ClinicalEvidence

Obesity in children

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ABSTRACT

INTRODUCTION: Obesity is the result of long-term energy imbalances, where daily energy intake exceeds daily energy expenditure. Along with long-term health problems, obesity in children may also be associated with psychosocial problems, including social marginalisation, low self-esteem, and impaired quality of life. Most obese adolescents stay obese as adults. Obesity is increasing among children and adolescents, with 16.8% of boys and 15.2% of girls in the UK aged 2 to 15 years obese in 2008. METHODS AND OUTCOMES: We conducted a systematic review and aimed to answer the following clinical questions: What are the effects of lifestyle interventions for the treatment of childhood obesity? What are the effects of surgical interventions for the treatment of childhood obesity? We searched: Medline, Embase, The Cochrane Library, and other important databases up to January 2010 (Clinical Evidence reviews are updated periodically, please check our website for the most up-to-date version of this review). We included harms alerts from relevant organisations such as the US Food and Drug Administration (FDA) and the UK Medicines and Healthcare products Regulatory Agency (MHRA). RESULTS: We found 14 systematic reviews and RCTs that met our inclusion criteria. We performed a GRADE evaluation of the quality of evidence for interventions. CONCLUSIONS: In this systematic review we present information relating to the effectiveness and safety of the following lifestyle interventions: behavioural, diet, and multifactorial interventions; physical activity; and bariatric surgery.

QUESTIONS

INTERVENTIONS

Key points

- Obesity is the result of long-term energy imbalances, where daily energy intake exceeds daily energy expenditure.

  Obesity in children is associated with physical as well as psychosocial problems. Long-term adverse health consequences of childhood obesity may include increased risk for cardiovascular and metabolic disease in adulthood.

  Most obese adolescents stay obese as adults.
- Obesity is increasing among children and adolescents, with 16.8% of boys and 15.2% of girls in the UK aged 2 to 15 years being obese in 2008.
- We don't know how lifestyle or surgical interventions help in improving quality of life of overweight and obese children or in reducing premature deaths associated with childhood overweight and obesity in the longer term.
- Multifactorial interventions (behavioural, dietary, and physical) may help overweight and obese children to lose weight.

  Multifactorial interventions may be more effective if they involve the family, are delivered in specialist settings, and combine changes in lifestyle habits, particularly diet and physical activity (generally involving behavioural management techniques).
- We don't know if behavioural, dietary, or physical interventions alone can help overweight and obese children lose weight.
- We don't know how effective surgical interventions are in treating obesity in children, as we found no high-quality RCTs.

DEFINITION

Obesity is a chronic condition characterised by an excess of body fat. It is most often defined by the body mass index (BMI), which is highly correlated with body fat. [1] BMI is weight in kilograms divided by height in metres squared (kg/m^2). In children and adolescents, BMI varies with age and sex. It typically rises during the first months after birth, falls after the first year, and rises again around the sixth year of life. [2] Thus, a given BMI value is usually compared against reference charts to obtain a ranking of BMI percentile for age and sex. The BMI percentile indicates the relative

position of the child's BMI as compared with a historical reference population of children of the same age and sex. Worldwide, there is little agreement on the definition of overweight and obesity among children; however, a BMI above the 85th percentile is generally considered to be at least "at risk for overweight" in the USA and UK. A BMI above the 95th percentile is variably defined as overweight or obese but generally indicates a need for intervention. In this review, we have considered treatment of children for overweight and obesity, including children with a BMI above the 85th percentile for age and sex in a community setting. We have included interventions given to the children, their parents, or both.

INCIDENCE/ PREVALENCE

The prevalence of obesity (generally BMI >95th percentile) is steadily increasing among children and adolescents. In the UK in 2008, it was estimated that 16.8% of boys and 15.2% of girls aged 2 to 15 years were obese, which was an increase from 11.1% in boys and 12.2% in girls in 1995, but a decrease from 19.4% in boys and 18.5% in girls in 2004. [3]

AETIOLOGY/ RISK FACTORS

Obesity is the result of long-term energy imbalances, where daily energy intake exceeds daily energy expenditure. [4] Energy balance is modulated by a myriad of factors, including metabolic rate, appetite, diet, and physical activity. [5] Although these factors are influenced by genetic traits in some children, the increase in obesity prevalence in the past few decades cannot be explained by changes in the human gene pool, and is more often attributed to environmental changes that promote excessive food intake and discourage physical activity. [5] [6] The risk of childhood obesity is related to childhood diet and sedentary time. Other risk factors are parental obesity, low parental education, social deprivation, infant feeding patterns, early or more rapid puberty (both a risk factor and an effect of obesity), extreme (both high and low) birth weights, and gestational diabetes. [2] Specifically, physical activity levels have decreased over the years and now only 36% of children and adolescents in the USA are meeting recommended levels of physical activity. [7] Among British children aged 4 to 15 years whose physical activity levels were objectively assessed using accelerometry, only 33% of boys and 21% of girls met the government recommendation for daily physical activity level. [3] Less commonly, obesity may also be induced by drugs (e.g., high-dose glucocorticoids), neuroendocrine disorders (e.g., Cushing's syndrome), or inherited disorders (e.g., Down's syndrome and Prader–Willi syndrome). [2]

PROGNOSIS

Most obese adolescents will become obese adults. For example, a 5-year longitudinal study of obese adolescents aged 13 to 19 years found that 86% remained obese as young adults. [8] Obesity is associated with a higher prevalence of insulin resistance, elevated blood lipids, increased blood pressure, and impaired glucose tolerance, which in turn may increase the risk of several chronic diseases in adulthood, including hypertension, dyslipidaemia, diabetes, cardiovascular disease, sleep apnoea, osteoarthritis, and some cancers. [2] [9] [10] [11] [12] Perhaps a less recognised but important short-term comorbidity of overweight/obesity, particularly in adolescent children, is functional impairment in several psychosocial domains, including social marginalisation, low self-esteem, and impaired quality of life. [2] [13] [14] [15] [16] It is important that clinicians emphasise improvements in diet, physical activity, and health independently of changes in body weight.

AIMS OF INTERVENTION

To achieve gradual reduction in BMI and BMI percentile, and to prevent the morbidity and mortality associated with obesity, without undue adverse effects. In children, a reduction in BMI can often be achieved by maintaining current body weight during normal growth in height with ageing. [17]

OUTCOMES

Change in overweight Proxy measures assessed in studies included mean weight loss (kg), change in BMI (kg/m^2), change in BMI z score, change in BMI percentile, change in percentage overweight or obese (percent over the median weight for age and sex), and change in other adiposity indicators (waist circumference, hip circumference, waist-hip ratio, total fat mass, percentage fat mass). **Mortality** (associated with obesity). **Quality of life**. **Adverse effects**.

METHODS

Clinical Evidence search and appraisal January 2010. The following databases were used to identify studies for this systematic review: Medline 1966 to January 2010, Embase 1980 to January 2010, and The Cochrane Database of Systematic Reviews 2009, Issue 4 (1966 to date of issue). An additional search within The Cochrane Library was carried out for the Database of Abstracts of Reviews of Effects (DARE) and Health Technology Assessment (HTA). We also searched for retractions of studies included in the review. Abstracts of the studies retrieved from the initial search were assessed by an information specialist. Selected studies were then sent to the contributor for additional assessment, using predetermined criteria to identify relevant studies. Study design criteria for inclusion in this review were: published systematic reviews of RCTs and RCTs in any language; RCTs could be open or blinded, containing 20 or more individuals per arm, of whom 80% or more were followed up. Minimum length of follow-up was 12 weeks. We included studies in overweight and obese children (aged 18 years and younger), including children with a BMI above the 85th percentile for age and sex. We included systematic reviews of RCTs and RCTs where harms of

an included intervention were studied applying the same study design criteria for inclusion as we did for benefits. In addition we use a regular surveillance protocol to capture harms alerts from organisations such as the FDA and the MHRA, which are added to the reviews as required. We categorised studies of lifestyle interventions into 4 broad (and non-mutually exclusive) groups on the basis of the type of intervention given. We applied the following principles and definitions to do this. Multifactorial interventions involve the use of more than one mode of intervention (behavioural, diet, physical activity, or a combination) to reduce obesity or overweight. Behavioural interventions involve behavioural/cognitive theories or behavioural management principles to change behaviours that contribute to obesity. Where these theories were not described explicitly, we considered interventions to be behavioural if the mode of delivery involved behavioural techniques. However, most of the studies examining behavioural interventions tended to be classified as multifactorial interventions because these interventions aimed to exert their effects by modifying diet, level of physical activity, or both and so we could not separate the effect of the behavioural intervention from the effect of dietary and activity changes. So, in these cases, we have included these studies in the multifactorial option. We considered studies under the behavioural intervention option only if the study design enabled us to compare different behavioural intervention techniques or to separate the effects of the behavioural intervention from the effects of diet, exercise, or both. Examples are where the study allowed comparison of various intensity/types/modes/methods of specific behavioural interventions. Studies comparing dietary interventions involve comparing the effect of different diets (type or quantity of diet or delivery of dietary intervention) while holding other factors comparable between treatment groups. Studies comparing physical activity interventions involve the comparison of the effect of physical activity (mode or quantity) or any of its indicators (television watching, frequency and/or duration of exercise, etc). To aid readability of the numerical data in our reviews, we round many percentages to the nearest whole number. Readers should be aware of this when relating percentages to summary statistics such as relative risks (RRs) and odds ratios (ORs). We have performed a GRADE evaluation of the quality of evidence for interventions included in this review (see table, p 19). The categorisation of the quality of the evidence (high, moderate, low, or very low) reflects the quality of evidence available for our chosen outcomes in our defined populations of interest. These categorisations are not necessarily a reflection of the overall methodological quality of any individual study, because the Clinical Evidence population and outcome of choice may represent only a small subset of the total outcomes reported, and population included, in any individual trial. For further details of how we perform the GRADE evaluation and the scoring system we use, please see our website (www.clinicalevidence.com).

QUESTION **What are the effects of lifestyle interventions for the treatment of childhood obesity?**

OPTION **MULTIFACTORIAL INTERVENTIONS (BEHAVIOURAL/DIETARY/PHYSICAL)**

- For GRADE evaluation of interventions for Obesity in children, see table, p 19 .
- Multifactorial interventions (behavioural, dietary, and physical) may help overweight and obese children to lose weight.
- Multifactorial interventions may be more effective if they involve the family, are delivered in specialist settings, and combine changes in lifestyle habits, particularly diet and physical activity (generally involving behavioural management techniques).

Benefits and harms

Multifactorial interventions versus no treatment/usual care:

We found 4 systematic reviews (search dates 2007, [18] 2008, [19] 2006, [20] and 2007 [21]) assessing various multifactorial interventions in overweight children. The reviews identified many RCTs in common; however, they applied different inclusion criteria, and the first three reviews performed different meta-analyses, so we have reported on all 4 reviews here. We found three additional RCTs [22] [23] [24] and two subsequent RCTs. [25] [26]

Change in overweight

Compared with no treatment/usual care Multifactorial interventions may be more effective at managing obesity in children within 6 months to 1 year; however, which components of multifactorial interventions are effective at reducing BMI in obese children is unclear (very low-quality evidence).

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
Short-term effect of treatment in various settings (kg/m^2)					
[18] Systematic review	455 children aged 5 to 18 years in a school setting 5 RCTs in this analysis Subgroup analysis	**Change in BMI between intervention and control , 6 to 12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups –0.81 95% CI –1.18 to –0.45 P <0.0001 I^2 = 47%	○○○	behavioural interventions
[18] Systematic review	468 children aged 5 to 18 years in a specialty-care setting 3 RCTs in this analysis Subgroup analysis	**Change in BMI between intervention and control , 6 to 12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups –2.73 95% CI –3.73 to –1.72 P <0.0001 I^2 = 71%	○○○	behavioural interventions
[18] Systematic review	207 children aged 5 to 18 years in a primary-care setting 2 RCTs in this analysis Subgroup analysis	**Change in BMI between intervention and control , 6 to 12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups –0.64 95% CI –1.57 to +0.29 P = 0.18 I^2 = 63%	⟷	Not significant
[18] Systematic review	51 children aged 5 to 18 years in a community setting Data from 1 RCT Subgroup analysis	**Change in BMI between intervention and control , 6 to 12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups –0.44 95% CI –1.09 to +0.21 P = 0.18	⟷	Not significant
[18] Systematic review	80 children aged 5 to 18 years in an online setting Data from 1 RCT Subgroup analysis	**Change in BMI between intervention and control , 6 to 12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups –0.54 95% CI –1.38 to +0.30 P = 0.21	⟷	Not significant
Maintenance of BMI after treatment in various settings (kg/m^2)					
[18] Systematic review	70 children aged 5 to 18 years in a school setting	**Change in BMI between intervention and control , >12 months**	Change in BMI between groups –0.70 95% CI –1.29 to –0.11	○○○	behavioural interventions

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
	Data from 1 RCT Subgroup analysis	with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	P = 0.02		
[18] Systematic review	315 children aged 5 to 18 years in a specialty-care setting 2 RCTs in this analysis Subgroup analysis	**Change in BMI between intervention and control , >12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups –1.70 95% CI –2.38 to –1.02 P <0.0001 I^2 = 0%	○○○	behavioural interventions
[18] Systematic review	163 children aged 5 to 18 years in a primary-care setting Data from 1 RCT Subgroup analysis	**Change in BMI between intervention and control , >12 months** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings)	Change in BMI between groups 0 95% CI –0.40 to +0.40 P = 1.00	⟷	Not significant
Change in overweight (BMI; kg/m^2)					
[19] Systematic review	301 children aged <12 years 4 RCTs in this analysis	**Change in overweight , 6 months** with multifactorial lifestyle interventions including behavioural component with usual care including intervention aimed only at the parent, parenting-skills training, self-help, brief counselling session, and passive health education Absolute numbers not reported	WMD –0.06 kg/m^2 95% CI –0.12 kg/m^2 to –0.01 kg/m^2	○○○	lifestyle interventions
[19] Systematic review	264 children aged <12 years 3 RCTs in this analysis	**Change in overweight , 12 months** with multifactorial lifestyle interventions including behavioural component with usual care including intervention aimed only at the parent, parenting-skills training, self-help, brief counselling session, and passive health education Absolute numbers not reported	WMD –0.04 kg/m^2 95% CI –0.12 kg/m^2 to +0.04 kg/m^2	⟷	Not significant
[19] Systematic review	291 children aged at least 12 years 3 RCTs in this analysis	**Change in overweight , 6 months** with multifactorial lifestyle interventions including behavioural component with usual care including intervention aimed only at the parent, parenting-skills training, self-help,	WMD –0.04 kg/m^2 95% CI –0.17 kg/m^2 to –0.12 kg/m^2	○○○	lifestyle interventions

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
		brief counselling session, and passive health education Absolute numbers not reported			
[19] Systematic review	231 children aged at least 12 years 2 RCTs in this analysis	**Change in overweight , 12 months** with multifactorial lifestyle interventions including behavioural component with usual care including intervention aimed only at the parent, parenting-skills training, self-help, brief counselling session, and passive health education Absolute numbers not reported	WMD –0.14 kg/m^2 95% CI –0.18 kg/m^2 to –0.10 kg/m^2	○○○	lifestyle interventions
[20] Systematic review	193 children 8 years or younger 2 RCTs in this analysis Subgroup analysis	**SMD in adiposity measurement (mainly BMI) , 6 months** with combined diet and physical activity with no treatment, usual care or education, self-esteem class, lower-intensity intervention, information or counselling only Absolute numbers not reported	SMD –0.70 95% CI –1.00 to –0.40 P <0.0001	○○○	combined diet and physical activity
[20] Systematic review	378 children aged 9 to 18 years 10 RCTs in this analysis Subgroup analysis	**SMD in adiposity measurement (mainly BMI) , 6 months** with combined diet and physical activity with no treatment, usual care or education, self-esteem class, lower-intensity intervention, information or counselling only Absolute numbers not reported	SMD –0.49 95% CI –0.81 to –0.18 P = 0.002	○○○	combined diet and physical activity
[20] Systematic review	514 children aged up to 18 years 11 RCTs in this analysis Subgroup analysis	**SMD in adiposity measurement (mainly BMI) , 6 months** with combined diet and physical activity interventions involving the family with no treatment, usual care or education, self-esteem class, lower-intensity intervention, information or counselling only Absolute numbers not reported	SMD –0.64 95% CI –0.88 to –0.39 P <0.0001	○○○	combined diet and physical activity
[20] Systematic review	662 children aged up to 18 years 12 RCTs in this analysis Subgroup analysis	**SMD in adiposity measurement (mainly BMI) , 6 months** with combined diet and physical activity interventions targeting the children directly with no treatment, usual care or education, self-esteem class, lower-intensity intervention, information or counselling only Absolute numbers not reported	SMD –0.17 95% CI –0.40 to +0.05 P = 0.13	⟷	Not significant
[27] RCT	147 African-American girls aged 12 to 16 years, BMI 90th percentile or greater (standard population unspec-	**Change in BMI , 6 months** –0.1 kg/m^2 with 24 to 26 sessions of high-intensity interventions	P = 0.20	⟷	Not significant

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
	ified); recruited from local churches with mostly higher-income family members; 123 in analysis In review [21]	+0.4 kg/m^2 with 6 sessions of moderate-intensity interventions See further information on studies for details of interventions The difference between groups was reported as significant based on attendance of high-intensity sessions: –0.8 kg/m^2 in girls attending at least 75% of sessions *v* +0.5 kg/m^2 in girls attending <75% sessions; P = 0.01			
[22] RCT	120 school children aged 10 to 13 years, BMI 95th percentile or greater (standard population unspecified)	**Difference in mean BMI , 12 weeks** –1.1 kg/m^2 with instruction and physical activity +0.4 kg/m^2 with no specific intervention	P = 0.047 Borderline significance	○○○	instruction and physical activity
[23] RCT	120 adolescent girls (mean age 15.5 years) with BMI >24 kg/m^2	**Mean BMI , 10 months** 24.4 kg/m^2 with individually tailored weight-loss programme 26.6 kg/m^2 with no treatment Programme involved aerobic exercises, dietary modification (energy intake from 50% protein, 40% carbohydrate, and 10% fat), and behavioural modification Chest, waist, and hip circumferences were also significantly different between groups (P <0.05)	P <0.05	○○○	tailored weight-loss programme
[25] RCT	258 children aged 5 to 10 years, overweight or obese (International Obesity Taskforce [IOTF] definition), but not very obese (1990 UK growth reference BMI z score 3 or more)	**Adjusted mean difference in BMI , 6 months** with 4 standard primary-care consultations over 12 weeks, aimed at changing diet and physical activity and supplemented by purpose-designed family materials with standard care with GP (visits to GP do not involve weight-related discussion) Absolute numbers not reported	Adjusted mean difference –0.12 95% CI –0.40 to +0.15 P = 0.4	⟷	Not significant
[25] RCT	258 children aged 5 to 10 years, overweight or obese (IOTF definition), but not very obese (1990 UK growth reference BMI z score 3 or more)	**Adjusted mean difference in BMI , 12 months** with 4 standard primary-care consultations over 12 weeks, aimed at changing diet and physical activity and supplemented by purpose-designed family materials with standard care with GP (visits to GP do not involve weight-related discussion) Absolute numbers not reported	Adjusted mean difference –0.11 95% CI –0.45 to +0.22 P = 0.5	⟷	Not significant
[26] RCT	192 children aged 8 to 12 years, BMI 97th percentile or greater	**Change in BMI , 6 months** –0.68 kg/m^2 with family interventions +0.54 kg/m^2 with nutrition consultation sessions	Difference –1.22 P = 0.0007	○○○	family interventions

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
		See further information on studies for details of interventions The RCT reported a substantial variation in the number of sessions attended by the children in the intervention group			
[26] RCT	192 children aged 8 to 12 years, BMI 97th percentile or greater	**Change in BMI , 18 months** +1.50 kg/m^2 with family interventions +1.72 kg/m^2 with nutrition consultation sessions See further information on studies for details of interventions The RCT reported a substantial variation in the number of sessions attended by the children in the intervention group	Difference –0.21 kg/m^2 P = 0.56	⟷	Not significant
Body fat					
[22] RCT	120 school children aged 10 to 13 years, BMI 95th percentile or greater (standard population unspecified)	**Difference in mean % body fat , 12 weeks** –1.6% with instruction and physical activity +1.2% with no specific intervention	P = 0.008	○○○	instruction and physical activity
Mean weight					
[23] RCT	120 adolescent girls (mean age 15.5 years) with BMI >24 kg/m^2	**Mean weight , 10 months** 64.1 kg with individually tailored weight-loss programme 71.5 kg with no treatment Programme involved aerobic exercises, dietary modification (energy intake from 50% protein, 40% carbohydrate, and 10% fat), and behavioural modification	P <0.05	○○○	tailored weight-loss programme
[24] RCT **4-armed trial**	131 children aged 8 to 12 years, 20% higher than "normal" weight (using WHO standard)	**Change in weight from baseline , 12 weeks** From 49.5 kg to 46.3 kg with exercise plus behavioural intervention From 47.8 kg to 46.3 kg with nutrition plus behavioural intervention From 48.3 kg to 46.06 kg with exercise plus nutrition plus behavioural intervention From 49.3 kg to 50.1 kg with no treatment See further information on studies for details of interventions	No between-group significance assessment reported P <0.01 from baseline for exercise plus behaviour and for exercise plus nutrition plus behaviour P values from baseline reported as not significant for nutrition plus behaviour and for no treatment		
% overweight					
[26] RCT	192 children aged 8 to 12 years, BMI 97th percentile or greater	**Change in % overweight , 6 months** –7.58% with family interventions –0.66% with nutrition consultation sessions	Difference –6.92% P = 0.0005	○○○	family interventions

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
		See further information on studies for details of interventions The RCT reported a substantial variation in the number of sessions attended by the children in the intervention group			
[26] RCT	192 children aged 8 to 12 years, BMI 97th percentile or greater	**Change in % overweight , 18 months** –1.16% with family interventions –0.17% with nutrition consultation sessions See further information on studies for details of interventions The RCT reported a substantial variation in the number of sessions attended by the children in the intervention group	Difference –0.99% P = 0.62	⟷	Not significant

Mortality

No data from the following reference on this outcome. [18] [19] [20] [21] [22] [23] [24] [25] [26]

Quality of life

No data from the following reference on this outcome. [18] [19] [20] [21] [22] [23] [24] [25] [26]

Adverse effects

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
Adverse effects					
[18] Systematic review	Number of children not reported 8 RCTs in this analysis	**Adverse effects** with behavioural interventions to reduce weight in the short term and stabilise weight during maintenance period with control ("minimal" or "no treatment", "usual activity" for interventions given in school settings) The review reported that there were no effects of treatment on growth, eating disorders, or body image, and minimal injury during exercise programmes for studies involving children aged 5 to 12 years Adverse effects not reported for studies in children aged 12 to 18 years or for studies including mixed children and adolescents	Significance not assessed		

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
[19] Systematic review	Number of children not reported 36 RCTs in this analysis	**Adverse effects** with multifactorial lifestyle interventions including behavioural component Absolute numbers not reported The review reported no adverse effects on linear growth, eating or behavioural disorder, and psychological well-being	Significance not assessed		
[23] RCT	120 adolescent girls (mean age 15.5 years) with BMI >24 kg/m^2	**Adverse effects** with individually tailored weight-loss programme with no treatment Programme involved aerobic exercises, dietary modification (energy intake from 50% protein, 40% carbohydrate, and 10% fat), and behavioural modification The RCT reported mild adverse events (debility, dizziness, and nausea) but reported that these did not affect the girls' daily lives	Significance not assessed		

No data from the following reference on this outcome. [20] [21] [22] [24] [25] [26]

Multifactorial interventions versus bariatric surgery:

We found no systematic review or RCTs.

Further information on studies

[18] The review included 14 RCTs, three controlled clinical trials, and one controlled trial with unclear randomisation, 1794 obese (>95th percentile) children aged 5 to 18 years.

[19] The review categorised any intervention involving behavioural management techniques aimed at changing thinking patterns or actions, particularly in relation to diet and physical activity, as a behavioural intervention. However, for the purpose of this *Clinical Evidence* review, we have categorised these under multifactorial interventions, as it was not possible to separate the behavioural component from the diet or physical activity components of the interventions.

[27] Active treatment consisted of 24 to 26 sessions of high-intensity interventions for 6 months (parents, usually the mothers, were invited to every other session; intervention consisted of experiential and interactive behavioural activity, 30-minute moderate to vigorous physical exercise, preparation and/or consumption of low-fat, portion-controlled meals or snacks; behavioural intervention targeting dietary habit change used the decision-making principles of substitution, moderation, and abstinence; 1-day "kick-off retreat" at the beginning of each intervention cycle, daily wear of a two-way paging device (to receive and send messages regarding diet and physical activity at key times during the day); and 4 to 6 motivational interview sessions during the study period. Control consisted of 6 sessions of moderate intensity, which were comparable to the intervention group but did not offer two-way pagers, phone interview, or "kick-off" retreats.

[22] Active treatment consisted of 30-minute instruction given in schools twice a week for 12 weeks (instructions included information on healthy diet and exercise) and physical activity (non-competitive aerobic activities) three times a week.

[24] Exercises were tailored to reaching 50% of maximum oxygen consumption or 65% of maximum heart rate, and prescribed for a frequency and duration of 1 hour per session per day for 5 days a week over a period of 12 weeks. Nutrition: caloric restriction tailored for a given body mass to achieve weight loss of around 0.3 to 0.5

kg/week (plus daily food intake to meet specific proportions from fat, protein, and carbohydrates). Exercise plus nutrition group: combining both interventions. Behavioural interventions, aimed at providing education on healthy diet and physical activity, delivered across all three groups.

[26] Family intervention (adapted from Stoplight Eating Plan) involving 20 group meetings (60 minutes each meeting) during 0 to 6 months (separate adult and child groups); lifestyle coach for weekly self-monitoring records and setting weekly goals; 6 booster sessions at 6 to 12 months and no contact between 12 to 18 months; behavioural strategies aimed at improving diet and physical activity levels. Control consisted of two nutrition consultation sessions to develop individual nutrition plan; no contact between assessments (but offered the intervention after 18-month follow-up).

Comment:

The first review identified organised physical activity sessions, parental involvement, and behavioural management techniques that included participant training and support as likely to lead to reduction in BMI; however, there were no quantitative data to support these observations. [18]

Most studies have been done in different settings, including research or specialty clinic settings, schools, or primary care. Most of the children in these studies had BMI values exceeding the 95th percentile or exceeding the 85th percentile. There was insufficient evidence for the effect of multifactorial interventions among children with a BMI between the 85th and 95th percentiles.

Although multifactorial intervention overall is effective in reducing BMI in obese children, there is less evidence as to which feature or component of the intervention is optimal, as most RCTs were not designed to test this hypothesis. For example, RCTs were not designed to compare behavioural, diet, and physical activity, as most behavioural management techniques invariably incorporate altering dietary habit and physical activity levels, which are the two key important mediating factors. Moreover, family-based interventions, interventions delivered in specialised care centres, and more intense interventions tended to have stronger effect sizes than did interventions without family involvement, interventions provided in primary care or even school settings, or less intense interventions.

In most of these RCTs, multifactorial interventions were compared with controls (i.e., family-based versus control or no treatment rather than non-family-based approach as a comparison). Interventions that provided one-to-one counselling on diet and physical activity should have a control group given similar contact time/opportunity with the counsellor but a different content (e.g., broad health advice).

Although multifactorial interventions may be effective in reducing BMI within 6 to 12 months after the delivery of the intervention, there is little evidence to suggest that this effect is maintained in the longer term (beyond 12 months).

Economic cost has been described in only one RCT. [25] The RCT estimated that weight-related counselling in a primary care setting costs $1317 per intervention child compared with $81 per control child (estimates will be lower if the number of children given the intervention per general practice is increased).

Clinical guide:
Multifactorial interventions are given to overweight children to increase their daily energy expenditure, decrease their energy intake, and modify their behaviours to help them to lose weight. We found that the combination of behavioural management and modification of diet and physical activity may be useful for managing obesity in children and adolescents. There is some evidence that multifactorial interventions delivered in a specialist healthcare setting, and involving the family of the obese child in the management programme, may be effective. There is little evidence that the effect of multifactorial intervention is maintained in the long term. It is very difficult to get compliance to long-term follow-up in many of these studies.

OPTION BEHAVIOURAL INTERVENTIONS ALONE

- For GRADE evaluation of interventions for Obesity in children, see table, p 19 .
- We found no direct information from RCTs on the effects of behavioural interventions alone for obesity in children.

Benefits and harms

Behavioural interventions versus no treatment or other behavioural interventions:

We found no systematic review or RCTs specifically examining behavioural interventions alone or examining the differences between types of behavioural intervention technique (e.g., interventions given to parent *v* child). We found 4 systematic reviews [18] [19] [20] [21] and 5 additional or subsequent RCTs [22] [23] [24] [25] [26] that incorporated behavioural methodology in the delivery of the intervention. However, these interventions may include modifying behaviour to alter diet or physical activity (see option on multifactorial interventions, p 3).

Further information on studies

Comment: Based on the evidence from the multifactorial intervention section, the use of behavioural therapy management, within the context of altering diet- and/or physical activity-related behaviour, or in combination with diet and physical activity interventions, is likely to be effective in reducing BMI. However, there is a paucity of evidence to identify the most effective form of behavioural management for tackling obesity in children.

Clinical guide:
Behavioural interventions are given to overweight children (with or without their parents present at intervention) to help people use, change, or maintain health behaviours and to help them to lose weight. As described in the multifactorial intervention section, behavioural interventions were most often prescribed in conjunction with changes in diet and exercise.

OPTION DIET ALONE

- For GRADE evaluation of interventions for Obesity in children, see table, p 19 .
- We don't know if dietary interventions alone can help overweight and obese children lose weight.

Benefits and harms

Dietary interventions alone versus usual care/no treatment:

We found two systematic reviews. [20] [19] The systematic reviews included some RCTs in common; however, they applied different inclusion criteria. We only report data here from the first review (see further information on studies, below). We found one additional RCT [28] and one subsequent RCT. [29]

Change in overweight

Compared with usual care/no treatment We don't know whether any dietary intervention is more effective than no intervention/usual care or alternative diet at reducing obesity in children or adolescents (low-quality evidence).

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
Change in overweight					
[20] Systematic review	259 children 6 RCTs in this analysis	**SMD in adiposity measurement (mainly BMI) , 3 to 30 months** with diet-only intervention with control Absolute numbers not reported Diet-only interventions included reduced glycaemic-load diet, protein-sparing modified diet, low-carbohydrate diet, high-protein diet, and hypocaloric diet Controls consisted of low-fat diet, combination of high protein and	SMD –0.22 95% CI –0.56 to +0.11	⟷	Not significant

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
		low-fat diet, lower-protein diet, or "usual" diet			
[28] RCT	98 children attending weight-loss boot camp (with activity-based programme and education sessions), mean age about 14 years, mean BMI 33.1 kg/m^2; 80 children analysed	**BMI standard deviation score (based on UK Child Growth Foundation's reference), change from baseline** From 2.83 to 2.54 with high-protein diet (22.5% protein, 30% fat, and 47.5% carbohydrate) From 3.1 to 2.84 with standard diet of 15% protein, 30% fat, and 55% carbohydrates Boot camp regimen included activity-based and education sessions	P >0.05	⟷	Not significant
[29] RCT	98 prepubertal Chilean children aged 8 to 10 years, BMI 85th percentile or greater (CDC 2000 growth standard), reported to consume 2 or more servings a day of sugar-sweetened beverages (SSB)	**Change in BMI , 16 weeks** +0.08 kg/m^2 with replacing SSB with milk –0.09 kg/m^2 with no treatment Children instructed to consume 3 servings a day for 16 weeks (around 200 g a serving) of milk delivered to homes and not to consume SSB Changes in % fat, total fat mass, and trunk fat mass were not different between groups (all P >0.05); change in lean mass was higher in intervention group than in control group (P = 0.04)	P = 0.33	⟷	Not significant

Mortality

No data from the following reference on this outcome. [20] [28] [29]

Quality of life

No data from the following reference on this outcome. [20] [28] [29]

Adverse effects

No data from the following reference on this outcome. [20] [28] [29]

Dietary interventions alone versus bariatric surgery:

We found no systematic review or RCTs.

Further information on studies

[19] The second review (search date 2008, 6 RCTs [2 RCTs also identified by the first review]) assessed the effects of dietary interventions separately in children under 12 years and adolescents aged over 12 years. The review did not pool the data because of differences in types of intervention and in comparison groups. None of the additional 4 RCTs, which were not identified by the first review, fulfilled *Clinical Evidence* inclusion criteria and so we have not reported these further.

Comment: **Clinical guide:**
Dietary interventions are given to overweight children (with or without their parents present at the intervention) to decrease their daily energy intake, and to help them lose weight. In adults, moderate dietary restriction has been shown to promote modest weight loss; thus, we sought evidence that diet alone can reduce obesity in children. However, in our review, we found that there was no evidence that dietary modification on its own reduced BMI in obese children.

OPTION PHYSICAL ACTIVITY ALONE

- For GRADE evaluation of interventions for Obesity in children, see table, p 19 .
- We don't know if physical activity interventions alone can help overweight or obese children lose weight.

Benefits and harms

Physical activity versus no treatment/usual care:

We found two systematic reviews (search dates 2006 [20] and 2008 [19]) assessing the effect of activity-based interventions on obesity in children. The systematic reviews included some RCTs in common; however, they applied different inclusion criteria. We only report data here from the first review (see further information on studies, below). We found two subsequent RCTs. [30] [31]

Change in overweight

Compared with no treatment/usual care Physical activity interventions alone may be more effective than usual care/no treatment or lower intensity activity at reducing adiposity or amount of weight gain, but we don't know whether they are more effective at reducing BMI (low-quality evidence).

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
Change in overweight					
[20] Systematic review	791 children 17 RCTs in this analysis	**SMD in BMI or adiposity measurement** with physical activity interventions with control Absolute numbers not reported Control interventions included lifestyle education alone; non-active control; lower-intensity treatments	SMD –0.24 95% CI –0.42 to –0.06 P = 0.009	○○○	physical activity interventions
[20] Systematic review	433 children 11 RCTs in this analysis Subgroup analysis	**% overweight** with physical activity interventions with control Absolute numbers not reported Control interventions included lifestyle education alone; non-active control; lower-intensity treatments	SMD –0.02 95% CI –0.21 to +0.18 P = 0.86	⟷	Not significant

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
[20] Systematic review	358 children 6 RCTs in this analysis Subgroup analysis	**% fat or fat-free mass** with physical activity interventions with control Absolute numbers not reported Control interventions included lifestyle education alone; non-active control; lower-intensity treatments	SMD –0.52 95% CI –0.73 to –0.30 P <0.0001	○○○	physical activity interventions
[30] RCT **3-armed trial**	100 children aged 7 to 11 years in a school setting, BMI 85th percentile or greater (US CDC 2000 growth standard)	**Change in BMI z score , 14 to 15 weeks** with low-dose aerobics with high-dose aerobics with no treatment Absolute numbers not reported Low-dose aerobic exercise group (36 children): exercise sessions to achieve a heart rate >150 bpm for 20 minutes a session, 5 days a week High-dose aerobic exercise group (37 children): exercise sessions to achieve a heart rate >150 bpm for 40 minutes a session, 5 days a week	P value not reported Reported as not significant between groups	⟷	Not significant
[31] RCT	78 children aged 5 to 10 years, BMI 85th percentile or greater	**Change in weight , 6 months** +0.58 kg with physical exercise programme +1.95 kg with no treatment Physical exercise programme consisted of recreational activities with moderate-intensity energy expenditure (playing ball, running, jumping, and dancing) for 50 minutes a session, 3 sessions a week for 6 months; no dietary advice provided	Difference –1.37 95% CI –2.00 to –0.74 P <0.001	○○○	physical exercise programme
[31] RCT	78 children aged 5 to 10 years, BMI 85th percentile or greater	**Change in BMI , 6 months** –0.27 kg/m^2 with physical exercise programme +0.26 kg/m^2 with no treatment Physical exercise programme consisted of recreational activities with moderate-intensity energy expenditure (playing ball, running, jumping, and dancing) for 50 minutes a session, 3 sessions a week for 6 months; no dietary advice provided	Difference –0.53 kg/m^2 95% CI –1.06 kg/m^2 to –0.002 kg/m^2 P = 0.049	○○○	physical exercise programme

Mortality

No data from the following reference on this outcome. [20] [30] [31]

Quality of life

No data from the following reference on this outcome. [20] [30] [31]

Adverse effects

Ref (type)	Population	Outcome, Interventions	Results and statistical analysis	Effect size	Favours
Adverse effects					
[30] RCT **3-armed trial**	100 children aged 7 to 11 years in a school setting, BMI 85th percentile or greater (US CDC 2000 growth standard)	**Adverse effects** with low-dose aerobics with high-dose aerobics with no treatment Absolute numbers not reported Low-dose aerobic exercise group (36 children): exercise sessions to achieve a heart rate >150 bpm for 20 minutes a session, 5 days a week High-dose aerobic exercise group (37 children): exercise sessions to achieve a heart rate >150 bpm for 40 minutes a session, 5 days a week The RCT reported 1 fracture	Significance not assessed		

No data from the following reference on this outcome. [20] [31]

Physical activity versus bariatric surgery:
We found no systematic review or RCTs.

Further information on studies

[19] The second systematic review included 12 RCTs, 5 of which were included in the first review and categorised under physical activity interventions. It compared primarily physical activity-based interventions versus control. The review noted heterogeneity in design and interventions across RCTs. The interventions varied from making small changes in lifestyle (focusing on pedometer walking), increasing physical activity level or reducing sedentary activity, or after-school activity programme. The review did not pool the data. None of the additional RCTs, which were not included in the first systematic review, met *Clinical Evidence* criteria for inclusion in this option, because they were too small, had low follow-up, or included behavioural or dietary components in the intervention group, Therefore, we have not reported these RCTs.

Comment:

Clinical guide:
Physical activity interventions are given to overweight children (with or without their parents present at the intervention) to increase their daily energy expenditure, and to help them lose weight. Low levels of physical activity and greater amounts of sedentary activity are associated with childhood obesity; thus, we sought evidence from studies that addressed physical activity alone as an intervention. However, in our review, we found that physical activity is most often prescribed in conjunction with moderate dietary restriction. Increasing physical activity may contribute to weight loss or prevent excessive weight gain, but it may be relevant to consider the separate effects on fat mass and non-fat mass, particularly in growing children.

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

OPTION BARIATRIC SURGERY New

- For GRADE evaluation of interventions for Obesity in children, see table, p 19 .
- We found no direct information from RCTs on the effects of bariatric surgery for obesity in children.

Benefits and harms

Bariatric surgery versus no treatment or other interventions:

We found no systematic review or RCTs on bariatric surgery that met our inclusion criteria.

Further information on studies

Comment: One RCT (50 adolescents, aged 14–18 years, BMI >35 kg/m^2) comparing gastric banding with an optimal lifestyle programme has been published subsequent to the search date of this *Clinical Evidence* review. [32] We will assess this RCT for inclusion at the next update of this review.

GLOSSARY

Behavioural interventions Strategies to help people acquire the skills, motivations, and support to change diet and exercise patterns.

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

Low-quality evidence Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low-quality evidence Any estimate of effect is very uncertain.

SUBSTANTIVE CHANGES

Bariatric surgery New option added. Categorised as Unknown effectiveness as we found no RCT evidence to assess its effects.

Behavioural interventions alone No new evidence added. Existing evidence reassessed in line with new stricter inclusion criteria and one small RCT excluded. Categorisation unchanged (Unknown effectiveness).

Diet alone New evidence added. [20] [19] [28] [29] Categorisation unchanged (Unknown effectiveness) as dietary interventions assessed were too diverse to draw any conclusions.

Multifactorial interventions New evidence added. [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] Categorisation unchanged (Likely to be beneficial).

Physical activity alone New evidence added. [19] [20] [30] [31] Categorisation unchanged (Unknown effectiveness) as there remains insufficient evidence to judge this intervention alone owing to poor quality of many trials we identified.

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Disclaimer

GRADE **Evaluation of interventions for Obesity in children.**

Important outcomes			Change in overweight, Mortality, Quality of life						
Studies (Participants)	**Outcome**	**Comparison**	**Type of evidence**	**Quality**	**Consistency**	**Directness**	**Effect size**	**GRADE**	**Comment**
What are the effects of lifestyle interventions for the treatment of childhood obesity?									
at least 20 (at least 1223) [18] [19] [20] [21] [22] [23] [24] [25] [26]	Change in overweight	Multifactorial interventions versus no treatment/usual care	4	–1	0	–2	0	Very low	Quality point deducted for statistical heterogeneity in analysis. Directness points deducted for diverse interventions and comparisons
8 (455) [20] [28] [29]	Change in overweight	Dietary interventions alone versus usual care/no treatment	4	0	0	–2	0	Low	Directness points deducted for diverse interventions and comparisons
at least 17 (at least 979) [20] [19] [30] [31]	Change in overweight	Physical activity versus no treatment/usual care	4	0	0	–2	0	Low	Directness points deducted for diverse interventions and comparisons

We initially allocate 4 points to evidence from RCTs, and 2 points to evidence from observational studies. To attain the final GRADE score for a given comparison, points are deducted or added from this initial score based on preset criteria relating to the categories of quality, directness, consistency, and effect size. Quality: based on issues affecting methodological rigour (e.g., incomplete reporting of results, quasi-randomisation, sparse data [<200 people in the analysis]). Consistency: based on similarity of results across studies. Directness: based on generalisability of population or outcomes. Effect size: based on magnitude of effect as measured by statistics such as relative risk, odds ratio, or hazard ratio.