up with a paediatric endocrinologist, geneticist, behavioural therapist, physiotherapist and dietician. Those that fail target at 6 months in the program and fulfil surgical criteria are offered bariatric surgery. Data extracted from database retrospectively, dependent upon user in terms of data input, authors report high level of patient follow-up although according to data chart at 5 years significant number of patients data not recorded. Carries significant bias and subsequently downgraded
2-	cohort	174 patients n=137 in LAGB and n=37 in VSG	Obese patients (adolescent) underwent laparoscopic vertical sleeve gastrectomy (VSG). Excess weight perioperatively 66.7±22.1kg, BMI 50.1±9.4kg/m2.	Clinical effectiveness of the intervention compared to existing interventions	Comparison of laparoscopic vertical sleeve gastrectomy (VSG) to adjustable gastric band (LAGB) in terms of i) weight loss	i) At 2 years follow up patients who underwent VSG vs LAGB showed significant greater percent excess weight loss, 70.9 ±20.7 vs 35.5±28.6 respectively, P=0.004. At 2 years significant reduction in overall BMI in the VSG group compared to LAGB group, 33kg/m2 ±6.2 vs 40.5kg/m2 ±10.9, P=0.099). No VSG patients regained preoperative weight at 6 and 12 months, whilst 10% (11/111) of LAGB patients had regained their preoperative weight	Evaluation of seromarkers associated with obesity postoperatively	Both VSG and LAGB significantly improved levels of HDL, HgA1c and fasting glucose. VSG alone results in significant reduction in total triglycerides level	Pedroso, Felipe E.; Gander, Jeffery; Oh, Pilyung Stephen; Zitsman, Jeffrey L.. Laparoscopic vertical sleeve gastrectomy significantly improves short term weight loss as compared to laparoscopic adjustable gastric band placement in morbidly obese adolescent patients. J. Pediatr. Surg. 2015;50(1):115-122.	At 5 years complication rate in LAGB group was 23.4% (32/137) and included port displacement (8%), band displacement (8%), port leakage (0.7%), bowel obstruction (1.5%), esophagitis (3.65), gastric prolapse (0.7%) and bleeding (0.7%), authors reported limited long term follow-up in VSG patients however reported on day D12 post operative one death as a result of mesenteric venous thrombosis.	Yes	Population: Morbidly obese adolescents. No significant difference between VSG vs LAGB group in terms of age, gender, ethnicity, weight and BMI. In both groups predominately females, weight in both groups. LAGB 136.1±/26.9kg and VSG group 138.2±/25.4). No difference between both groups for seromarkers associated with obesity, total triglycerides, total cholesterol, HDL, LDL, HgA1c and CRP P>0.05. However fasting glucose 90 vs 85.9 P=0.02 was greater in the VSG group. Mean age LAGB patients 16.9 ±1.2. VSG mean age 17.3 ±1.82. Overall comments: Single institute retrospective evaluation of prospectively collected database of LAGB and VSG. Authors observed greater weight loss in VSG group compared to LAGB group. Authors comment upon death due to massive mesenteric venous thrombosis and related to adult VSG patients where a higher incidence of venous thrombosis has been observed. Several limitations in the study, lack of long term follow-up in VSG group, smaller group of patients in the VSG patients, surgery conducted at different time points, also missed follow-up and lack of data collection. Study downgraded to -2
2-	cohort	135 patients recruited, 5 pts with mutations and matched to 14 controls	Obese patients with MC4R mutations (n=4) underwent bariatric surgery (LAGB or gastric sleeve resection).	Clinical effectiveness of the intervention	Study evaluating weight loss in patients with MC4R mutation carrier	3 patients underwent gastric banding with percent excess weight loss (EWL) postoperatively was 36% at 5 years in one pt, 47% at 4 yrs in 2nd pt, 85% at 1 year. One patient had gastric sleeve resection with %EWL of 96% at 1 year postoperatively. Patients when matched to controls there was no significant difference in %EWL (p<0.31) , BMI change (p<0.27) or absolute weight loss (p<0.20)	-	-	Censani, Marisa; Conroy, Rushika; Deng, Liyong; Oberfield, Sharon E.; McMahon, Donald J.; Zitsman, Jeffrey L.; Leibel, Rudy L.; Chung, Wendy K.; Fennoy, Ilene. Weight loss after bariatric surgery in morbidly obese adolescents with MC4R mutations. Obesity (Silver Spring) 2014;22(1):225-231.	Not noted	Yes	Population: Obese adolescents, with a mean BMI 54.4±8.6kg/m2. Inclusion criteria 14-18yrs of age, BMI>40kg/m2 or >35kg/m2 with at least one co-morbidity. Patients required to achieve Tanner stage 4, have a history of obesity for at least 5 years, failed attempts at dietary and medical management of obesity. Patients had to be evaluated via MDT team. All patients screened for MC4R mutations. Mean age 16.5 ±1.2yrs. Overall comments: Study represents a small sample size of MC4R mutation carriers, lack of power. Also intermittent follow-up varying from 1 year to 5 years. Non-blinded study. Downgraded to 2 because of significant bias

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2+	Cohort	162 patients (81 patients in each group)	81 morbidly obese adolescents underwent laparoscopic gastric bypass surgery. All patients had been in a comprehensive conventional treatment program for at least one year	Clinical effectiveness of the intervention	Evaluated weight change at 2 years in the i) surgical group and ii) comparison with control and adult surgical group	i) Observed at 1 and 2 years body weight decreased from 133kg (+/-22Kg) to 92kg (+/-17kg) and 89kg (+/-18kg) respectively (p<0.001). Represents 32% weight loss after 2 years and corresponds to a 76% excess weight loss. ii) weight change after 2 years was -32% (CI -35% to -30%) in surgically treated adolescent, weight gain of +3% (CI:0-7%) in conventionally treated adolescents and weight loss of -31% (CI-34% to -29%) in adults undergoing surgery.	ii) Health related quality of life. Evaluated using SF-36 at 1 and 2 year follow-up	At 1 year follow report significant improvements observed in 7/8 SF-36 health domains and physical component summary score. At 2 years report significant improvement from baseline in all 4 physical health domains, 2/4 mental health domains.	Göthberg, Gunnar; Gronowitz, Eva; Flodmark, Carl-Erik; Dahlgren, Johanna; Ekblom, Kerstin; Mårild, Staffan; Marcus, Claude; Olbers, Torsten. Laparoscopic Roux-en-Y gastric bypass in adolescents with morbid obesity--surgical aspects and clinical outcome. Semin. Pediatr. Surg. 2014;23(1):42675.	i) 2 year follow-up 12 patients (15%) underwent surgical interventions, five (6.2%) operation for internal hernia, 6 (7.4%) underwent cholecystectomy. ii) 5 year follow up (incomplete), showed additional four other patients operated for ileus, 2 for internal hernia and 2 further for cholecystectomy.	Yes	Population: Obese adolescents, with mean BMI 45.5kg/m2. Obesity matched groups by age, sex and BMI. 25 patients (31%) had a neuropsychiatric diagnosis, 13 had existing to previous self destructive behaviour and 33 (41%) had contacts with psychiatric units. Inclusion criteria included aged 13-18yrs, BMI>40 or >35kg/m2 with comorbidity, and pubertal tanner stage >111 an passed peak height growth velocity. Age 13-18 yrs old, mean age in surgery group 16.5yrs (±1.2) and in control group 15.8 (±1.2). Overall comments: Authors conclude 95% of operated adolescents achieved a weight loss greater than 50% of excess weight. All patients were prescribed daily multivitamin and mineral supplements, Vitamin B12 and calcium-VitD tablets, and additionally females were prescribed iron tablets. Authors report poor compliance in the intake of prescribed supplements in 2/3rd of patients. Additionally authors report significant improvement in cardiovascular risk factors and better glucose and lipid control in the discussion, with any other reference throughout the paper. Non blinded study and control arm were selected from a obesity register, selection criteria not clearly defined and definition of 'conventional treatment' remains unclear. Non-randomised study
3	Case-control	93 patients (31 patients in each of the three groups).	All adolescents were evaluated by the surgical team and eligible patients referred for a psychiatric evaluation. Involved a clinical interview and series of self-report questionnaires (including Beck Depression Inventory BDI, Peds Quality of life, eating disorder questionnaire (EDE-Q) and questionnaire on eating and weight patterns revised (QEWP-R). Group A patients with suicidal ideation and behaviour (SIB) at baseline, were case matched for gender, age and surgery type to 31 adolescents (Group B) with current or past psychiatric treatment and (Group C) 31 adolescents denying lifetime SIB or psychiatric treatment	Clinical effectiveness of the intervention	Study evaluates i) prevalence and ii) correlates suicidal ideation and behaviour (SIB) among adolescents receiving bariatric surgery	At baseline adolescents with SIB reported significantly lower total levels of health related quality of life when compared to patients that never received psychiatric treatment (Group C), 64.3 vs 76.7, p=0.01, and also a difference between depressive symptoms (p=0.004) between both groups. Depressive symptoms did decrease significantly in SIB group over the 12 months post surgery, although study no difference between groups for change in depressive symptoms or BMI following surgery	-	-	McPhee, Jeanne; Khtyavich Freidl, Eve; Eicher, Julia; Zitsman, Jeffrey L.; Devlin, Michael J.; Hildebrandt, Tom; Sysko, Robyn. Suicidal Ideation and Behaviours Among Adolescents Receiving Bariatric Surgery: A Case-Control Study. Eur Eat Disord Rev 2015;0(0):0.	None noted	Yes	Population: Morbidly obese adolescents undergoing laparoscopic adjustable gastric banding. 83% of the patients were female, BMI in each group A-C as follows 46.9±6.1, 48.8±7.8 and 46.7±8.0 respectively. Criteria to be enrolled into the centre for adolescent bariatric surgery programme was i) age 14-17yrs, ii) BMI>40kg/m2 or BMI>35kg/m2 with serious medical co-morbidity iii) history of obesity for at least 5 years and failure of lifestyle interventions for 1 year. iv) women suitable for contraception and no plans to become pregnant over the course of the year. v) absence of medical contraindications for surgery. Mean age in each group Group A 16±1.2, Group B (Psychiatric history) 16±1.0 and Group C (no psychiatric history) 15.9±1.1. Overall comments: Review of 206 charts of adolescents receiving bariatric surgery. Small sample size, limited statistical power, equal groups. Dependence upon retrospective data collection, no consistency with data records. Authors conclude the importance of recognising at time of surgery the risk of SIB in both pre-operative and post operative periods. Low level study

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3	Case-control	329 patients, discharge data from University Health System Consortium (UHC) (includes 110 academic medical centre and nearly 250 affiliated hospitals)	All obese adolescents who underwent bariatric surgery. 136 adolescents underwent LAGB (gastric banding), 47pt had LSG (sleeve gastrectomy) and 146 pts had LRYGB (Roux-en Y Gastric bypass). Over the study period LAGB showed a decrease in trend over the years, whilst SG showed an increased with LRYGB remaining stable.	Clinical effectiveness of the intervention	Study evaluated i) morbidity and mortality ii) length of hospital stay (LOS) iii) overall cost, iv) intensive care unit admission rate and readmission rate. Outcomes compared to adult bariatric surgery, 49519 adult bariatric surgeries were performed during the same period	Compared to adult bariatric surgery the 30 day in hospital morbidity was 0 vs 2.2% p<0.02 ii) LOS 1.99±1.37 vs 2.38±3.19, p<0.03 and 30 day readmission rate 0.30 vs 2.02% p<0.05, iii) overall cost was comparable, \$9375±6452 vs \$9600±8016, p=0.61) and iv) ICU admission higher in the adolescent group 9.78%vs6.30% p<0.05			Pallati, Pradeep; Buettner, Shelby; Simorov, Anton; Meyer, Avishai; Shaligram, Abhijit; Oleynikov, Dmitry. Trends in adolescent bariatric surgery evaluated by UHC database collection. Surg Endosc 2012;26(11):3077-3081.		Yes	Population: All obese adolescents who underwent bariatric surgery. Co-morbidities were prevalent, 24.6% with hypertension, 19.8% chronic pulmonary disease, 15.5% depression, 14.9% diabetes, 14.9% with liver disease, 7% with hypothyroidism. (13-18yrs). Overall comments: The authors observed in this study adolescents patients undergoing bariatric surgery when compared to adult patients, had significantly lower morbidity rates. LOS, readmission rate, although ICU admission rate were higher and cost comparable. Retrospective study involving multicentre patient analysis. limited to 30 day outcomes, no long term follow-up. In addition authors note no specific definition of morbid obesity were established prior to input of data. Also the database is compiled from discharge abstract data so may not truly reflect the in hospital morbidity and mortality. Low level evidence study
3	Case series	116 patients	Obese children < 14yrs underwent laparoscopic sleeve gastrectomy (LSG)	Clinical effectiveness of the intervention	To evaluate postoperative i) weight loss and ii) postoperative growth	i) At 1 year post operatively patients <14yrs lost 64% of excess weight. BMI decreased up to the 5th post operative year, lose of -17.3± 2.5 points on BMI scale. Adolescents who underwent surgery, BMI change at five years was -22.8±14.6. ii) The height z score of patients at one year in the surgical group was significantly greater when compared to the control group (NSWN), 0.8±1.4 vs 0.0±1.1, P<0.001 respectively. Children who underwent LSG (<14yr) had a significant growth at an average rate of 0.9mm/month (95% CI: 0.03-0.13) when compared to matched controls. At the 4th year of follow up the surgical group had a statistically significant increase in height gaining on average 5.3cm more than the NSWM group.	To evaluate resolutions of co-morbidities and to compare to adolescent surgical group	87% of Patients <14yrs who underwent surgery had complete remission of co-morbidities. Remission was similar in the adolescent group P=0.72.	Alqahtani, Aayed; Elahmedi, Mohamed; Qahtani, Awadh R. Al. Laparoscopic Sleeve Gastrectomy in Children Younger Than 14 Years: Refuting the Concerns. Ann. Surg. 2015;0(0):0.	3.4% (4 children) <14yr experienced complication. 2 pts reported wound infection, 1 patient had gastroesophageal reflux symptoms and 1 patient developed nausea and vomiting. In the adolescent group 5.1% developed post operative complications, 4 readmitted with metabolic neuropathy, 1 vomiting and 1 for line leak. No mortality reported at 5 year follow-up and no significant difference in terms of complications between two surgical groups (P=0.77)	Yes	Population: Obese children < 14yrs of age. Children with obesity associated syndromes were excluded from selection of patients from the database. Obesity associated co-morbidities pre-operatively, 44.8% (n=52) had OSA, 9.5% (n=11) diabetes, 27.6% (n=32) had hypertension and 17.2% (n=20) had dyslipidaemia. Mean age 11.2yr ±2.5 yrs (< 14yr old). Overall comments: Retrospective study that extracted data of young nonsyndromic children (age <14yrs) from a multidisciplinary program underwent laparoscopic sleeve gastrectomy. The authors reports 90% power at 4 years follow up. Further long term studies are required to evaluate the physiological changes that occur as a result of bariatric surgery (including those that affect growth and skeletal maturity). This study evaluates patients retrospectively from a database, and a concise criteria for stratification of subgroups has not been identified. Low grade evidence study that does not meet the criteria for a cohort study.

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3	Case series	16 patients	First consecutive 16 obese adolescents underwent laparoscopic adjustable gastric banding.	Clinical effectiveness of the intervention	Study evaluated i) weight loss ii) physical and biological comorbidities iii) health related quality of life (QOL). Prior to surgery psychosocial history revealed, 9 adolescent had more psychiatric disorder, 4 had depression, 4 anxiety, 3 behavioural problems, and 2 self mutilation, and with 11 suffering from eating disorder. In addition at time of surgery 15 patients expressed psychological distress, 11 being teased, 7 decrease in self esteem, 14 body dissatisfaction, 5 anxiety and one attempted suicide.	2 years postoperatively i) median BMI decreased from 43kg/m2 to 33kg/m2, corresponding to a 49.2% excess body weight loss p<0.001. ii) Majority of co-morbidities, glucose intolerance, hypertension and sleep apnoea resolved within the first 12months iii) QOL on the PedsQL scale improved of every physical and psychosocial dimension tested at one year, although did not reach statistical significance.	-	-	Schmitt, Françoise; Riquin, Elise; Beaumesnil, Marion; Dinomais, Mickaël; Topart, Philippe; Weil, Dominique; Malka, Jean; Coutant, Régis; Podevin, Guillaume; Bouhours-Nouet, Natacha. Laparoscopic adjustable gastric banding in adolescents: Results at two years including psychosocial aspects. J. Pediatr. Surg. 2015;0(0):0.	No peri-operative or immediate post operative complications, 11 pts (69%) experienced one or more complication after LAGB, commonest (86%) was food intolerance and/or gastric pouch or lower oesophagus dilatation, which resolved with simple dietary advice/partial deflation of LAGB. No severe surgical complications observed. 3 re-interventions for device failure or band removal	Yes	Population: Obese adolescents with median BMI of 43kg/m2. Patients referred to surgery following failure of at least one year of conventional lifestyle interventions. All patients had a BMI>40kg/m2 or >35kg/m2 with associated comorbid conditions. All patients suffered from one or more associated comorbidities. Mean age 17.4yrs (16.1-18.1). Overall comments: Small single centre prospective study evaluating LAGB. Although specialised obesity centre and may not reflective of other settings. Low level evidence study
3	Case series	15 patients	Morbidly obese adolescents initially underwent a preoperative 3 month program. Phase one consisted of medical examination, psychological measures, self-monitoring, tailored diet, physical activity schedule, group cognitive behaviour orientated therapy and psycho educational parent training	Clinical effectiveness of the intervention	i) Adherence to program ii) Weight loss (peri-operatively) iii) Parental involvement iv) Outcome post peri-operative programme	i) All patients completed the preoperative phase. 70% of patients followed a structured diet. Patients complied with self monitoring and body dissatisfaction score improved, although not significant. EDI-2 body dissatisfaction score p=0.06. 86% of patients did not engage in physical activity preadmission but at follow-up 80% of patients were engaging in activity ii) Weight and BMI decreased significantly overtime (preadmission/admission to 3 months follow-up, P<0.001). The mean BMI loss between admission and 3 months F/U was 3.14kg/m2 (SD 2.05). iii) Overall Parental participation was poor, with 50% failing to attend guidance sessions and 20% only occasionally. iv) Four patients with low adherence were found to be ineligible for surgery due to lack of compliance. 5/15 underwent bariatric (sleeve) surgery, 6 continued with conservative follow-up	-	-	Fennig, Silvana; Brunstein-Klomek, Anat; Sasson, Ariel; Halifa Kurtzman, Irit; Hadas, Arie. Feasibility of a Dual Evaluation/Intervention Program for Morbidly Obese Adolescents. Isr J Psychiatry Relat Sci 2015;52(2):107-112.	None noted	Yes	Population: Morbidly obese adolescents with BMI>50 or BMI>35 with obesity related complications. No difference of BMI between patients, 10 patients were female and 5 male. 100% of patients had a fatty liver, 30% obstructive sleep apnoea, followed by acanthosis nigricans, hyperinsulinemia and diabetes. In terms of psychiatric comorbidities, 70% had depressive symptoms, 30% ADHD and 20% generalized anxiety disorder. Exclusion criteria for program, exclusion of patients with disease related aetiology for obesity, drug induced, severe medical or psychiatric problems. Mean age 14.47yrs (8 to 17 yrs). Overall comments: This study supports preoperative programme in terms of real time assessment is prior to surgery. The study found overall poor parental participation, which highlights the importance of developing tools to improve such participation. The study identified 4/15 patients who poorly complied to lifestyle interventions. This is a small phase I pilot study prior to the entire protocol being evaluated in a randomised controlled efficacy trial.
3	Case series	22 patients	Obese adolescents undergoing laparoscopic RYGB	Clinical effectiveness of the intervention	To evaluate i) weight loss ii) insulin sensitivity	i) At one year follow up following RYGB, BMI declined by mean of 38% from baseline to 39±8.0 kg/m2 P<0.01. ii) Fasting glucose and insulin values declined by 54% and 63% respectively (P<0.01) at 12months post surgery. At baseline 54.% (12/22) patients were hyperinsulinemic and at 12months (0/15) Insulin sensitivity index increased by 300% (P<0.01), acute insulin response to glucose decreased by 56% (P<0.001). β cell function improved as reflected by a decrease in the proinsulin to C-peptide ratio by 21% (P<0.01).	-	-	Inge, Thomas H.; Prigeon, Ronald L.; Eider, Deborah A.; Jenkins, Todd M.; Cohen, Robert M.; Xanthakos, Stavra A.; Benoit, Stephen C.; Dolan, Lawrence M.; Daniels, Stephen R.; D'Alessio, David A.. Insulin Sensitivity and β-Cell Function Improve after Gastric Bypass in Severely Obese Adolescents. J. Pediatr. 2015;0(0):0.	Complications within 30days of operation included 4 subjects requiring reoperation (1 for GI leakage and 3 for small bowel obstruction), one readmitted for dehydration and 3 with gastrojejunal anastomotic strictures requiring endoscopic dilation.	Yes	Population: Obese adolescents with a BMI 61.1 ± 12.27 kg/m2. 14/22 patients were female (63.6%). Comorbidities at baseline include 75% of patients with obstructive sleep apnoea, 28% hypertension, 25% polycystic ovary syndrome, 68% with dyslipidaemia. Mean age 17.1 ± 1.42yrs (14.5yr-20.1yr) Overall comments: In this small observational study an improvement in both insulin sensitivity and β cell function in severely obese adolescent was observed. They observed marked metabolic improvements even when obesity persisted at 12months (38.9kg/m2). The authors recognise that one of the limitations of the study was missing data as a result of missed visits, also patients were only followed up for 12 months. The study was of a small sample size and lack of a control group.

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3	Case series	88 patients	Adolescents assessed at baseline and 1, and 2 years after surgery using a battery of generic and obesity specific questionnaire to evaluate outcomes in mental health. Two questionnaires the Beck Youth Inventories (BYI) and Beck Depression Inventory II (BDI-II) were administered by clinical psychologist, with collected forms 72% at baseline, 59% at 1 year and 72% at 2 year follow up. Other questionnaire collection rates varied between 85-95%.	Clinical effectiveness of the intervention	To evaluate changes in mental health over 2 years in adolescents undergoing gastric bypass surgery	At 2 years after surgery symptoms of anxiety (P=0.001), depression (P=0.001), anger (P=0.001) and disruptive behaviour (P=0.022) were significantly reduced. In addition obesity related issues such as self esteem (P<0.001), self concept (P<0.001) and overall mood (P=0.24) also displayed a significant improvement. Improvements were predominately observed in the first year post surgery, with stabilisation in the second year. 19% of patients still had depressive symptoms following surgery	BMI loss	BMI reduced significantly from baseline 45.6kg/m2 at both 1 year post surgery 30.9kg/m2 (P<0.001) and 2 years post surgery 30.1kg/m2 (P<0.001). No difference between BMI at 1 and 2 years post operatively (P=0.065). At 2 years 50% of the adolescents were no longer in the obese range BMI<30	Järholm, Kajsa; Karlsson, Jan; Olbers, Torsten; Peltonen, Markku; Marcus, Claude; Dahlgren, Jovanna; Gronowitz, Eva; Johnsson, Per; Flodmark, Carl-Erik. Two-year trends in psychological outcomes after gastric bypass in adolescents with severe obesity. Obesity (Silver Spring) 2015;23(10):1966-1972.	-	Yes	Population: Adolescents who have undergone gastric bypass surgery. Study sample were enrolled consecutively from the AMOS cohort (ongoing Swedish 1- year prospective study) 65% girls and 35% boys. Inclusion criteria included BMI >40 or >35 with comorbidity. Adolescents should have attended an obesity treatment program for at least 1 year. Exclusion criteria included psychotic disease or ongoing drug abuse. Mean age 16.8 ± 1.2 yrs (13-18 yrs). Overall comments: Authors observed an improvement in mental health in adolescents over the 2 years after bariatric surgery. Study found significant reduction in anxiety symptoms after 2 years. In addition symptoms of depression, anxiety, anger, disruptive behaviour and self concept were found to be at the same level as norms of adolescents. Study lacks control group, hence low level study
3	Case series	11 patients	Adolescents underwent laparoscopic Roux-en-Y gastric bypass, with 45% of patients having a concomitant hernia repair. Median length of stay was three day (range 2- 4 days)	Cost effectiveness	Cost-effectiveness was estimated using three parameters, added cost (one time intervention costs net of saving from reduced medical care in the future), health related quality of life (HRQL) and probability of death within each yearly cycle, hence quality adjusted life years (QALYs). The BMI was linked with annual total health care expenditures from nationally representative medical expenditures panel survey to estimate saving from reduced medical use associated with lower BMI after surgery, and increased HRQL. BMI was linked to life expectancy data from CDC. In the surgery cohort the authors estimated reductions in BMI after surgery and assumed post surgery weight regain of 5% per year in the first five year. In the no surgery cohort BMI was assumed to remained unchanged (BMI of 48.7).	At one year follow-up the mean weight loss was 37.5kg (±13.5) and BMI reduction of 13.3kg/m2, P<0.001. Mean total intervention costs/person was \$25854. Estimated a unit change in BMI associated with future medical care saving of \$157/year (P<0.01) and an increase in HRQL of 0.004(p<0.01) and life expectancy. According the model utilised the study found that at a threshold of 100,000/QALY bariatric surgery was not cost-effective in the first three years, but was cost effective after that \$80,065/QALY, in year four and \$36,570/QALY in year seven.	-	-	Bairdain, Sigrid; Samnaliev, Mihail. Cost-effectiveness of Adolescent Bariatric Surgery. Cureus 2015;7(2):e248.	No perioperative or postoperative complications described	Yes	Population: Obese adolescents, medium preoperative BMI was 48.7(6.6) kg/m2. Predominately female n=10. Median age 17. Overall comments: No comparison with cohort of individual undergoing lifestyle intervention. Also health states for specific obesity related comorbidities were not included, which may in fact have a huge impact upon QALYs. The lack of long term data and reliance upon external data for HRQL, life expectancy and savings was one of the limitations of this study. Low evidence study

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3	case series	49 patients	Obese adolescents underwent laparoscopic adjustable gastric banding (LAGB) following more than 2 years follow-up and at least 1 year lifestyle intervention in a MDT program (includes dietary interventions and physical activity).	Clinical effectiveness of the intervention	To evaluate i) weight loss ii) co-morbidity post intervention	i) At 6, 12 and 24 months after surgery, weight was 103.7±20.8kg, 98.7±21kg and 93.6±19.3kg respectively (p<0.001), corresponding to excess weight loss (EWL) of 31.6±17.2%, 41.8±21.4% and 59.1±24.9% (p<0.0001). Multivariate analysis showed number of consultations/year was the only variable significantly associated with weight loss, differences found on BMI (p=0.008) and EWL (p=0.005). ii) Metabolic disorders were corrected, insulin resistance decreased to 17%	-	-	Khen-Dunlop, Nazih; Dabbas, Myriam; De Filippo, Gianpaolo; Jais, Jean-Philippe; Hervieux, Erik; Téliou, Caroline; Chevallier, Jean-Marc; Michel, Jean-Luc; Aigrain, Yves; Bougnères, Pierre; Goulet, Olivier; Révillon, Yann. Primordial Influence of Post-operative Compliance on Weight Loss After Adolescent Laparoscopic Adjustable Gastric Banding. <i>Obes Surg</i> 2015;0(0):0.	No intraoperative complication except one gastric perforation. During follow-up 6 gastric bands removed, 5 for slippage and 1 for intolerance. One procedure performed for cholecystectomy. One mortality secondary to gastric haemorrhage with band erosion (died from uncontrolled bleeding).	Yes	Population: Adolescents over 14 years of age with severe obesity either BMI>40 without co-morbidities or BMI>35 with major co-morbidity. Mean BMI pre surgery was 42.5±5.9kg/m ² . 37 girls (75%) and 12 boys (25%). No patient had hypertension, one pt sleep apnoea, high incidence of insulin resistance (IR) with a mean HOMA-IR of 5.2±3.1, 75% of patients had metabolic syndrome, 87% of patients with Steatosis. Mean age 16.2±0.9yrs. Overall comments: The authors note that gastric banding was chosen in the adolescent population because it is a restrictive technique, not requiring visceral resection and reversible. Authors acknowledge that long term complications after gastric banding are well recognised and include intolerance, slippage, intragastric erosion, port dysfunction, high rate of re-intervention. Prospective case series, no control group for comparison, low level evidence study
3	case series	16 patients	Assessment of food cravings utilising the Food Craving Inventory preoperatively and post Roux-en-Y gastric bypass (RYGB)	Clinical effectiveness of the intervention	To evaluate the longitudinal effect of RYGB on food cravings in adolescents, using the food craving inventory (FCI), 28 item questionnaire.	RYGB produced a significant negative nonlinear trend (P<0.05) for total food cravings and for each subscale (sweets, high fat foods, carbohydrates and fast food) over the 24 month study period. The largest negative effect upon food cravings occurred in the first 6 months with minimal decreases at 24months. BMI change was not found to be a significant predictor of food cravings (P=0.09).	-	-	Cushing, Christopher C.; Peugh, James L.; Brode, Cassie S.; Inge, Thomas H.; Benoit, Stephen C.; Zeller, Meg H.. Longitudinal trends in food cravings following Roux-en-Y gastric bypass in an adolescent sample. <i>Surg Obes Relat Dis</i> 2015;11(1):14-18.	-	Yes	Population: Severely obese adolescently BMI>40kg/m ² . Also patients included had no developmental problems. Predominately females 62.5%, with a mean BMI of 59.91±8.71kg/m ² . Mean age 16.2±1.4years. Overall comments: Small pilot study of assessment of food cravings. Prospectively collected at a single paediatric tertiary care hospital. Data collected at baseline, 3,6,12,18 and 24 months. Limited study with no control group and very small sample size, low level evidence study.

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3	case series	137 patients	Adolescent undergoing laparoscopic adjustable gastric banding (LAGB). Patients were enrolled prior to surgery to attend 6 monthly visits to meet nutritionist and surgeon, to help develop healthy eating and lifestyle habits and assess compliance. If after 3-4 visits evidence of excellent compliance considered for surgery. Psychiatric screening pre surgery was undertaken and patients treated if required. All Patients completed Peds Quality of Life Inventory (PedsQL), Centre for Epidemiologic Studies Depression scale (CES-D), Beck Depression Index (BDI) preoperatively.	Clinical effectiveness of the intervention	i) Mean weight loss and mean BMI ii) Percent change in BMI iii) Prevalence of medical co-morbid conditions	i) After LAGB the mean weight loss was 12.7kg, 17.4kg, 17.6kg and 21.8kg at 6, 12, 18 and 24 months respectively. At 36 months the mean total weight loss was 24.2kg. Mean BMI at 6, 12, 18, 24 and 36 months was 43.8, 41.6, 41.5, 40.5 and 39.3 kg/m2. Excess weight loss (EWL) was 28.7%, 35.1% and 41.2% at 1, 2 and 3 years postop. Excess BMI loss was 28.4%, 35.9% and 41.1% at 1, 2 and 3 years post op. ii) Percent change in BMI was 12.6%, 14.8% and 18.9% at 1, 2 and 3 years post op. Trend of weight loss was significant P<0.0001. 12 months post LAGB 14% (19/137) patients lost >50% of their excess BMI but 49% lost at least 20%. ii) Co-morbid conditions: 50% of patients (1/2) with diabetes resolved, 40.3% (29/72) insulin resistance, 37.5%(18/48) Metabolic syndrome, 50% (20/40) with PCOS, 33.3% (9/30) hypertension, 31.7% (33/104) dyslipidaemia, 34.7% (17/49) OSA and 31.8% (14/44) asthma patients resolved after LAGB			Zitsman, Jeffrey L.; DiGiorgi, Mary F.; Fennoy, Ilene; Kopchinski, Janet Schauben; Sysko, Robyn; Devlin, Michael J.. Adolescent laparoscopic adjustable gastric banding (LAGB): prospective results in 137 patients followed for 3 years. Surg Obes Relat Dis 2015;11(1):101-109.	i) No surgical deaths <30 days post op ii) Perioperative complications: plantar fasciitis and reoperation for port site bleeding and ileus. 30 pts (22%) underwent one or more operation for complication, 12 for port complications, 2/5 with gastric prolapse and symptomatic proximal pouch enlargement. iii) At time of report 53% of patients had exited the study. Of those followed up 2 died, 1 suicide and 1 myocardial infarction. 22 patients completed 5 year follow up -11 patients had their bands removed (2 for intractable esophagitis, 5 for weight loss failure, 4 did not tolerate a band) iv) 27 patients (20%) had their bands removed between 12 and 60 months following implantation.	Yes	Population: Obese adolescents undergoing LAGB. Mean preoperative weight 136.1kg, mean BMI 48.3kg/m2 and excess BMI 23.6kg/m2. At least one co-morbidity present in 128 pts (93%). Assessment included type 2 diabetes (2pts), insulin resistance (50% of pts), metabolic syndrome (35%), polycystic ovary syndrome (29.2% of females), hypertension (21.9%), dyslipidaemia (75%), obstructive sleep apnoea (35.8%) and asthma (32%). Mean age 17±1.2yrs Adolescents (14-18yr). Overall comments: Authors report the study is the largest single centre report of LAGB in adolescents from the US to date. Authors conclude although LAGB was associated with significant weight loss, nevertheless patient selection through screening and monitoring did not guarantee an individual would lose weight. Although serious complications were uncommon, 36% of the study population required additional surgery. Low grade evidence study with no control group/comparative group, authors also note that patients often missed benchmark visits (although predominantly subsequently followed up).
3	case series	14 patients (matched to 14 adults > 20 yrs)	Adolescents underwent Roux-en-Y Gastric Bypass. Mean BMI was 47.2±11.1 kg/m2. In terms of co-morbidities, diabetes mellitus, hypertension, cholesterol and obstructive sleep apnoea were evaluated. 64.3% (n=9) patients had no co-morbid conditions with 35.7% (n=5) had one comorbid condition	Clinical effectiveness of the intervention	To evaluate i) weight loss	At 12 months the mean percent of excess weight loss in the adolescent group was 70.5±17% compared to 67.0±18.6% in the control group p>0.71 (NS)	To evaluate remission/Improvement of co-morbidities	Of the 5 patients in the adolescent group, 4 patients had improvement or resolution of co-morbidity. In the adult control group post operatively 3/6 patients had resolution of co-morbidity, whilst 3 of the other patients had 1-2 comorbidities. NS difference	DuCoin, Christopher; Moon, Rena C.; Mulatre, Mertalaine; Teixeira, Andre F.; Jawad, Muhammad A.. Safety and effectiveness of Roux-en-Y gastric bypass in patients between the ages of 17 and 19. Obes Surg 2015;25(3):464-469.	No serious adverse effects noted in the follow-up periods. 2 patients required revisional surgery, one from each group	Yes	Population: Obese adolescents (15 patients identified from 2048 pts, one patient lost to follow-up). Pts included 13 females and 1 male, mean BMI of 47.2±11.2kg/m2. Mean age 18.4 ±0.8yrs (Pts 17-19 yrs). Overall comments: Several limitations including retrospective chart review, small study size which does not allow adequate power or proper statistical analysis. Single surgeon centre study.

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3	case series	226 patients (i) 74pt prepubertal, ii) 115 adolescents, iii) 37 young adults	Obese children and adolescent underwent sleeve gastrectomy. All patients had at least one co-morbidity with an average of 2.1 co-morbidities per patients. >40% of patients had OSA, 23% type 2 diabetes, of the 192 pts 85% had NAFLD with 33.9% (n=6%) had non-alcoholic steatohepatitis and 13.5% (n=26) had bridging fibrosis	Clinical effectiveness of the intervention	To evaluate i) remission and improvement in co-morbidities in children and adolescents following sleeve gastrectomy ii) weight loss and growth parameters	i) Within 2 years of follow-up 90.3% of co-morbidities were in remission or improved. 64.9% had remission/improvement within the first 3 months postoperatively. No further improvement or remission beyond 2 years. 88.5% of diabetes patients achieved normal fasting plasma glucose and HbA1c levels without medication. 17% of the dyslipidaemia related co-morbidities did not resolve. Lost to follow up in each of 3 years were as follows 4.2%, 7.6% and 15.3% respectively. ii) Mean BMI z score at 1, 2 and 3 years respectively were as follows: 2.01±0.87, 2.00±1.07 and 1.66±0.65 respectively. No significant difference in postoperative BMI when comparing changes in prepubertal, adolescent and young adult cohorts. All patients at different age groups were reported to have normal growth velocity			Alqahtani, Aayed R.; Elahmedi, Mohamed O.; Al Qahtani, Awadh. Co-morbidity resolution in morbidly obese children and adolescents undergoing sleeve gastrectomy. Surg Obes Relat Dis 2014;10(5):842-850.	Report no major complications, one patient required a blood transfusion postoperatively, 1 patient treated with intravenous antibiotics.	Yes	Population: Obese children and adolescents with a mean BMI of 48.2±10kg/m2 and BMI z score 2.99 ±0.35. Mean preoperative height was 158±15.1cm. Co-morbidities were assessed over 3 year, obstructive sleep apnoea (OSA) assessed using paediatric sleep questionnaire and polysomnography and resolution according to PSQ score alone, diabetes, pre-diabetes, hypertension, pre-hypertension and dyslipidaemia. MDT approach for assessment. Inclusion criteria BMI of at least 40kg/m2 or BMI>35kg/m2 with co-morbid condition or weight >99th percentile for age, and failure to achieve weight reduction of at least 10% of baseline weight during a 6 month period of follow-up, dedicated caregiver and psychological and psychosocial assessment. Overall mean age 14.4±4yr Mean age: i) prepubertal 9.8yrs±2.4 (5-12yr) ii) adolescents 15.4±1.7 (13-17yr) and iii) young adults 19.2±8 (18-21yr). Overall comments: Data extracted from King Saud University Obesity Chair Research Database, collects prospective outcomes of paediatric bariatric surgery. Authors report 69.1% of patients were complaint to planned visits. No long term study, patients not randomised, reliance upon database input. Low level evidence.
3	case series	242 patients (n=277, 13 decline, 22 did not undergo surgery) Study concluded at 5 academic referral	66% of patients underwent laparoscopic Roux-en-Y gastric bypass, 28% of vertical sleeve gastrectomy and 6% of adjustable gastric banding.	Safety of the intervention	Evaluated i) major and ii) minor complications within 30 days of operation	No deaths during the initial hospitalisation or within 30 days of operation. i) Major complications: 19 patients (7.9%) experienced 20 major complications. 12 patients (5%) had 13 major perioperative complications including one intraoperative splenic injury. 7/12 underwent early re-operation for intestinal obstruction, bleeding, confirmed or suspected GI leak. 7 patients (2.9%) had major complications post discharge, including pulmonary embolus, 3 with GI leak of which two patient did not require intervention, one required drain/stent placement and one abdominal operation. One patient had suicidal ideation. ii) Minor complications: 37 patients (14.9%) had minor complications. 19 patients (7.9%) had 20 minor perioperative complications that included 4 minor injuries to solid organs at operation and 6 urinary tract infections. 27 patients (11.2%) had minor complications, 11 patients had abdominal/gastrointestinal complaints and dehydration, whilst five patients required an upper GI endoscopy			Inge, Thomas H.; Zeller, Meg H.; Jenkins, Todd M.; Helmtrath, Michael; Brandt, Mary L.; Michalsky, Marc P.; Harmon, Carroll M.; Courcoulas, Anita; Horlick, Mary; Xanthakos, Stavra A.; Dolan, Larry; Mitsnefes, Mark; Barnett, Sean J.; Buncher, Ralph; Teen-LABS Consortium. Perioperative outcomes of adolescents undergoing bariatric surgery: the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study. JAMA Pediatr 2014;168(1):47-53.	complications evaluated as primary outcome	Yes	Population: Obese adolescents undergoing bariatric surgery, with a median BMI of 50.5kg/m2. 51% had four or more major co-morbid conditions. Most common comorbidities, 74% with dyslipidaemia, 57% sleep apnoea, 46% back and joint pain, 45% hypertension and 37% fatty liver disease. The cohort were primarily non-Hispanic (93%), Caucasian (72%) and female (76%). Mean age 17.1± 1.6 years. Overall comments: Prospective multi-site observational study, consecutive adolescents (age <19 years) undergoing bariatric surgery at each of five Teen-LABS centres. The study have observed that 92% of the 242 severely obese adolescents underwent surgery without major complications. Low level evidence study

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3	case series	345 patients (58 hospital)	Adolescents and young adults undergoing primary bariatric procedure. MDT approach including a paediatrician, child psychologist, surgeon and primary care provider. The following operating techniques were undertaken: 34% (n=118) gastric banding, 34% (n=116) gastric bypass, 23% (n=78) sleeve gastrectomy, 8% (n=28) gastric balloon, 0.9% (n=3) biliopancreatic diversion, 0.6% (n=2) gastric pacemaker.	Clinical effectiveness of the intervention	i) Weight loss (BMI measured)	i) Overall the mean BMI significantly decreased after surgery (follow-up up to 18months), mean difference -25.5% (-12.7kg/m2, SD=8.2kg/m2, 95%CI -14, -11.5). BMI loss was similar in those <18yr old compared to those >18yrs old, P=0.273. When anthropometric measures were compared to type of surgery it was found that gastric bypass surgery, BMI loss -33% (-16.36kg/m2) and sleeve gastrectomy -29% (-15.39kg/m2) displayed similar BMI reductions, and were significantly greater when compared to adjustable gastric band surgery -20% (-9.48kg/m2), P<0.005.	ii) Changes in comorbidities	Among the 167 patients followed up the rates were as follows: i) diabetes mellitus requiring insulin showed a 40% reduction, P=0.723 (5 to 3pt), ii) diabetes mellitus not requiring insulin 64% reduction, P=0.10 (11 to 4 pts), iii) 49% reduction in hypertension rates (55 to 28pts), P<0.001, iv) 42% reduction in sleep apnoea rates (12 to 7pts).	Lennerz, B. S.; Wabitsch, M.; Lippert, H.; Wolff, S.; Knoll, C.; Weiner, R.; Manger, T.; Kiess, W.; Stroh, C. Bariatric surgery in adolescents and young adults--safety and effectiveness in a cohort of 345 patients. Int J Obes (Lond) 2014;38(3):334-340.	Complications for all primary procedures (n=345). Intraoperative complications occurred at a rate of 0.8% for gastric banding, 2.6% gastric bypass and 0% sleeve gastrectomy. Postoperative complications rate of 2.5% for gastric banding, 5.2% for gastric bypass and 9.1% sleeve gastrectomy. There was no significant difference in complication rates between the 3 procedures for intraoperative (P=0.375) and general post operative complications (P=0.075).	Yes	Population: Obese adolescents undergoing bariatric surgery. Causative endocrine disorders were excluded and patients achieved longitudinal growth (mature bone age). Mean BMI was 47.4 +/- 9.1kg/m2. Predominately female, 67% of patients n=231. Common comorbidities: 30.1% (n=104) had hypertension, 8.7% (n=30) diabetes mellitus, 2.6% (n=9) other cardiovascular diseases, 9.9% (n=34) pulmonary diseases, 5.8% (n=20) with sleep apnoea, 2.9% (n=10) cholelithiasis, 10.4% (n=36) gastro-oesophageal reflux disease, 2.9% (n=10) varicose veins, 30.1% (n=104) degenerative skeletal disease, 20.3% (n=70) spinal column disease, 12.2% (n=42) gonarthrosis and 13% (n=45) and 13% (n=45) with Coxarthrosis. Mean age 19.2yrs, 15% of pts (n=52) <18 yrs, 18-21 yrs. 98% of patients >15yrs of age. Overall comments: Prospective longitudinal registry data, limited because of incomplete data input and unrecognised biases. Also there is a concerns with data accuracy with both acquisition and entry performed to multiple entities. No non-surgical control group and short observation period. According to the registry data ~50% of young adults and adolescents were lost to follow-up, and authors have acknowledge that additional mechanisms need to be implemented to improve patient adherence and also to assess long term safety and efficacy in this cohort of patients. Low level evidence
3	case report	1 patient	Obese child underwent laparoscopic sleeve gastrectomy	Clinical effectiveness of the intervention	i) Weight loss	Weight loss of 27% over 2 years following surgery from 33kg to 24kg and normalisation of body mass index from 41 to 24 kg/m2.	-	-	Mohaidly, Mohammed Al; Suliman, Ahmed; Malawi, Horia. Laparoscopic sleeve gastrectomy for a two- and half year old morbidly obese child. Int J Surg Case Rep 2013;4(11):1057-1060.	-	Yes	Population: Obese toddler with OSA. BMI of 41.1kg/m2. At the age of 14months (BMI 29kg/m2) started on both dietary and medical interventions. His hormonal and chromosomal work-up was reported as normal Overall comments: Authors report that parents of the child did not comply with instructions and had non-compliant with follow-up appointments. Case report low level evidence
3	Case series	228 patients (5 centres)	Obese adolescent undergoing Roux-en-Y gastric bypass (n=161) or sleeve gastrectomy (n=67).	Clinical effectiveness of the intervention	i) Mean weight loss at 3 years after the procedure ii) Resolution of co-morbidities iii) Impact upon weight related quality of life	i) Mean weight at 3 years had decreased by 27% (CI: 25 to 29), 28% decrease in those patients who underwent gastric bypass (CI 25 to 30, P<0.001) and 26% who underwent sleeve gastrectomy (CI 22 to 30, P<0.001). Mean BMI decrease for all patients at 3 years was 28% (decrease of BMI 53kg/m2 at baseline to 38kg/m2), in the bypass group 28% change (BMI 54kg/m2 to 39kg/m2) and in the sleeve gastrectomy group 26% (50kg/m2 to 37kg/m2). Authors reported at 3 years 26% of the patients were no longer obese, although at 3 years 2% of patients who underwent gastric bypass and 4% of those who underwent sleeve gastrectomy exceeded baseline weight ii) At 3 years remission of type 2 diabetes occurred in 95% (CI 85 to 100) who had the condition at baseline, remission of abnormal kidney function in 86% (CI 72 to 100), remission of prediabetes in 76% (CI 56 to 97) and elevated blood pressure in 74% (CI 64 to 84), dyslipidemia in 66% (CI 57 to 74). iii) Overall improvement in weight related quality of life at 3 years, baseline score increased from 63 to 83, P<0.001	Assessment of micronutrients post surgery	At baseline low ferritin levels found in 5% of patients, and at 3 years after bariatric procedure hypoferritinemia was found in 57%, P<0.001 (95% CI 50 to 65) of patients. Vitamin B12 levels decreased by 35% with 8% of patients being deficient at 3 years. In addition Vitamin A deficiencies at baseline in 6% of patients who underwent gastric bypass and at 3 years in 16% of patient who underwent this procedure, P=0.008	Inge, Thomas H.; Courcoulas, Anita P.; Jenkins, Todd M.; Helmrath, Michael A.; Brandt, Mary L.; Harmon, Carroll M.; Zeller, Meg H.; Chen, Mike K.; Xanthakos, Stavra A.; Horlick, Mary; Buncher, C. Ralph; Teen-LABS Consortium. Weight Loss and Health Status 3 Years after Bariatric Surgery in Adolescents. N. Engl. J. Med. 2015;0(0):0.	13% of patients had undergone one or more additional intrabdominal procedures in 3 years (47 procedures performed in 30 patients). Upper endoscopic procedure preformed in 13% of patients. One patient died 3.3 years after bypass surgery from complications following a hypoglycemic event, patient had known type I diabetes	Yes	Population: Obese adolescents with a mean BMI of 53/. 75% were female and 72% caucasian. Associated co-morbidities at baseline, 96 patients had elevated blood pressure, 171 pts dyslipidemia, 36 patients with abnormal kidney function. Aged 17±1.6yrs. Overall comments: Prospective multicenter observational study, that enrolled consecutive adolescent ≤ 19 years of age. 3year follow-up study. Authors recognise limitation of study in terms of size and the observational nature of study which results in significant bias. Low level evidence study.

Appendix Two

Literature search terms

Assumptions / limits applied to search:	
Original search terms:	n/a
Updated search terms - Population	children OR juvenile OR paediatric OR paediatrics OR paediatric OR pediatrics OR adolescent OR adolescents OR child OR minor OR minors OR infant OR infants OR preschool OR pre-school OR youth OR youths OR teen OR teens OR teenager OR teenagers OR childhood OR adolescence
Updated search terms - Intervention	bariatric OR obesity surgery OR obesity surgical OR gastric band* OR gastric bypass OR sleeve gastrectomy OR gastric balloon
Updated search terms - Comparator	n/a

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Updated search terms - Outcome	n/a
Inclusion criteria	General inclusion criteria
	<p>In order of decreasing priority, articles will be selected based on the following criteria.</p> <ol style="list-style-type: none"> 1. All relevant systematic reviews and meta-analysis in the last 5 years and those in 5-10 years period which are still relevant (e.g. no further updated systematic review available) 2. All relevant RCTs and those in the 5-10 years period which are still relevant (e.g. not superseded by a next phase of the trial/ the RCT is one of the few or only high quality clinical trials available) <p>>>>> If studies included reaches 30, inclusion stops here</p> <ol style="list-style-type: none"> 3. All relevant case control and cohort studies, that qualify after exclusion criteria <p>>>>> If studies included reaches 30, inclusion stops here</p> <ol style="list-style-type: none"> 4. All relevant non analytical studies (case series/ reports etc.) that qualify after exclusion criteria <p>>>>> If studies included reaches 30, inclusion stops here</p>
	Specific inclusion criteria
	<p>Quantitative and qualitative studies 5-10 years International English language</p> <p>Include single centre studies with > 20 subjects (suggested by PWG presumably as much of the evidence will come from these sources)</p>
Exclusion criteria	General exclusion criteria
	<p>Studies with the following characteristics will be excluded:</p> <ol style="list-style-type: none"> 1. Does not answer a PICO research question 2. Comparator differs from the PICO 3. < 50 subjects (where studies with >50 subjects exist) 4. No relevant outcomes 5. Incorrect study type 6. Inclusion of outcomes for only one surgeon/doctor or only one clinical site (where studies with > one surgeon/doctor or one clinical site exist) 7. Narrative / non-systematic reviews (relevant referenced studies to be included)
	Specific exclusion criteria
	n/a