BMJ Best Practice

Obesity in children

Straight to the point of care

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Summary

Obesity in children has increased in recent decades. Causes are multi-factorial including biological, genetic disposition, behavioural and environmental influences.

Calculating body mass index (BMI) is the most widely accepted method of screening for obesity in children. Abnormal BMI cut-offs in children are determined by age- and sex-specific percentiles.

Impaired glucose tolerance and type 2 diabetes mellitus are prevalent in children with obesity.

Preventing excessive weight gain in children is of paramount importance in confronting the obesity epidemic, as obesity is difficult to treat at all ages, and children with obesity tend to become adults with obesity.

The cornerstone of treatment is lifestyle modification including dietary modification and physical activity. Pharmacotherapy and metabolic/bariatric surgery may be considered as an adjunct to lifestyle modification in youth with severe obesity.

Definition

Obesity is a condition of excessive body fat or adiposity that exceeds healthy limits.

The most widely accepted method to screen for excess adiposity is calculation of body mass index (BMI).[1] In the US, abnormal BMI cut-offs in children are determined by age- and sex-specific percentiles based on growth charts, as the amount of body fat changes with age and differs between boys and girls.[2]

An age- and sex-adjusted BMI between the 85th and 94th percentiles is defined as overweight, and a BMI ≥95th percentile (or ≥ to 30 kg/m², which ever is lower) is defined as obesity.[3][4] Severe obesity is defined as BMI of 120% of the 95th percentile.[5] [6] For children aged <2 years, BMI normative values are not available. Weight-for-height values above the 95th percentile in this age group can be categorised as overweight.[7]

The World Health Organization 2006 growth standard is recommended in many countries for children aged 0-5 years, and for children aged 0-2 years in the US. [WHO: Child growth standards.] (https://www.who.int/tools/child-growth-standards/standards)

Epidemiology

Obesity in children and adolescents is a global health issue with increasing prevalence in low-income and middle-income countries (LMICs) as well as a high prevalence in many high-income countries.[8] In 2019, the World Obesity Federation estimated there would be 206 million children and adolescents aged 5–19 years living with obesity in 2025, and 254 million in 2030.[9] In the US, data obtained from the National Health and Nutrition Examination Survey (NHANES) demonstrate that the prevalence of obesity among US children has been increasing since 1990.[5] Boys and girls are affected equally.[5]

NHANES data from 2017 to 2018 showed that 13.4% of 2- to 5-year-olds, 20.3% of children aged 6 to 11 years, and 21.2% of people aged 12 to 19 years had obesity.[10]

Non-Hispanic African-American children and Hispanic children had higher prevalence of overweight and all classes of obesity compared with other races. Asian-American children had markedly lower rates of overweight and all classes of obesity.[5] Native American and Alaska Native children have a high prevalence of severe obesity, and obesity develops at a younger age in this population.[11]

Overall estimates of childhood obesity tend to be higher in the US as compared with other countries.[5] The National Child Measurement Programme in England 2020-2021 report found obesity prevalence among 4 and 5-year-olds rose from 9.9% in 2019-2020 to 14.4% in 2020-2021. In England, data collected from mainstream state-maintained schools demonstrated that the prevalence of children aged 4-5 (those in 'reception' school classes) living with obesity in England during 2021-2022 was over twice as high in the most deprived areas (13.6%) than in the least deprived areas (6.2%). This difference was also seen in aged 10-11 (those in 'Year 6' school classes) with 31.3% living with obesity in the most deprived areas compared with 13.5% in the least deprived areas.[12] [13]

Aetiology

Obesity in children is multifactorial. Interactions among factors such as genetic predisposition, behavioural and cultural practices, biological factors, and environmental influences lead to discordant energy balance. Energy intake in excess of energy expenditure eventually leads to overweight and obesity in predisposed people.

Rapid weight gain during infancy and pre-school years has been associated with an increased risk of childhood and adolescent obesity.[14] [15] [16] Pre-school children who are overweight (BMI >85th percentile) between the ages of 24 and 54 months have a five-fold greater likelihood of being overweight at 12 years of age.[17] Children with obesity at age 8 years will tend to have more severe obesity, as well as increased morbidity, as adults.[18] [19]

Behavioural, environmental, and socio-economic changes must play an important role even in genetically predisposed children, as the prevalence of obesity in children has increased dramatically over the last 30 years despite a low likelihood of a rapid change in the genetic make-up of the population.

Many factors typically co-exist in an individual person, making it difficult to determine the impact of any one factor independently of the others on the development of obesity.

Genetic predisposition[20]

- A child's risk of obesity is increased with ≥1 parents with obesity.
- Twin studies have demonstrated that BMI and obesity are highly heritable.

- Epidemiological studies have shown that Hispanic and African-American children have a higher incidence of obesity, compared with white and Asian-American children.[5]
- Associations between BMI, physical activity, and TV/video viewing vary according to sex and race.[21]

In-utero environment[22] [23] [24] [25]

- Maternal pre-pregnancy obesity and gestational weight gain are associated with fetal macrosomia and childhood obesity.
- Maternal gestational diabetes is associated with increased newborn fat mass, higher BMI, and higher prevalence of overweight/obesity in children.
- Poor nutrition in utero has been correlated with obesity in childhood and adulthood.

Behavioural practices[26] [27] [28] [29]

- Sub optimal dietary habits leading to increased energy intake, including energy-dense foods, large portion sizes, fast food, and sugary beverages, are thought to play a role in the development of obesity.
- Children who get less exercise are at higher risk of obesity.
- Obesity risk is increased in children who have screen time (e.g., television, video games, internet) greater than 2 to 3 hours per day.
- Epidemiological studies show a link between short sleep time and development of obesity in infants, children, and adolescents.

Environmental and social influences[25]

- Technological advances have led to a decrease of physical activity.
- In addition, energy-dense foods and high-sugar beverages are easily available both in schools and in the community, and are often less costly than healthier alternatives.[30]
- Children raised in poor families have a higher risk of obesity.

Medical and pharmacotherapeutic factors[31] [32]

- Include endocrine disorders (e.g., hypothyroidism, Cushing syndrome, pseudohypoparathyroidism, hypothalamic obesity following surgery for a craniopharyngioma) and genetic syndromes (e.g., Prader-Willi syndrome, Bardet-Biedl syndrome) and mood disorders such as depression, anxiety, etc.
- Exposure to long-term corticosteroids increases the risk of obesity.
- Exposure to antibiotics or acid-suppressing medication at age <2 years has been associated with increased risk of obesity in later childhood.

Pathophysiology

Several physiological systems control how the body regulates weight. The arcuate nucleus, located in the hypothalamus, serves as the master centre of weight regulation by integrating hormonal signals that direct the body to adjust its food intake and energy expenditure.

The arcuate nucleus contains two major types of neurons with opposing actions. Activation of the peptide neurotransmitters neuropeptide Y (NPY) and agouti-related peptide (AgRP) leads to stimulation of appetite and decrease in metabolism. In contrast, activation of pro-opiomelanocortin (POMC)/cocaine and amfetamine-regulated transcript neurons causes release of melanocyte-stimulating hormone, which inhibits eating.

Short-term feeding has been linked to two peptide hormones produced in the digestive tract, ghrelin and peptide YY, which control how much and how often we eat on a given day. Ghrelin is a potent appetite

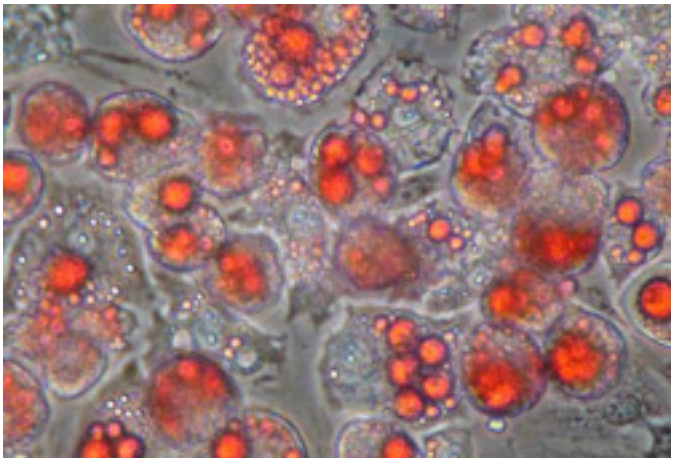
stimulator that is produced in the stomach and activates the NPY/AgRP neurons. Increased ghrelin levels are associated with meal initiation. Peptide YY may play an important role in satiety, as it activates the POMC neurons while inhibiting the NPY/AgRP neurons.

Longer-term weight regulation, over months to years, is linked to leptin and insulin.[33] Leptin is released from adipocytes and normally promotes satiety. When fat stores and leptin levels decrease, NPY/AgRP neurons are activated and POMC neurons are inhibited, thereby stimulating weight gain. The opposite occurs with increased fat mass and increased leptin levels. However, some people with obesity develop leptin and insulin resistance, reducing satiety and disrupting the homeostatic mechanisms affecting body weight.[34]

A diet high in sugar and saturated fat may induce hypothalamic inflammation and leptin resistance.[35] Visceral adipose tissue can induce and maintain local and systemic inflammation.[36] The triggers for this inflammation and its contribution to metabolic changes in obesity have not been fully elucidated.

Gut microbiota variations have been associated with weight gain and adiposity.[37]

Hedonic signals from overeating can override weight-regulating physiological mechanisms. Procuring and eating palatable food activates dopaminergic signalling in the corticolimbic system, giving a sense of reward and pleasure. This causes people to continue eating, even in the presence of satiety signals.[38]



3T3-L1 adipocytes stained with Oil Red O (ORO). ORO stains lipid droplets red

From the collection of Dianne Deplewski; used with permission

Case history

Case history #1

An 8-year-old white girl presents for further evaluation of excessive weight gain and acanthosis nigricans. She was born at term following a pregnancy complicated by gestational diabetes, and had a birth weight of 4.5 kg. Her weight was >95th percentile for height by 2 years of age and has been accelerating further away from the normal weight curve since. She has followed the 95th percentile for height. She has a large appetite with excessive calories eaten throughout the day. She has limited activity, and watches 5 to 6 hours of television daily. She had a tonsillectomy and adenoidectomy for obstructive sleep apnoea at 6 years of age. There is an extensive family history of obesity, and her father's body mass index (BMI) is 35 and mother's BMI is 45. The child's height is 143 cm, and weight 80 kg, giving her a BMI of 38.8, which is markedly greater than the 95th percentile for age and sex.

Case history #2

A 15-year-old black girl presents for evaluation of irregular periods and acne. Excessive weight gain is not a primary concern of the family, and they feel that she is simply "big-boned". However, her weight has been >97th percentile since 5 years of age, with acceleration further above the normal weight curve since. Both parents have obesity with type 2 diabetes. Her father also has hyperlipidaemia and had a myocardial infarction at 47 years of age. The child drinks at least 5 cans of regular calorie soft drinks daily and eats at fast food restaurants several times weekly. She has limited physical activity. Her height, weight, and BMI are 168 cm, 121.2 kg, and 42.8, respectively.

Other presentations

Children who have obesity associated with hormonal abnormalities (e.g., hypothyroidism, Cushing syndrome) typically present with short stature and other symptoms specific to the condition.

Children with syndromic obesity, such as Prader-Willi syndrome and Bardet-Biedl syndrome, often have developmental delay, dysmorphic features, and hypogonadism, in addition to having short stature.

Children can also present with hypothalamic obesity following treatment for intracranial lesions such as craniopharyngioma.

Approach

Diagnosis is based primarily on a thorough history and examination in conjunction with the child's body mass index (BMI). Waist circumference and skinfold thickness may be used to support the diagnosis. Imaging techniques are rarely used.

History

Many children do not present with a specific complaint of obesity or rapid weight gain; thus, screening for excess adiposity is important at all visits.

Review environmental, social, and family factors that may contribute to obesity and influence the likelihood of successful treatment.[42][57]

Children who have one or two parents with obesity are at higher risk of developing obesity, as are children who are overweight at a young age, non-Hispanic black children and Hispanic children, and children raised in families of lower socio-economic status.[5] [17][25] Maternal history of gestational diabetes, weight gain or obesity during pregnancy, or poor nutrition during pregnancy should be noted.[24] [25] The child may have been born small for gestational age.

Reviewing dietary history is important to assess potential modifiable dietary choices. Assessing daily exercise patterns is also important, as sedentary behaviour (e.g., computer/television screen time >2-3 hours/day) has been associated with obesity.[27] [28] Enquire specifically about the duration, intensity, and type of physical activity.[58]

Patients may present with symptoms of complications/comorbidities associated with obesity including:

- Headache (associated with hypertension and pseudotumor cerebri)
- Snoring or daytime somnolence (obstructive sleep apnoea)
- Abdominal pain (cholelithiasis)
- Hip pain (slipped capital femoral epiphysis)
- Polyuria or polydipsia (type 2 diabetes)
- Irregular menses and/or hirsutism (polycystic ovary disease).

A full medical and family history should also be obtained as indicated to rule out other causes of obesity due to disease such as hypothyroidism, Cushing syndrome, pseudohypoparathyroidism, and hypothalamic obesity following surgery for a craniopharyngioma.

Medication history for drugs including neuropsychiatric medications, corticosteroids, antibiotics, and acid-suppressing agents should be elicited.[31] [32] [59]

Enquire about psychosocial consequences of obesity: for example, bullying, teasing, and low self-esteem. Ask specifically about any disordered eating habits or attempts to lose/control weight. Children may use unhealthy methods such as vomiting, laxative misuse, or diet pills, in an attempt to lose or control weight.[60] Binge eating (eating large amounts in the absence of hunger) is common among children and adolescents with overweight/obesity, and is associated with increased hours of screen time.[61] Obesity increases a child's risk of anxiety and depression.[62] [63]

Children with gene mutations present with severe, early-onset obesity, usually associated with disruption of normal appetite control mechanisms.

Physical examination

Children with overweight or obesity have a higher prevalence of hypertension; thus, blood pressure should be measured.[3] [64] Acanthosis nigricans may be seen in children with obesity and is associated with insulin resistance. Acne and/or hirsutism may be associated with polycystic ovary syndrome.

Short stature associated with obesity should raise the suspicion of a hormonal abnormality as the cause of obesity (e.g., hypothyroidism, Cushing syndrome). Developmental delay, dysmorphic features, and hypogonadism in addition to short stature suggest a genetic syndrome such as Prader-Willi and Bardet-Biedl syndromes. Hypogonadism may also be present with leptin deficiency, and red hair and hypocortisolism are observed in pro-opiomelanocortin deficiency.

Indices of body fat

BMI

- The most widely accepted measure of body fat is the BMI (weight in kilograms divided by height in metres squared).[64] Accurate measurements of both height and weight are therefore very important.
- Abnormal BMI cut-offs in children are determined by age- and sex-specific percentiles based on growth charts.[2] A BMI >85th percentile is defined as overweight.[4] [64][65]
- Obesity is classified as:[3] [5] [6] [66]
    - Class 1 (BMI ≥95th percentile)
    - Class 2 (BMI 120% to 139% of the 95th percentile, or an absolute BMI of ≥35 kg/m² to <40 kg/m², whichever is the lower for age and sex)
    - Class 3 (BMI ≥140% of the 95th percentile, or an absolute BMI ≥ 40kg/m², whichever is the lower for age and sex).
- For children <2 years of age, BMI normative values are not available. Weight-for-height values above the 95th percentile in this age group can be categorised as overweight.[7]
- Although BMI is an indirect measure of body fat, it has been found to correlate with adiposity.[1] [67] However, it does not distinguish between subcutaneous and visceral fat (the latter having been shown to be associated with cardiovascular and metabolic risk factors).[68] [69] Children who are very muscular may have a BMI in the abnormal range despite having normal to low adiposity.

Waist circumference

- Waist circumference or waist-hip ratio can be used as an indirect measure of visceral adiposity (which has been shown to be associated with cardiovascular and metabolic risk factors).[68] [69]
- Measurement of waist circumference is non-invasive and may be helpful in addition to BMI to identify overweight children at a higher metabolic risk.
- Waist circumference percentiles have been developed for children aged 2 to 19 years.[2] However, the cut-off values that would indicate risk above that of BMI measurement are not available.[59]
- In adults, waist circumferences >102 cm (>40 inches) for men and >88 cm (>34 inches) for women are associated with an increased risk of metabolic problems.[70]

Growth charts can be found at the UK Royal College of Paediatrics and Child Health and the World Health Organization: [Royal College of Paediatrics and Child Health: growth charts] (https://www.rcpch.ac.uk/resources/growth-charts) The World Health Organization 2006 growth standard is recommended in many countries for children aged 0-5 years, and for children aged 0-2 years in the US. [WHO: Child growth standards.] (https://www.who.int/tools/child-growth-standards/standards)

Investigations

Investigations to screen for common complications/comorbidities:[18] [64][71]

- Fasting lipoproteins to screen for dyslipidaemia in children over the age of 10 years, with a BMI ≥85th percentile
- Fasting glucose, a 2-h plasma glucose during a 75-g oral glucose tolerance test, or haemoglobin A1c to screen for type 2 diabetes mellitus in children with obesity, or overweight and over the age of 10 years
- Liver function tests (LFTs) to screen for non-alcoholic fatty liver disease in children with obesity, or overweight and over the age of 10 years.[72] [73]

Investigations to identify medical causes of obesity depend on the patient's symptoms and presentation (e.g., short stature, fatigue, violaceous striae, hirsutism, irregular menses, dysmorphic features), but could include:

- Thyroid function tests for hypothyroidism
- Urinary free cortisol or midnight salivary cortisol for Cushing syndrome
- Serum calcium, phosphate, and parathyroid hormone for pseudohypoparathyroidism
- Hypothalamopituitary testing in hypothalamic obesity following surgery for craniopharyngioma
- Therapeutic trial of discontinuing medications suspected of causing obesity, where possible[59]
- Genetic testing in patients suspected of having:
    - Monogenic obesity
    - Bardet-Biedl syndrome
    - Prader-Willi syndrome.

Appropriate tests for the primary care physician to obtain include fasting lipoproteins, fasting glucose or haemoglobin A1c, a comprehensive metabolic panel, and thyroid function tests. The physician should consider referring the patient to a paediatric endocrinologist if any of these tests are abnormal, or if more specific tests such as urinary free cortisol, midnight salivary cortisol, pituitary hormones, or genetic testing are thought to be needed.

Comorbidities

In a review of studies, the American Academy of Pediatrics found that the prevalence of abnormal lipid values and glucose metabolism, and raised blood pressure and mean alanine transaminase varied with weight classification. It found children with overweight or obesity to be associated with greater comorbidity prevalence.[73] Overall, however, the results showed that the vast majority of children, even those with obesity, have normal values.[73]

History and exam

Key diagnostic factors

body mass index (BMI) ≥95th percentile (common)

- Most widely accepted measure of body fat (weight in kilograms divided by height in metres squared).[64]
- Accurate and replicable measurements of both height and weight are important to calculate BMI.
- Abnormal BMI cut-offs in children are determined by age- and sex-specific percentiles based on growth charts. [Royal College of Paediatrics and Child Health: growth charts] (https://www.rcpch.ac.uk/resources/growth-charts) [WHO: child growth standards] (https://www.who.int/tools/child-growth-standards/standards)
- A BMI between the 85th and 94th percentile is usually defined as overweight.[64] Obesity is classified as: class 1 (BMI ≥95th percentile); class 2 (BMI 120% to 139% of the 95th percentile, or an absolute BMI of ≥35 kg/m² to <40 kg/m², whichever is the lower for age and sex); class 3 (BMI ≥140% of the 95th percentile or an absolute BMI ≥40 kg/m², whichever is the lower for age and sex).[3] [5] [6] [66]

weight ≥95th percentile for height (common)

- For children aged <2 years, BMI normative values are not available. Weight-for-height values above the 95th percentile in this age group can be categorised as overweight.[7]

Other diagnostic factors

increased waist-hip ratio (common)

- Can be used as an indirect measure of visceral adiposity (which has been shown to be associated with cardiovascular and metabolic risk factors).[68] [69]
- Measuring waist circumference is non-invasive and may be helpful in addition to BMI to identify overweight children at a higher metabolic risk. Waist circumference percentiles have been developed for children aged 2 to 19 years.[2] However, the cut-off values that indicate risk above that of BMI measurement are not available.[59]

hypertension (common)

- Children with overweight or obesity have a higher prevalence of hypertension; thus, blood pressure should be monitored closely. Approximately 13% of overweight children have elevated systolic blood pressure, and 9% have elevated diastolic blood pressure.[64]

Risk factors

Strong

parents with obesity

- A child's risk of obesity is increased with ≥1 parents with obesity.[39]
- Maternal pre-pregnancy obesity and gestational weight gain are associated with fetal macrosomia and childhood obesity.[22] [23] In addition, maternal obesity before pregnancy, mothers who gained more weight during pregnancy and gestational diabetes are all associated with increased birth weight.[40] [41]

rapid weight gain in infancy

- Rapid weight gain during infancy has been associated with an increased risk of childhood obesity.[14] [15] [16] [42]

weight gain in early childhood

- Children who have a body mass index (BMI) >85th percentile between the ages of 24 and 54 months have a 5-fold greater likelihood of being overweight at age 12 years.[17]
- Children with obesity at age 8 years will tend to have more severe obesity, as well as increased morbidity, as adults.[18] [19]

non-Hispanic black or Hispanic ethnicity

- Epidemiological studies have shown that Hispanic children and African-American children have a higher incidence of obesity, compared with white and Asian-American children.[5]
- Associations between BMI, physical activity, and TV/video viewing vary according to sex and race.[21]

poor socioeconomic status

- Children raised in poor families have a higher risk of obesity.[12] [13] [25] [42]

sedentary lifestyle

- Children who get less exercise are at higher risk of obesity.[27] [43]

Weak

intrauterine growth restriction

- Poor nutrition in utero has been correlated with obesity in childhood and adulthood.[25]

maternal gestational diabetes

- Maternal gestational diabetes is associated with increased newborn fat mass, higher BMI, and higher prevalence of overweight/obesity in children.[24]

diet high in energy-dense foods, fast foods, and high-sugar beverages

- Implicated as a risk factor for the development of obesity in children.[44] The impact of other factors such as specific eating patterns (eg, frequent snacking, skipping breakfast), portion sizes, eating speed, and glycaemic load on obesity development is still not clear but may be a factor.[44] However, dietary choices alone do not consistently lead to obesity.

screen time >2-3 hours/day

- Obesity risk is increased in children who have daily screen time (e.g., television, video games, internet) >2-3 hours per day.[28] Screen exposure influences risk of obesity in children and adolescents via increased exposure to food marketing, increased thoughtless eating while watching screens, displacement of time spent in physical activities, reinforcement of sedentary behaviours, and reduced sleep time.[45] [46]

sleep deprivation

- Epidemiological studies show a link between short sleep time and development of obesity in infants, children, and adolescents.[8] [29]

exposure to corticosteroids, antibiotics, or acid-suppressing medication

- Exposure to long-term corticosteroids increases the risk of obesity.[31]
- Exposure to antibiotics or acid-suppressing medication at age <2 years has been associated with increased risk of obesity in later childhood.[32]

urban environment

- One systematic study of many exposures in the urban environment suggests that an exposure pattern characterised by higher levels of ambient air pollution, road traffic and road traffic noise is associated with increased childhood obesity risk.[47]

maternal smoking in pregnancy

- There is an association between maternal prenatal smoking and childhood overweight and obesity.[42] [48]

maternal consumption of ultra-processed foods

- Maternal consumption of ultra-processed food during the child rearing period was found to be associated with an increased risk of overweight or obesity in offspring.[49]

Investigations

Other tests to consider

Test	Result
fasting blood glucose • To screen for type 2 diabetes mellitus. • The American Diabetes Association recommends that children >10 years of age (or at onset of puberty, if it begins at an earlier age) with a body mass index (BMI) >85th percentile plus one or more other risk factors (e.g., family history of type 2 diabetes in a first- or second-degree relative, non-white race, and/or conditions associated with insulin resistance such as acanthosis nigricans, polycystic ovary syndrome, hypertension, dyslipidaemia, small for gestational age, or maternal history of diabetes or gestational diabetes mellitus during the child's gestation) should have a fasting blood glucose test, a 2 hour plasma glucose during a 75 g oral glucose tolerance test, or haemoglobin A1c. Screening should be conducted at a minimum of every 3 years or more frequently if BMI is increasing, or risk factor profile is deteriorating.[74]	**normal, or impaired glucose tolerance (5.6-6.9 mmol/L [100-125 mg/dL]), or diabetic (≥7 mmol/L [≥126 mg/dL])**
serum lipids • To screen for dyslipidaemia. • All children should be screened for lipid abnormalities with a non-fasting, non-HDL cholesterol level between ages 9 to 11 years and 17 to 21 years.[71] • A fasting lipid panel should be obtained in children with a BMI ≥85th percentile.[18] • Lipid abnormalities in children often persist into adulthood.[71] • Cut-off values are as follows.[71] Normal: cholesterol <4.40 mmol/L (<170 mg/dL), LDL <2.85 mmol/L (<110 mg/dL); borderline: cholesterol 4.40 to 5.15 mmol/L (170-199 mg/dL), LDL 2.85 to 3.34 mmol/L (110-129 mg/dL); elevated: cholesterol >5.18 mmol/L (>200 mg/dL), LDL >3.37 mmol/L (>130 mg/dL).	**normal or elevated**
liver function tests • To screen for non-alcoholic fatty liver disease, as most patients will be asymptomatic. • Children >10 years of age with a BMI ≥95th percentile, or with a BMI ≥85th percentile and other risk factors, should be screened twice a year with a serum alanine aminotransferase (ALT).[72] • Children should be referred to a hepatologist if ALT or AST is ≥2 times the upper limit of normal.[64]	**normal or elevated transaminases**

Emerging tests

Test	Result
DEXA • Can be used to assess total body fat. • Use of this method is limited by the expense of the method and the inability to distinguish between subcutaneous and visceral fat. • It is used mainly in the research setting.	**elevated for age and sex**
bioelectric impedance analysis • A non-invasive and relatively inexpensive assessment of body composition. However, measurements are highly variable, as they are affected by the patient's hydration status.[75]	**elevated for age and sex**
abdominal CT or MRI • Can be used to accurately measure visceral fat.[76] However, these methods are costly, and should only be done in the research setting.	**increased visceral fat**

Differentials

Condition	Differentiating signs / symptoms	Differentiating tests
Primary hypothyroidism	• Fatigue. • Attenuated growth. • Cold intolerance. • Constipation. • Declining school performance. • Dry skin. • Coarse hair. • Goitre.	• Free T4 will be low for age. • Thyroid-stimulating hormone (TSH, also known as thyrotropin) will be elevated for age.
Secondary hypothyroidism	• Fatigue. • Poor growth. • Cold intolerance. • Constipation. • Dry skin. • Coarse hair.	• Free T4 will be low for age. • Thyroid-stimulating hormone (TSH, also known as thyrotropin) will be low or normal for age.
Cushing syndrome	• Attenuated growth. • Violaceous striae. • Buffalo hump. • Central adiposity. • Moon facies. • Hirsutism. • Hypertension. • Diabetes.	• The 24-hour urinary free cortisol or midnight salivary cortisol is elevated for age.
Prader-Willi syndrome	• Short stature. • Small hands and feet. • Almond-shaped eyes. • Picking on skin. • Delayed puberty. • Developmental delay. • Hyperphagia. • History of poor feeding and hypotonia as infant.	• Genetic testing shows imprinting error on chromosome 15q11-q13.
Bardet-Biedl syndrome	• Dysmorphic extremities. • Retinitis pigmentosa. • Developmental delay. • Hypogonadism. • Renal defects.	• Mutations in several different genes have been linked to Bardet-Biedl syndrome.[77]
Pseudohypoparathyroidism	• Short stature. • Round face. • Short metacarpals. • Developmental delay. • Basal ganglia calcification.	• Serum calcium levels show hypocalcaemia. • Serum phosphate levels show hyperphosphataemia. • Serum parathyroid hormone level is elevated.
Monogenic obesity	• Severe, early-onset obesity.	• Genetic testing identifies gene mutation in candidate genes such as leptin, ghrelin, adiponectin, peptide

Condition	Differentiating signs / symptoms	Differentiating tests
	• Usually associated with disruption of normal appetite control mechanisms.	YY(3-36), and melanocortin 4 receptor (MC4-R).[3][78] • Mutations in MC4-R are the most common cause in children, occurring in approximately 5% of cases.[79] • The obesity gene map database and the National Institutes of Health and Centers for Disease Control and Prevention database of association studies can be used as a source of candidate genes: [National Institute on Aging: genetic association database] (https://geneticassociationdb.nih.gov)
Hypothalamic obesity	• Severe obesity following treatment for intracranial lesions such as craniopharyngioma. • Excessive appetite.	• Abnormal hypothalamopituitary testing.
Obesity due to medication	• Several classes of medication can be associated with weight gain, including neuropsychiatric medications, (eg, risperidone, olanzapine, clozapine)., anti-epileptics (eg, sodium valproate), insulin, corticosteroids, antibiotics, and acid-suppressing agents.[31] [32] [59]	• Discontinuation of drug as a therapeutic trial.
Lipoedema	• Lipoedema is a condition characterised by swelling and enlargement of the lower limbs due to abnormal deposition of subcutaneous fat often dismissed as simple obesity. In addition, easy bruising and pain with soft tissue pressure, as well as the step-off at the ankles are hallmark symptoms.[80] Disease onset is usually at or soon after puberty but can develop at other times of hormonal change	• Lipoedema is diagnosed based on the symptoms and clinical examination. Imaging studies, such as CT and MRI may be useful in clinical examination. Patients with lipedema demonstrate diffuse fatty hypertrophy throughout the bilateral lower extremities without skin abnormalities on MRI and CT imaging. [NIH: Genetic and Rare Diseases Information Center: Lipedema] (https://rarediseases.info.nih.gov/

Condition	Differentiating signs / symptoms	Differentiating tests
	(such as pregnancy or even menopause).[81]	diseases/10542/lipedema) [82]

Criteria

Body mass index (BMI) percentiles based on age and sex

The following classification may be used in children >2 years of age based on BMI percentiles for specific age and sex:[64]

- Underweight: <5th percentile
- Normal weight: 5th to 84th percentile
- Overweight: 85th to 94th percentile
- Obesity: ≥95th percentile.

Obesity is further classified as:[3] [5] [6] [66]

- Class 1 (BMI ≥95th percentile)
- Class 2 (BMI 120% to 139% of the 95th percentile, or an absolute BMI of ≥35 kg/m² to <40 kg/m², whichever is the lower for age and sex)
- Class 3 (BMI ≥140% of the 95th percentile, or an absolute BMI ≥40 kg/m², whichever is the lower for age and sex).

For children aged <2 years, BMI normative values are not available. Weight-for-height values above the 95th percentile in this age group can be categorised as overweight.[7] The World Health Organization 2006 growth standard is recommended in many countries for children aged 0-5 years, and for children aged 0-2 years in the US. [WHO: Child growth standards.] (https://www.who.int/tools/child-growth-standards/standards)

Screening

Many children do not present with a complaint of obesity or rapid weight gain. It is therefore important that all children be screened for obesity risk with calculation and plotting of body mass index (BMI) on an annual basis, especially those with a family history of obesity or those with a history of intrauterine growth restriction.[83]

The UK Royal College of Paediatrics and Child Health recommends universal height and weight monitoring for children from birth to leaving secondary school.[84]

Children and their families should be informed of healthy eating and activity habits at a young age in the hopes of preventing a condition that is difficult to treat at any age and that often persists into adulthood.

Approach

Effective treatment strategies for childhood obesity are important, since children with obesity tend to become adults with obesity, and they have significant health risks related to the obesity.[39][59] While still growing, some overweight children may be able to maintain or reduce their rate of weight gain, thereby allowing normal growth and development while lowering their BMI percentile.

Treatment modalities include healthy lifestyle modifications (e.g., dietary changes, increases in physical activity, and decreases in sedentary behaviours), pharmacotherapy, and metabolic/bariatric surgery.[3] [59] [85][86][87] There is evidence that more intensive interventions such as pharmacotherapy and metabolic/bariatric surgery are more effective.[85] [88][89]

The American Academy of Pediatrics (AAP) recommends that medications should be offered to adolescents 12 years or over with obesity, in line with indication and risks, alongside lifestyle and behaviour treatment. The use of medications can also be considered in children with obesity 8-11 years with other risk factors, however evidence is currently insufficient in children under 12 years.[3]

The AAP also outline criteria for consideration for paediatric metabolic and bariatric surgery as a BMI of ≥40 kg/m² or 140% of the 95th centile for age and sex (whichever is lower), or if there are comorbid conditions a BMI ≥35 kg/m² or 120% of the 95th centile for age and sex (whichever is lower); age is not included as a sole determinant of eligibility for surgery but data is limited in the younger age group and therefore additional research is needed particularly for recommendations to be made for children aged 12 years and younger.[3]

Although research into obesity in children is growing, there remain many barriers to delivery of effective obesity treatment. One review of Cochrane reviews found that interventions for treating children and adolescents with overweight and obesity were less likely to be undertaken in culturally diverse populations, in those with complex health needs or disabilities, nor in those living with social disadvantage, all of which might make adherence to standard therapies more challenging.[90] This should be taken into consideration when considering the individual management of patients. Additionally interventions should be financially sustainable, and should utilise innovative strategies in order to keep children and their families engaged throughout the process.[85]

Lifestyle modification

Lifestyle modification is one of the cornerstone treatments for all children with a body mass index (BMI) ≥85th percentile.[3]

Lifestyle modification includes education around diet and physical activity, plus behavioural therapy, so that children and their families can make and sustain changes.[3] [57][91]

Lifestyle interventions lead to significant weight loss and improved cardiometabolic parameters, compared with no treatment: BMI (-1.25 kg/m², 95% confidence interval [CI] -2.18 to -0.32) and BMI z score (-0.10, 95% CI -0.18 to -0.02).[87]

Intensity of lifestyle modification treatment is variable but the main factor found to contribute to effectiveness is the intensity (or dose) of the intervention, measured in hours of face-to-face contact. The number of hours delivered is directly proportional to the likelihood that a child will experience a reduction in BMI.[3] For example, the US Preventive Services Task Force found that ≥52 hours per year was associated with a difference in change in BMI z-score from baseline of -0.31, while 26 to 51 hours was associated with a difference in change in BMI z-score from baseline of -0.17 (this was 0.01 for 6 to

25 hours and -0.09 for 1 to 5 hours, respectively).[83] It may be delivered through regularly scheduled visits in primary care, with assistance from dieticians and clinicians with experience in behaviour change/motivational interviewing, or through weekly visits to a dedicated paediatric weight management team, or as an in-hospital/residential programme. Escalation to more intensive weight management programmes depends on the child's age, response to treatment, risk factors, and motivation, among others.[3]

In-hospital lifestyle modification programmes may be effective for children with obesity susceptibility gene loci, indicating the importance of addressing environmental, social, and behavioural factors.[92]

It is imperative that the parents and family also adopt healthy lifestyle habits and shared decision making for the child to have success with weight maintenance or weight loss.[3] [93]

Diet

Children should be encouraged to eliminate sugar-sweetened beverages, decrease portion sizes, and limit both energy-dense and fast foods.[3] [59] [94][95][96] [97] [98] Eliminating sugar-sweetened beverages drinks from the diet has been shown to significantly reduce caloric intake and obesity.[3] [96]

Diets rich in fruits and vegetables should be suggested, and healthy food choices should be offered in the school.[95] Family meals should be encouraged. More frequent family meals are associated with a higher intake of fruits and vegetables, and a lower intake of fast food and take-away food, in US adolescents.[99] If possible, unhealthy foods should be removed from the home.

US nutritional guidelines encourage all children to consume nutrient-dense foods, including fruits, vegetables, wholegrains, beans, peas, lentils, eggs, seafood, unsalted nuts and seeds, fat-free and low-fat dairy products, and lean meats (prepared without added sugar, salt, and saturated fats).[98]

Advise regular meals to avoid grazing and snacking, and provide education on portion control.[91]

Physical activity

Children should be encouraged to get at least 60 minutes of physical activity per day.[3] [94][98][100] The activity should be age appropriate and fun for the child, to encourage compliance.[58] Play activities such as climbing or playing catch or tag are encouraged. Physical activity improves cardiovascular fitness, muscle fitness, weight status, and bone health. It has additional benefits for cognition and behaviour: increased physical activity has been associated with better academic performance, reduced risk of smoking, and reduced risk of depressive symptoms.[58]

Family involvement in promoting physical activity is encouraged. Parents and carers have an essential role in modelling healthy behaviours and setting realistic goals.[58]

Television viewing and other discretionary screen time (e.g., computer and video games, internet) should be limited. The American Academy of Pediatrics recommends no media use in children under the age of 18 months, a 1 hour limit for ages 2-5 years old and a parent-monitored plan for media use in older children.[3] The American Heart Association recommends:[101]

- Removing screens from bedrooms and during meals
- Encouraging daily device-free social interactions and outdoor play
- Supporting parents to enforce limitations on screen time and to set a healthy example of screen-based behaviour.

Children with obesity often experience personal barriers to movement and exercise, including mobility barriers. Therefore, tailoring and adapting paediatric exercise interventions will often be necessary, particularly for those that report musculoskeletal pain, high rates of fatigue, urinary incontinence, skin chafing, or have impaired motor skills or other conditions (e.g., muscular dystrophy, immobility, etc).[8]

Behavioural therapy

Support to make and sustain changes in the child's and family's behaviour is a key component of lifestyle modification.[3] [57][91]

Components of behavioural therapy may include:[3] [8] [57][91]

- Identifying eating cues such as boredom, stress, loneliness, or screen time
- Goal setting
- Rewards for reaching goals
- Self-monitoring behaviour
- Involving parents/carers in modelling desired behaviours.

There is moderate-quality evidence that multidisciplinary interventions, combining diet, physical activity, and behavioural components, reduce weight in adolescents who are overweight or have obesity, compared with no intervention or usual care.[102]

The effect of family- and parent-based weight loss treatments on child weight loss were compared in a randomised trial of 150 children with obesity or who were overweight (8 to 12 years old) and their parents, over a period of 24 months. Weight loss treatment was delivered in 20 one-hour group meetings with 30-minute individualised behavioural coaching sessions over 6 months, with or without the child present. Parent-based treatment was shown to be non-inferior to family-based weight loss treatment.[103]

Motivational interviewing

A patient-centered counselling style which focuses on shared decision making and the patients' self identified motivations for change, in contrast with a more traditional healthcare professional led approach. It aims to result in a particular behaviour change, such as reducing intake of a particular food or having more meals together as a family. Motivational interviewing consists of four processes:

1. Engaging: establishing a relationship and collaborative role; understanding patient issues
2. Focussing: identifying appropriate strategies to change weight
3. Evoking: highlighting motivations for change; empowering patients to make change
4. Planning: completing effective plans for change; appropriately managing relapse

Psychosocial comorbidities

Associated psychosocial problems (e.g., bullying, teasing, low self-esteem) or psychiatric conditions (e.g., anxiety, depression) should be sought and treated.[91]

Pharmacotherapy

Following conservative measures, treatment may include medication, with ongoing intensive lifestyle modification support. The American Academy of Pediatrics (AAP) recommends that pharmacotherapy should be offered to adolescents 12 years and over with obesity, in line with indication and risks, alongside lifestyle and behaviour treatment. The use of medications can also be considered in children with obesity 8-11 years with other risk factors, however evidence is insufficient in children under 12 years.[3]

Orlistat

- Inhibits fat absorption through the inhibition of enteric lipase, and is approved for children ≥12 years of age.[104]
- In clinical trials of orlistat in adolescents, BMI change ranged from -0.55 kg/m² up to -4.09 kg/m².[105]
- Adverse effects include steatorrhoea, faecal urgency, and flatulence, which limits its use in children.[3]

Liraglutide

- Glucagon-like peptide-1 (GLP-1) agonists decrease hunger by delaying gastric emptying and by acting on targets in the central nervous system.
- Liraglutide is approved in the US and Europe for chronic weight management in children 12 years and older with obesity (i.e., body weight above 60 kg and an initial BMI corresponding to ≥30 kg/m² for adults by international cut-offs), in addition to a reduced-calorie diet and increased physical activity.
- One randomised controlled trial found that liraglutide plus lifestyle therapy is more effective for weight loss than placebo plus lifestyle therapy.[106] In the study of 251 adolescents with obesity, conducted over 3 years, 43% of participants in the liraglutide plus lifestyle therapy group achieved a 5% reduction in body mass index (BMI), and 21% achieved a 10% reduction in BMI. In the placebo plus lifestyle therapy group, 19% of participants achieved a 5% reduction in BMI, and 8% achieved a 10% reduction in BMI.[106]

Semaglutide

- Another GLP-1 agonist which is approved in the US and Europe for chronic weight management in children 12 years and older with an initial BMI ≥95th percentile for age and sex as an adjunct to diet and exercise.
- A phase 3 clinical trial including 201 participants (all except one with BMI ≥95th percentile) demonstrated a 16% decrease in BMI in treated participants as compared to the placebo group after 68 weeks. At the end of the study, 73% of those treated with semaglutide lost at least 5% of their starting body weight.[107]
- Common adverse effects include nausea, vomiting, and diarrhoea.

Metformin

- Metformin inhibits hepatic gluconeogenesis and is commonly used in the treatment of type 2 diabetes mellitus (DM) in children 10 years and older. The evidence for effectiveness of metformin for weight loss in children is conflicting and is not approved for the treatment of obesity in children.[3] Some studies demonstrate the benefit of adding metformin in mitigating the weight gain seen in children and adolescents.[88][108] Those studies that did demonstrate effect typically included higher doses, more intensive lifestyle adjunct treatment and use in children with more severe obesity and/or a secondary diagnosis.[3]
- One systematic review investigated the efficacy of metformin in treating obesity in children without type 2 DM. At 6 months, children prescribed metformin experienced an average BMI reduction of -1.38 kg/m² (95% CI -1.93 kg/m² to -0.83 kg/m²). However, reduction in BMI was considered to be modest, and metformin was not clinically superior to other options for treating childhood obesity.[109]

- A subsequent randomised controlled trial reported a decrease in BMI with metformin, compared with placebo, in pre-pubertal children, but not in pubertal children.[110] Further, larger studies are required.
- The AAP suggests that metformin can be considered as an adjunct to intensive health behaviour and lifestyle treatment when other indications for use of metformin are present.[3]

Phentermine/topiramate

- Phentermine is an anorectic that decreases appetite and topiramate is an anticonvulsant with weak carbonic anhydrase inhibitor activity that induces weight loss. Although the precise mechanism of action in weight loss is currently unknown, it has been hypothesised to be secondary to dopamine, GABA and glutamate alterations.[111] [112]
- The combination of phentermine/topiramate is approved in the US for the treatment of obesity in adolescents (12-17 years old) with an initial BMI in the 95th percentile or greater standardised for age and sex.
- A study of the pharmacokinetic and pharmacodynamic properties of a fixed-dose combination of phentermine/topiramate conducted in adolescents with obesity demonstrated statistically significant weight loss.[113] [114] However, adverse effects include depression and difficulties with concentration and memory, which may limit its usefulness in adolescents. Topiramate can cause fetal harm in pregnant women, and has been demonstrated to show an increase in oral clefts with first trimester exposure to topiramate.[115] The European Medicines Agency has refused a marketing authorisation for phentermine/topiramate.

Metabolic/bariatric surgery

Treatment for children with severe obesity may include bariatric surgery, with ongoing intensive lifestyle modification support with or without medication.

Guidelines suggest that surgery is considered in children with BMI ≥40, or BMI ≥35 with clinically significant comorbidities.[3] [116] Clinically significant comorbidities include: obstructive sleep apnoea, type 2 diabetes mellitus, idiopathic intracranial hypertension, non-alcoholic fatty liver disease, Blount's disease, slipped capital femoral epiphysis, GORD, and hypertension.[116]

Surgery does not negatively impact pubertal development, and therefore a specific Tanner stage and bone age should not be considered a requirement for surgery.[117]

Numerous risk factors associated with cardiovascular disease have been shown to improve among adolescents with severe obesity undergoing bariatric surgery. Increased weight loss, female sex, and younger age predict a higher probability of resolution of specific cardiovascular risk factors.[118] Clarifying predictors of change in these risk factors may help identify patients and optimise the timing of adolescent bariatric surgery to improve clinical outcomes.[118]

One study that modelled the effect of adolescents with or without a psychiatric diagnosis found no association between preoperative psychiatric diagnoses and postsurgical weight loss outcomes.[119] The results of this study suggest that psychiatric problems should not necessarily be a contraindication to surgery. Bariatric surgery has been associated with improvement in quality of life and depression.[120]

The surgical approaches used most often are the Roux-en-Y gastric bypass and vertical sleeve gastrectomy - also known as laparoscopic sleeve gastrectomy.[116] One prospective cohort study found that long-term follow-up (7 to 10 years) after vertical sleeve gastrectomy in children and adolescents demonstrates durable weight loss, maintained comorbidity resolution, and unaltered growth.[121] Surgery

should only be performed by an experienced surgeon who works with a team capable of following the patient for long-term nutritional or psychosocial issues.

Outcomes of bariatric surgery in the adolescent population are being studied vigorously.[122][123]

Overweight children (BMI ≥85th to 94th percentile)

All children and their families should be supported to make lifestyle modifications.[3] [57] [91]

Children who have remained at the same BMI percentile over several years, and who do not have other medical risks or family history of obesity, may be at lower risk of excess body fat, as BMI is only an indirect measure of adiposity. The goal of treatment is weight velocity maintenance (or weight maintenance after linear growth is complete) and close assessment for increasing BMI percentiles or development of other risk factors.[64]

Children with additional risk factors (e.g., family history of type 2 diabetes, non-white race, and/or conditions associated with insulin resistance such as acanthosis nigricans, polycystic ovary syndrome, hypertension, or dyslipidaemia) should receive more intensive lifestyle modification therapy.

Age <6 years[64] [86]

- The goal of treatment is weight maintenance or slow weight gain
- Healthcare professionals should treat overweight comorbidities concurrently
- Motivational interviewing is recommended
- Intensive health behaviour and lifestyle treatment should be considered. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.

Age 6 to 12 years[64] [86]

- The goal of treatment is weight maintenance
- Healthcare professionals should treat overweight comorbidities concurrently
- Motivational interviewing is recommended
- Intensive health behaviour and lifestyle treatment is recommended. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.

Age 12 to 18 years[64] [86]

- The goal of treatment is weight maintenance or gradual weight loss
- Healthcare professionals should treat overweight comorbidities concurrently
- Motivational interviewing is recommended
- Intensive health behaviour and lifestyle treatment is recommended. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.

Children with obesity (BMI ≥95th percentile) and children with severe obesity (BMI ≥120% of 95th percentile)

All children and their families should be supported to make lifestyle modifications.[3] [57] [91] Escalation to more intensive weight management programmes depends on the child's age, response to treatment, risk factors, and motivation among others.[3]

Age <6 years[64] [86]

- The goal of treatment is weight maintenance (weight loss of up to 1 lb/month or 0.5 kg/month may be acceptable if BMI is 21 or 22 kg/m²)

- Healthcare professionals should treat overweight comorbidities concurrently
- Motivational interviewing is recommended
- Intensive health behaviour and lifestyle treatment should be considered. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months

Age 6 to 12 years[64] [86]

- The goal of treatment is gradual weight loss (1 lb/month or 0.5 kg/month)[64]
- Healthcare professionals should treat overweight comorbidities concurrently
- Motivational interviewing is recommended
- Intensive health behaviour and lifestyle treatment should be recommended. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.

Age 12 to 18 years[64] [86]

- The goal of treatment is weight loss not to exceed 0.9 kg (2 lb) per week.[64]
- Children with an inadequate weight response should be referred for tertiary care interventions, which may include medications and/or other interventions.[124]
- Healthcare professionals should treat overweight comorbidities concurrently
- Motivational interviewing is recommended
- Intensive health behaviour and lifestyle treatment should be recommended. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months
- Weight loss pharmacotherapy is recommended. It should be utilised according to risks and benefits, as an adjunct to behaviour and lifestyle treatment
- A referral to comprehensive paediatric metabolic and bariatric surgery programmes should be made, to local or regional centres. A referral does not necessarily mean the child will have surgery but provides opportunity for additional evaluation of risks and benefits, and provision of further information to families to make an informed decision.

Treatment algorithm overview

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Ongoing (summary)		
body mass index (BMI) ≥85th to 94th percentile (overweight)		
	1st	**lifestyle modification and treatment of comorbidities**
	plus	**motivational interviewing**
	adjunct	**intensive health behaviour and lifestyle treatment**
body mass index (BMI) ≥95th percentile (obesity) or BMI ≥120% of 95th percentile (severe obesity)		
age 2-11 years	**1st**	**lifestyle modification and treatment of comorbidities**
	plus	**motivational interviewing**
	adjunct	**intensive health behaviour and lifestyle treatment**
age 12-18 years	**1st**	**lifestyle modification and treatment of comorbidities**
	plus	**motivational interviewing**
	plus	**intensive health behaviour and lifestyle treatment**
	adjunct	**pharmacotherapy**
	adjunct	**specialist referral for consideration of surgery**

Treatment algorithm

Please note that formulations/routes and doses may differ between drug names and brands, drug formularies, or locations. Treatment recommendations are specific to patient groups: see disclaimer

Ongoing

body mass index (BMI) ≥85th to 94th percentile (overweight)

1st **lifestyle modification and treatment of comorbidities**

» Lifestyle modification is one of the cornerstone treatments for all children with a body mass index (BMI) ≥85th percentile.

» In children <6 years the goal of treatment is weight maintenance or to slow weight gain. In children 6-12 years the goal is weight maintenance, and in children 12-18 years the goal is weight maintenance or gradual weight loss.[64]

» Lifestyle modification includes education around diet and physical activity, plus behavioural therapy, so that children and their families can make and sustain changes.[3] [57] [91] Lifestyle interventions lead to significant weight loss and improved cardiometabolic parameters, compared with no treatment: BMI (-1.25 kg/m², 95% confidence interval [CI] -2.18 to -0.32) and BMI z score (-0.10, 95% CI -0.18 to -0.02).[87]

» Intensity of lifestyle modification treatment is variable but the main factor found to contribute to effectiveness is the intensity (or dose) of the intervention, measured in hours of face-to-face contact. The number of hours delivered is directly proportional to the likelihood that a child will experience a reduction in BMI.[3] For example, the US Preventive Services Task Force found that ≥52 hours per year was associated with a difference in change in BMI z-score from baseline of -0.31, while 26 to 51 hours was associated with a difference in change in BMI z-score from baseline of -0.17 (this was 0.01 for 6 to 25 hours and -0.09 for 1 to 5 hours, respectively).[83] It may be delivered through regularly scheduled visits in primary care, with assistance from dieticians and clinicians with experience in behaviour change/motivational interviewing, or through weekly visits to a dedicated paediatric weight management team, or as an in-hospital/residential programme. Escalation to more intensive weight management programmes depends on the child's age, response to

Ongoing

treatment, risk factors, and motivation, among others.[3] In-hospital lifestyle modification programmes may be effective for children with obesity susceptibility gene loci, indicating the importance of addressing environmental, social, and behavioural factors.[92]

» It is imperative that the parents and family also adopt healthy lifestyle habits and shared decision making for the child to have success with weight maintenance or weight loss.[93]

» Diet: children should be encouraged to eliminate sugar-sweetened beverages, decrease portion sizes, and limit both energy-dense and fast foods.[59] [94][96] [97] [98] Eliminating sugar-sweetened beverages from the diet has been shown to significantly reduce caloric intake and obesity.[3][96] Diets rich in fruits and vegetables should be suggested, and healthy food choices should be offered in the school. Family meals should be encouraged. More frequent family meals are associated with a higher intake of fruits and vegetables, and a lower intake of fast food and take-away food, in US adolescents.[99] If possible, unhealthy foods should be removed from the home.

» US nutritional guidelines encourage all children to consume nutrient-dense foods, including fruits, vegetables, wholegrains, beans, peas, lentils, eggs, seafood, unsalted nuts and seeds, fat-free and low-fat dairy products, and lean meats (prepared without added sugar, salt, and saturated fats).[98]

» Advise regular meals to avoid grazing and snacking, and provide education on portion control.[91]

» Physical activity: children should be encouraged to get at least 60 minutes of physical activity per day.[94][98][100] The activity should be age appropriate and fun for the child, to encourage compliance. Play activities such as climbing or playing catch or tag are encouraged.[58] Family involvement in promoting physical activity is encouraged. Parents and caregivers have an essential role in modeling healthy behaviors and setting realistic goals.[58] Television viewing and other discretionary screen time (e.g., computer and video games, internet) should be limited. The American Academy of Pediatrics recommends no media use in children under the age of 18 months, a 1 hour limit for ages 2-5 years old and a parent-monitored plan for media use in older children.[3] The American Heart Association

Ongoing

recommends: removing screens from bedrooms and during meals; encouraging daily, device-free social interactions and outdoor play; and supporting parents to enforce limitations on screen time, and set an example of healthy screen-based behaviour.[101] Children with obesity often experience personal barriers to movement and exercise, including mobility barriers. Therefore, tailoring and adapting paediatric exercise interventions will often be necessary, particularly for those that report musculoskeletal pain, high rates of fatigue, urinary incontinence, skin chafing, or have impaired motor skills or other conditions (e.g., muscular dystrophy, immobility, etc).[8]

» Comorbidities should be treated concurrently.[86] Associated psychosocial problems (e.g., bullying, teasing, low self-esteem) or psychiatric conditions (e.g., anxiety, depression) should be sought and treated.[91]

plus **motivational interviewing**

Treatment recommended for ALL patients in selected patient group

» A patient-centered counselling style which focuses on shared decision making and the patients' self identified motivations for change, in contrast with a more traditional healthcare professional led approach. It aims to result in a particular behaviour change, such as reducing intake of a particular food or having more meals together as a family.

» Motivational interviewing consists of four processes: (1) engaging - establishing a relationship and collaborative role; understanding patient issues; (2) focussing - identifying appropriate strategies to change weight; (3) evoking - highlighting motivations for change; (4) empowering patients to make change; planning - completing effective plans for change; appropriately managing relapse.

adjunct **intensive health behaviour and lifestyle treatment**

Treatment recommended for SOME patients in selected patient group

» Intensive health behaviour and lifestyle treatment should be considered in children <6 years of age, and is recommended in children 6 years of age and older. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.[86]

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body mass index (BMI) ≥95th percentile (obesity) or BMI ≥120% of 95th percentile (severe obesity)

age 2-11 years — **1st**

lifestyle modification and treatment of comorbidities

» Lifestyle modification is one of the cornerstone treatments for all children with obesity.

» In children <6 years the goal of treatment is weight maintenance (weight loss of up to 1 lb/month or 0.5 kg/month may be acceptable if BMI is 21 or 22 kg/m²). In children 6-12 years the goal is gradual weight loss (1 lb/month or 0.5 kg/month).[64]

» Lifestyle modification includes education around diet and physical activity, plus behavioural therapy, so that children and their families can make and sustain changes.[3] [57] [91] Lifestyle interventions lead to significant weight loss and improved cardiometabolic parameters, compared with no treatment.[87]

» Intensity of lifestyle modification treatment is variable but the main factor found to contribute to effectiveness is the intensity (or dose) of the intervention, measured in hours of face-to-face contact. The number of hours delivered is directly proportional to the likelihood that a child will experience a reduction in BMI.[3] For example, the US Preventive Services Task Force found that ≥52 hours per year was associated with a difference in change in BMI z-score from baseline of -0.31, while 26 to 51 hours was associated with a difference in change in BMI z-score from baseline of -0.17 (this was 0.01 for 6 to 25 hours and -0.09 for 1 to 5 hours, respectively).[83] It may be delivered through regularly scheduled visits in primary care, with assistance from dieticians and clinicians with experience in behaviour change/motivational interviewing, or through weekly visits to a dedicated paediatric weight management team, or as an in-hospital/residential programme. Escalation to more intensive weight management programmes depends on the child's age, response to treatment, risk factors, and motivation among others.[3]

» In-hospital lifestyle modification programmes may be effective for children with obesity susceptibility gene loci, indicating the importance

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of addressing environmental, social, and behavioural factors.[92]

» It is imperative that the parents and family also adopt healthy lifestyle habits and shared decision making for the child to have success with weight maintenance or weight loss.[93]

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Ongoing

limitations on screen time, and set an example of healthy screen-based behaviour.[101] Children with obesity often experience personal barriers to movement and exercise, including mobility barriers. Therefore, tailoring and adapting paediatric exercise interventions will often be necessary, particularly for those that report musculoskeletal pain, high rates of fatigue, urinary incontinence, skin chafing, or have impaired motor skills or other conditions (e.g., muscular dystrophy, immobility, etc).[8]

» Comorbidities should be treated concurrently.[86] Associated psychosocial problems (e.g., bullying, teasing, low self-esteem) or psychiatric conditions (e.g., anxiety, depression) should be sought and treated.[3]

plus **motivational interviewing**

Treatment recommended for ALL patients in selected patient group

» A patient-centered counselling style which focuses on shared decision making and the patients' self identified motivations for change, in contrast with a more traditional healthcare professional led approach. The objective is not to set and achieve a particular goal. Rather, it aims to result in a particular behaviour change, such as reducing intake of a particular food or having more meals together as a family.

» Motivational interviewing consists of four processes: (1) engaging - establishing a relationship and collaborative role; understanding patient issues; (2) focussing - identifying appropriate strategies to change weight; (3) evoking - highlighting motivations for change; (4) empowering patients to make change; planning - completing effective plans for change; appropriately managing relapse.

adjunct **intensive health behaviour and lifestyle treatment**

Treatment recommended for SOME patients in selected patient group

» Intensive health behaviour and lifestyle treatment should be considered in children <6 years of age, and is recommended in children 6 years of age and older. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.[86]

age 12-18 years **1st** **lifestyle modification and treatment of comorbidities**

Ongoing

» Lifestyle modification is one of the cornerstone treatments for all children with obesity.

» In children 12-18 years the goal of treatment is weight loss not to exceed 0.9 kg (2 lb) per week.[64]

» Lifestyle modification includes education around diet and physical activity, plus behavioural therapy, so that children and their families can make and sustain changes.[3] [57] [91] Lifestyle interventions lead to significant weight loss and improved cardiometabolic parameters, compared with no treatment: BMI (-1.25 kg/m², 95% confidence interval [CI] -2.18 to -0.32) and BMI z score (-0.10, 95% CI -0.18 to -0.02).[87]

» Intensity of lifestyle modification treatment is variable but the main factor found to contribute to effectiveness is the intensity (or dose) of the intervention, measured in hours of face-to-face contact. The number of hours delivered is directly proportional to the likelihood that a child will experience a reduction in BMI.[3] For example, the US Preventive Services Task Force found that ≥52 hours per year was associated with a difference in change in BMI z-score from baseline of -0.31, while 26 to 51 hours was associated with a difference in change in BMI z-score from baseline of -0.17 (this was 0.01 for 6 to 25 hours and -0.09 for 1 to 5 hours, respectively).[83] It may be delivered through regularly scheduled visits in primary care, with assistance from dieticians and clinicians with experience in behaviour change/motivational interviewing, or through weekly visits to a dedicated paediatric weight management team, or as an in-hospital/residential programme. Escalation to more intensive weight management programmes depends on the child's age, response to treatment, risk factors, and motivation.[3] In-hospital lifestyle modification programmes are effective for children with obesity susceptibility gene loci, indicating the importance of addressing environmental, social, and behavioural factors.[92]

» It is imperative that the parents and family also adopt healthy lifestyle habits and shared decision making for the child to have success with weight maintenance or weight loss.[93]

» Diet: children should be encouraged to eliminate sugar-sweetened beverages, decrease portion sizes, and limit both energy-dense and fast foods.[59] [94][96] [97] [98] Eliminating

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sugar-sweetened beverages from the diet has been shown to significantly reduce caloric intake and obesity.[3] [96] Diets rich in fruits and vegetables should be suggested, and healthy food choices should be offered in the school. Family meals should be encouraged. More frequent family meals are associated with a higher intake of fruits and vegetables, and a lower intake of fast food and take-away food, in US adolescents.[99] If possible, unhealthy foods should be removed from the home.

» US nutritional guidelines encourage all children to consume nutrient-dense foods, including fruits, vegetables, wholegrains, beans, peas, lentils, eggs, seafood, unsalted nuts and seeds, fat-free and low-fat dairy products, and lean meats (prepared without added sugar, salt, and saturated fats).[98]

» Advise regular meals to avoid grazing and snacking, and provide education on portion control.[91]

» Physical activity: children should be encouraged to get at least 60 minutes of physical activity per day.[94][98][100] The activity should be age appropriate and fun for the child, to encourage compliance. Play activities such as climbing or playing catch or tag are encouraged.[58] Family involvement in promoting physical activity is encouraged. Parents and carers have an essential role in modelling healthy behaviours and setting realistic goals.[58]

» Television viewing and other discretionary screen time (e.g., computer and video games, internet) should be limited. The American Heart Association recommends: removing screens from bedrooms and during meals; encouraging daily, device-free social interactions and outdoor play; and supporting parents to enforce limitations on screen time, and set an example of healthy screen-based behaviour.[101] Children with obesity often experience personal barriers to movement and exercise, including mobility barriers. Therefore, tailoring and adapting paediatric exercise interventions will often be necessary, particularly for those that report musculoskeletal pain, high rates of fatigue, urinary incontinence, skin chafing, or have impaired motor skills or other conditions (e.g., muscular dystrophy, immobility, etc).[8]

» Comorbidities should be treated concurrently.[86] Associated psychosocial problems (e.g., bullying, teasing, low self-

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esteem) or psychiatric conditions (e.g., anxiety, depression) should be sought and treated.[91]

plus **motivational interviewing**

Treatment recommended for ALL patients in selected patient group

» A patient-centered counselling style which focuses on shared decision making and the patients' self identified motivations for change, in contrast with a more traditional healthcare professional led approach. The objective is not to set and achieve a particular goal. Rather, it aims to result in a particular behaviour change, such as reducing intake of a particular food or having more meals together as a family.

» Motivational interviewing consists of four processes: (1) engaging - establishing a relationship and collaborative role; understanding patient issues; (2) focussing - identifying appropriate strategies to change weight; (3) evoking - highlighting motivations for change; (4) empowering patients to make change; planning - completing effective plans for change; appropriately managing relapse.

plus **intensive health behaviour and lifestyle treatment**

Treatment recommended for ALL patients in selected patient group

» Intensive health behaviour and lifestyle treatment is recommended in all children 12-18 years of age. It is most effective with at least 26 hours of face-to-face, family-based, multi-component treatment over 3-12 months.[86]

adjunct **pharmacotherapy**

Treatment recommended for SOME patients in selected patient group

Primary options

» orlistat: 120 mg orally three times daily with each main meal that contains fat

OR

» liraglutide: 0.6 mg subcutaneously once daily for 1 week, increase dose by 0.6 mg/day at weekly intervals, maximum 3 mg/day

OR

» semaglutide: 0.25 mg subcutaneously once weekly for 4 weeks initially, increase dose gradually according to response and

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tolerance every 4 weeks, maximum 2.4 mg once weekly
It is important to note that the brand of semaglutide approved for weight management (Wegovy®) is different to the brands of semaglutide approved for type 2 diabetes, and the doses of each product are different.

Secondary options

» phentermine hydrochloride/topiramate: 3.75 mg (phentermine)/23 mg (topiramate) orally once daily in the morning for 14 days, followed by 7.5 mg (phentermine)/46 mg (topiramate) once daily in the morning, then adjust dose according to response, maximum 15 mg (phentermine)/92 mg (topiramate)
Extended-release capsules contain immediate-release phentermine and extended-release topiramate. Gradually discontinue 15 mg/92 mg dose to prevent possible seizures.

Tertiary options

» metformin: 500-2000 mg orally/day given in 2 divided doses

» Following conservative measures, treatment may include medication, with ongoing intensive lifestyle modification support. The American Academy of Pediatrics (AAP) recommends that pharmacotherapy should be offered to adolescents 12 years of age and over with obesity, in line with indication and risks, alongside lifestyle and behaviour treatment.[3]

» Orlistat inhibits fat absorption through the inhibition of enteric lipase, and is approved in some countries for children ≥12 years of age.[104] In clinical trials of orlistat in adolescents, BMI change ranged from -0.55 kg/m² up to -4.09 kg/m².[105] Adverse effects include steatorrhoea, faecal urgency, and flatulence, which limits its use in children.

» Liraglutide, a glucagon-like peptide-1 (GLP-1) agonist, is approved in the US and Europe for chronic weight management in children 12 years of age and older with obesity (i.e., body weight above 60 kg and an initial BMI corresponding to 30 kg/m² for adults by international cut-offs), in addition to a reduced-calorie diet and increased physical activity. One randomised controlled

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trial found that liraglutide plus lifestyle therapy is more effective for weight loss than placebo plus lifestyle therapy.[106] In the study of 251 adolescents with obesity, conducted over 3 years, 43% of participants in the liraglutide plus lifestyle therapy group achieved a 5% reduction in BMI, and 21% achieved a 10% reduction in BMI. In the placebo plus lifestyle therapy group, 19% of participants achieved a 5% reduction in BMI and 8% achieved a 10% reduction in BMI.[106]

» Semaglutide, another GLP-1 agonist, is approved in the US and Europe for chronic weight management in children 12 years of age and older with an initial BMI ≥95th percentile for age and sex as an adjunct to diet and exercise. One phase 3 clinical trial including 201 participants (all except one with BMI ≥95th percentile) demonstrated a 16% decrease in BMI in treated participants as compared to the placebo group after 68 weeks. At the end of the study, 73% of those treated with semaglutide lost at least 5% of their starting body weight.[107] Common adverse effects include nausea, vomiting, and diarrhoea.

» Metformin inhibits hepatic gluconeogenesis and is commonly used in the treatment of type 2 diabetes mellitus (DM) in children 10 years of age and older. The evidence for effectiveness of metformin for weight loss in children is conflicting, and is not approved for the treatment of obesity in children.[3] Some studies demonstrate the benefit of adding metformin in mitigating the weight gain seen in children and adolescents.[88][108] Those studies that did demonstrate effect typically included higher doses, more intensive lifestyle adjunct treatment and use in children with more severe obesity and/or a secondary diagnosis.[3]

» One systematic review investigated the efficacy of metformin in treating obesity in children without type 2 diabetes mellitus. At 6 months, children prescribed metformin experienced an average BMI reduction of -1.38 kg/m² (95% CI -1.93 kg/m² to -0.83 kg/m²). However, reduction in BMI was considered to be modest, and metformin was not clinically superior to other options for treating childhood obesity.[109] A subsequent randomised controlled trial reported a decrease in BMI with metformin, compared with placebo, in pre-pubertal children, but not in pubertal children.[110] Further, larger studies are required. The AAP suggests that metformin can

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be considered as an adjunct to intensive health behaviour and lifestyle treatment when other indications for use of metformin are present.[3]

» The combination of phentermine/topiramate is approved in the US for the treatment of obesity in adolescents (12-17 years old) with an initial BMI in the 95th percentile or greater standardised for age and sex. Phentermine is an anorectic that decreases appetite and topiramate is an anticonvulsant with weak carbonic anhydrase inhibitor activity that induces weight loss (although the precise mechanism of action in weight loss is currently unknown). One study of the pharmacokinetic and pharmacodynamic properties of a fixed-dose combination of phentermine/topiramate conducted in adolescents with obesity demonstrated statistically significant weight loss.[113] [114] However, adverse effects include depression and difficulties with concentration and memory, which may limit its usefulness in adolescents. Topiramate can cause fetal harm in pregnant women, and has been demonstrated to show an increase in oral clefts with first trimester exposure to topiramate.[115] The European Medicines Agency has refused a marketing authorisation for phentermine/topiramate.

adjunct

specialist referral for consideration of surgery

Treatment recommended for SOME patients in selected patient group

» A referral does not necessarily mean the child will have surgery but provides opportunity for additional evaluation of risks and benefits, and provision of further information to families to make an informed decision. A referral to comprehensive paediatric metabolic and bariatric surgery programmes should be made, to local or regional centres.

» Guidelines suggest that surgery is considered in children with BMI ≥40 with mild comorbidities, or BMI >35 with clinically significant comorbidities.[3] [116] Clinically significant comorbidities include: obstructive sleep apnoea, type 2 diabetes mellitus, idiopathic intracranial hypertension, non-alcoholic steatohepatitis, Blount's disease, slipped capital femoral epiphysis, GORD, and hypertension.[116]

» Surgery does not negatively impact pubertal development, and therefore a specific Tanner stage and bone age should not be considered a requirement for surgery.[117]

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» The surgical approaches used most often are the Roux-en-Y gastric bypass and vertical sleeve gastrectomy.[116] One prospective cohort study found that long-term follow-up (7 to 10 years) after vertical sleeve gastrectomy in children and adolescents demonstrates durable weight loss, maintained comorbidity resolution, and unaltered growth.[121] Surgery should only be performed by an experienced surgeon who works with a team capable of following the patient for long-term nutritional or psychosocial issues.

» Numerous risk factors associated with cardiovascular disease have been shown to improve among adolescents with severe obesity undergoing bariatric surgery. Increased weight loss, female sex, and younger age predict a higher probability of resolution of specific cardiovascular risk factors.[118] Outcomes of bariatric surgery in the adolescent population are being studied vigorously.[122][123]

Emerging

Setmelanotide

Setmelanotide, a melanocortin receptor 4 agonist administered by subcutaneous injection, is approved in the US and Europe for chronic weight management (weight loss and weight maintenance for at least 1 year) in children aged 6 years and older with obesity due to three rare genetic conditions: pro-opiomelanocortin (POMC) deficiency; proprotein subtilisin/kexin type 1 (PCSK1) deficiency; and leptin receptor (LEPR) deficiency, confirmed by genetic testing demonstrating variants in POMC, PCSK1, or LEPR genes considered pathogenic, probably pathogenic, or of uncertain significance. Phase 3 trials indicate that setmelanotide is safe and effective in people with severe obesity due to genetic mutations causing POMC deficiency or LEPR deficiency.[125] In the UK, setmelanotide is recommended as an option for treating obesity and controlling hunger caused by pro-opiomelanocortin (POMC) deficiency, including proprotein convertase subtilisin/kexin type 1 or leptin receptor (LEPR) deficiency in people aged 6 years and over.[126] Setmelanotide is also approved in the US and Europe for the treatment of obesity and hunger control in patients with confirmed Bardet-Biedl syndrome.

Amylin analogues

Amylin is a peptide that is co-secreted with insulin from the pancreatic beta cells and is thought to be important in the regulation of glucose and energy homeostasis. An analogue of amylin is available for the treatment of diabetes in adults and is undergoing clinical trials for the treatment of adult obesity.[127] [128]

Bupropion

Bupropion is a noradrenaline (norepinephrine) and dopamine reuptake inhibitor used in adults for depression and smoking cessation. It has been studied for treatment of obesity in adults. The combination of extended-release bupropion and the opioid antagonist naltrexone has been investigated.[129] [130] This combination has been approved in the US by the Food and Drug Administration (FDA) for the treatment of obesity in adults.

Zonisamide

Zonisamide is an anticonvulsant that induces weight loss. It has serotonergic and dopaminergic activity, and also inhibits sodium and calcium channels.[131]

Exendin 4

Exendin is an incretin mimetic undergoing clinical trials in adults with obesity. Exenatide, a synthetic version, is used for the treatment of type 2 diabetes in adults. It has been shown to decrease gastric emptying time and decrease food intake in clinical studies.[132] Initial trials in children have shown a reduction in body mass index (BMI) in severely children with obesity.[133] [134]

Peptide YY(3-36)

Peptide YY is released by the gastrointestinal tract following a meal and acts by suppressing appetite. Clinical trials with a nasal formulation in adults did not meet the primary endpoints, and thus were stopped. Peptide YY is being studied as a potential therapy in patients who did not lose sufficient weight following bariatric surgery.[135]

Ghrelin antagonists

Ghrelin is a small peptide secreted from the stomach that is thought to be a signal for meal initiation. Thus, antagonism of ghrelin may be useful to suppress food intake.

Primary prevention

Preventing childhood obesity is of paramount importance in controlling the obesity epidemic. Preventative strategies must begin early in life, as obesity is difficult to treat at all ages, and obesity tends to persist into adulthood.[39][50]

Breastfeeding has been shown to be associated with a lower incidence of obesity in childhood.[51] However, the data are inconsistent, with other studies showing no obvious effect.[52] Promotion of breastfeeding is still recommended based on other health benefits.

The American Academy of Pediatrics' recommendation to avoid offering juice to infants aged 6 months and under has been expanded to include infants aged 12 months and under, as juice offers infants no nutritional benefits and can predispose to inappropriate weight gain. Consumption should be limited to 170 mL per day for children aged 4 to 6 years, and 230 mL per day for children aged 7 to 18 years.[53]

Meta-analysis of 153 randomised controlled trials reported that combined dietary and physical activity interventions appear to reduce the risk of obesity in children aged 0 to 5 years.[54] Physical activity interventions reduce the risk of obesity in children aged 6 to 18 years. Combined dietary and physical activity interventions may be effective in children aged 6 to 18 years. Dietary interventions alone do not appear to be effective in this age group. The authors detected heterogeneity between the trial results that could not be fully explained by the setting or duration of the intervention.[54]

Labelling food with physical activity calorie equivalents has been shown to decrease calorie consumption.[55] This approach could benefit older children and adolescents who are making independent food choices outside the home.

Schools need to offer healthy food choices, and children should have daily physical education. In addition, fun and safe places to exercise should be provided in the community.

Advertising of fast foods and energy-dense foods directly to children should be restricted.

Prospective cohort studies of mother-child pairs in the US showed that adherence to a healthy lifestyle (including healthy body mass index [BMI], high-quality diet, regular exercise, no smoking, and limited alcohol intake) by mothers during their offspring's childhood and adolescence is associated with a substantially reduced risk of obesity in the children.[56] These findings highlight the potential benefits of multifactorial interventions in the family to reduce the risk of childhood obesity.[56]

A child's BMI should be calculated and plotted at least annually to identify those children with overweight or obesity, or who may be at risk for obesity, and the child's dietary history and physical activity history should be reviewed during routine well-child visits. Family history of obesity and the child's BMI trajectory should also be assessed. Anticipatory guidance encouraging healthy behaviours to decrease obesity risk should be provided routinely to all children, regardless of current BMI.[3]

Secondary prevention

Discussion of healthy nutrition and physical activity for children should be part of the anticipatory guidance given at all well-child visits.

Public health strategies need to be further developed to promote healthy lifestyle choices for children in the schools, with extension to the community.[159] [160] School- and community-based physical activity interventions, as part of an obesity prevention or treatment programme, can improve executive functions of children with obesity or overweight specifically. Dietary strategies in school may also benefit general school achievement in children with obesity. These findings may be used to influence public policy.[161] However, one Cochrane systematic review found low evidence that school-based interventions may improve physical fitness but may have little to no impact on body mass index.[162]

Patient discussions

When discussing weight, person-first language is recommended (e.g., child with obesity rather than 'obese child') with avoidance of weight bias and stigma.[42]

Lifestyle modification is the cornerstone in treatment of obesity and should utilise motivational interviewing alongside other techniques.[3] The patient should be advised to limit sugar-containing beverages, energy-dense foods, and fast foods, and to decrease portion sizes.[3] [59] [94][96] [97] [98] Sugar-sweetened beverages and energy-dense foods should be removed from the home. Family meals should be encouraged and meals taken at regular times. Children should consume nutrient-dense foods, including fruits, vegetables, wholegrains, beans, peas, lentils, eggs, seafood, unsalted nuts and seeds, fat-free and low-fat dairy products, and lean meats (prepared without added sugar, salt, and saturated fats).[98]

Patients should exercise for at least 60 minutes per day and reduce screen time to less than 1 hour per day for aged 2 to 5 years old or a parent-monitored plan for media use in older children.[3]

Family involvement is critical for success in weight maintenance or weight loss.

As children are still growing in height, they should concentrate on weight maintenance rather than weight loss (unless they have marked obesity).

[CDC: tips to help children maintain a healthy weight] (https://www.cdc.gov/healthyweight/children/index.html)

Monitoring

Monitoring

Body mass index (BMI) should be calculated and plotted at each visit to monitor for effects of treatment. Blood pressure should be monitored routinely.[3] Monitoring of psychosocial function and using an evaluation tool when a patient presents with symptoms of depression is also advised.[3]

As per the American Diabetes Association recommendations, risk-based screening for pre-diabetes and/or type 2 diabetes should be considered after the onset of puberty or after 10 years of age, whichever occurs earlier, in children and adolescents with a BMI ≥85th percentile who have one or more risk factors for diabetes. Risk factors include: maternal history of diabetes or maternal gestational diabetes during the child's gestation; family history of type 2 diabetes in first- or second-degree relative; Native American, African American, Latino, Asian American, Pacific Islander race/ethnicity; signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidaemia, polycystic ovary syndrome, or small-for-gestational-age birth weight). Screening should include fasting blood glucose, a 2-h plasma glucose during a 75-g oral glucose tolerance test, or haemoglobin A1c level checked at a minimum of every 3 years or more frequently if BMI is increasing or risk factor profile is deteriorating. Reports of type 2 diabetes before age 10 years exist, and screening can be considered with numerous risk factors.[3] [74] Fasting lipoproteins and liver function tests should also be checked routinely. The American Academy of Pediatrics expert committee suggests screening for lipid abnormalities, abnormal glucose metabolism, and abnormal liver function every 2 years starting at 10 years of age for children with BMI of 95th percentile and those with BMI of 85th to 94th percentile who have other risk factors.[3]

In children aged 10 or over who are overweight (BMI 85th to 94th percentile) consider screening for lipid abnormalities.[3]

FOLLOW UP

Complications

Complications	Timeframe	Likelihood
obesity in adults	**long term**	**high**
Approximately 55% of children with obesity go on to be adolescents with obesity, and approximately 80% of adolescents with obesity will remain to be adults with obesity.[39] In addition, those children with obesity at 8 years of age tend to have more severe obesity and increased morbidity as an adult.[18] [19]		
type 2 diabetes	**long term**	**high**
Risk factors for the development of diabetes in children include a body mass index (BMI) ≥85th percentile, family history of diabetes, race (e.g., Hispanic or black), and other risk factors such as acanthosis nigricans, polycystic ovary syndrome, or metabolic syndrome. The American Diabetes Association recommends that all children aged >10 years with a BMI ≥85th percentile plus one or more additional risk factors should have a fasting blood glucose test, a 2 hour plasma glucose during a 75 g oral glucose tolerance test, or haemoglobin A1c every 3 years, or more frequently if BMI is increasing, or risk factor profile is deteriorating.[74] Data from Denmark showed that an increased risk of adult type 2 diabetes was associated with male childhood overweight at aged 7 years of age only if it continued until puberty or later ages.[137]		
impaired glucose tolerance	**long term**	**high**
Children with obesity have a higher prevalence of impaired glucose tolerance and increased fasting insulin levels.[138] [139] Childhood obesity is associated with glucose intolerance in adulthood.[140]		
metabolic syndrome	**long term**	**high**
A constellation of metabolic derangements including waist circumference >90th percentile for age plus two of the following: hypertriglyceridaemia, low high-density lipoprotein (HDL), hypertension, or glucose intolerance. Higher risk in most children with obesity.[138] Treatment is aimed at lifestyle modification and weight loss. Childhood obesity is associated with glucose intolerance in adulthood.[140]		
cardiovascular disease	**long term**	**high**
Children with obesity are at risk of developing early aortic and coronary artery fatty streaks and fibrous plaques, and have a higher positive association with early stroke as adults.[18] [141] [142] [143] [144]		
hypertension	**long term**	**high**
Systolic blood pressure is elevated in 13%, and diastolic blood pressure in 9%, of children with obesity.[18]		

Complications	Timeframe	Likelihood
acanthosis nigricans	**long term**	**high**
Associated with high BMI and usually indicative of insulin resistance.[145]		
hyperlipidaemia	**long term**	**high**
A fasting lipid panel should be obtained in children with a BMI ≥85th percentile.[18] All children should be screened for lipid abnormalities with a non-fasting, non-HDL cholesterol between ages 9 to 11 years and 17 to 21 years.[71] Lipid abnormalities in children often persist into adulthood.[71] Cut-off values are as follows: normal: cholesterol <4.40 mmol/L (<170 mg/dL), LDL <2.85 mmol/L (<110 mg/dL); borderline: cholesterol 4.40 to 5.15 mmol/L (170-199 mg/dL), LDL 2.85 to 3.34 mmol/L (110-129 mg/dL); elevated: cholesterol >5.18 mmol/L (>200 mg/dL), LDL >3.37 mmol/L (>130 mg/dL).[71]		
post-surgical complications	**long term**	**high**
Complications of gastric bypass include infection, iron and vitamin deficiencies, cholecystitis, and small bowel or stomach obstruction. Fewer complications are associated with vertical sleeve gastrectomy as there is no rearrangement of the anatomy.[146]		
polycystic ovary syndrome	**long term**	**high**
Irregular menses, acne, and hirsutism are associated with polycystic ovary syndrome. Biochemical evidence of hyperandrogenism and polycystic ovaries on ultrasound is usually found. Treatment strategies include exercise and weight loss, oral contraceptives containing a progestogen with low androgenicity, and insulin-sensitising agents.		
obstructive sleep apnoea	**long term**	**medium**
The prevalence of obstructive sleep apnoea is highest in children with severe obesity.[147] Children may present with a history of snoring with pauses in breathing while sleeping, restless sleep, daytime somnolence, poor attention span, and poor academic performance. Tonsillar hypertrophy may be seen on examination. The diagnosis is made by polysomnography, and treatment includes tonsillectomy and adenoidectomy (if indicated) and continuous positive airway pressure (CPAP) during sleep.[148] Sleep apnoea may contribute to pulmonary arterial hypertension.		
non-alcoholic fatty liver disease	**long term**	**medium**
Children with obesity are at higher risk of developing simple steatosis, steatohepatitis, fibrosis, and cirrhosis. Children >10 years of age with a BMI ≥95th percentile, or with a BMI ≥85th percentile and other risk factors, should be screened annually with liver function tests.		

FOLLOW UP

Complications	Timeframe	Likelihood
Definitive diagnosis is made with a liver biopsy. Treatment is weight loss.		
psychosocial morbidities	**long term**	**medium**
Overweight children are likely to experience social discrimination and bullying. Obesity increases a child's risk of anxiety, depression, and weight stigmatisation.[62] [63]		
cholelithiasis	**long term**	**medium**
More prevalent in overweight children and children with obesity, and can be associated with rapid weight loss.[149] Children usually present with intermittent, intense, colicky pain in the right upper quadrant of the abdomen. Diagnosis is made with abdominal ultrasound, and treatment is usually surgical.		
intertrigo	**long term**	**medium**
Irritation in the folds of the skin. Affected areas are typically red and macerated. Treatment consists of good hygiene combined with mild emollients. Topical corticosteroids can be used as necessary.		
furunculosis	**long term**	**medium**
Infection in the folds of the skin. Treatment consists of proper hygiene, hot moist compresses to facilitate drainage, incision and drainage, and antibiotics as needed.		
obesity hypoventilation syndrome	**long term**	**low**
Due to excess adipose tissue on the chest and abdomen. Treatment is weight loss and continuous positive airway pressure (CPAP) during sleep.		
slipped capital femoral epiphysis	**long term**	**low**
Typically seen between the ages of 9 and 16 years; boys are affected more often than girls.[152] Typically presents with hip or knee pain, pain with walking, and decreased range of motion at the hip. Treatment is surgical.		
Blount's disease	**long term**	**low**
A bowing of the lower extremities (i.e., tibia vara), which is typically painless.[152] Radiographical features include changes in the proximal medial tibial metaphysis. Treatment is typically surgical, although orthotic management can be attempted in patients <3 years of age.		

Complications	Timeframe	Likelihood
asthma	**long term**	**low**
Children with obesity have a higher risk of asthma independent of other factors.[154] Overweight/obesity is associated with increased asthma severity, poorer asthma control, and lower quality of life.[155] Symptoms of shortness of breath and reduced exercise tolerance may be attributed to obesity, confounding the diagnosis.		
increased cancer risk	**long term**	**low**
Adolescent obesity is associated with increased cancer risk in adulthood. One cohort study with over 2,000,000 participants reported a hazard ratio of 1.26 (95% CI 1.18 to 1.35) in men with adolescent obesity, and a hazard ratio of 1.27 (95% CI 1.13 to 1.44) in women, after exclusion of breast and cervical cancers.[156]		
eating disorder	**long term**	**low**
Obesity treatment helps improve eating disorder symptoms, including binge eating, however, a small number undergoing obesity treatment might develop an eating disorder during or after an intervention.[157] [158]		
constipation	**variable**	**medium**
Can be exacerbated by obesity.[150]		
gastro-oesophageal reflux	**variable**	**medium**
Can be exacerbated by obesity.[151]		
idiopathic intracranial hypertension	**variable**	**low**
Children present with severe headaches with photophobia. They occasionally have double vision and impairment of cranial nerve VI. Blurred optic discs may be noted on examination.[153]		

Prognosis

Treatment of obesity at any age is a challenge. Even with successful weight loss, children are at risk of rebound back to, or above, their previous weight.

Family involvement in the weight loss regimen is imperative for success. Children with obesity are at high risk of becoming adults with obesity, and obesity in adults is a serious health risk.[18] [39][136] Approximately 55% of children with obesity go on to be adolescents with obesity, and approximately 80% of adolescents with obesity will remain adults with obesity.[39]

Diagnostic guidelines

United Kingdom

Obesity: identification, assessment and management (https://www.nice.org.uk/guidance/cg189)

Published by: National Institute for Health and Care Excellence **Last published:** 2023

North America

Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity (https://publications.aap.org/pediatrics/article/151/2/e2022060640/190443/Clinical-Practice-Guideline-for-the-Evaluation-and)

Published by: American Academy of Pediatrics **Last published:** 2023

Pediatric obesity - assessment, treatment, and prevention (https://www.endocrine.org/clinical-practice-guidelines)

Published by: The Endocrine Society **Last published:** 2017

Severe obesity in children and adolescents: identification, associated health risks, and treatment approaches (https://professional.heart.org/en/guidelines-and-statements)

Published by: American Heart Association **Last published:** 2013

Treatment guidelines

United Kingdom

Obesity: identification, assessment and management (https://www.nice.org.uk/guidance/cg189)

Published by: National Institute for Health and Care Excellence **Last published:** 2023

Community pharmacies: promoting health and wellbeing (https://www.nice.org.uk/guidance/ng102)

Published by: National Institute for Health and Care Excellence **Last published:** 2018

International

Guidelines on physical activity and sedentary behaviour (https://www.who.int/publications/i/item/9789240015128)

Published by: World Health Organization **Last published:** 2020

North America

Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity (https://publications.aap.org/pediatrics/article/151/2/e2022060640/190443/Clinical-Practice-Guideline-for-the-Evaluation-and)

Published by: American Academy of Pediatrics **Last published:** 2023

Recommendations for treatment of child and adolescent overweight and obesity (https://pediatrics.aappublications.org/content/120/Supplement_4)

Published by: American Academy of Pediatrics **Last published:** 2023

Indications for metabolic and bariatric surgery (https://asmbs.org/app/uploads/2022/10/ASMBS-IFSO-Guidelines-2022-PIIS1550728922006414.pdf)

Published by: American Society for Metabolic and Bariatric Surgery; International Federation for the Surgery of Obesity and Metabolic Disorders **Last published:** 2022

Dietary guidelines for Americans, 2020-2025 (https://www.dietaryguidelines.gov)

Published by: US Department of Health and Human Services; US Department of Agriculture **Last published:** 2020

Physical activity guidelines for Americans (https://health.gov/our-work/physical-activity/current-guidelines)

Published by: US Department of Health and Human Services **Last published:** 2018

Clinical practice guideline for the treatment of obesity and overweight in children and adolescents (https://www.apa.org/obesity-guideline)

Published by: American Psychological Association **Last published:** 2018

Pediatric obesity - assessment, treatment, and prevention (https://www.endocrine.org/clinical-practice-guidelines)

Published by: The Endocrine Society **Last published:** 2017

Canadian 24-hour movement guidelines for children and youth (https://csepguidelines.ca)

Published by: Canadian Society for Exercise Physiology **Last published:** 2017

Pediatric weight management: evidence-based nutrition practice guideline (https://www.andeal.org/topic.cfm?menu=5296&cat=5632)

Published by: Academy of Nutrition and Dietetics **Last published:** 2015

Recommendations for growth monitoring, and prevention and management of overweight and obesity in children and youth in primary care (https://canadiantaskforce.ca/guidelines/published-guidelines/)

Published by: Canadian Task Force on Preventive Health Care **Last published:** 2015

Asia

Clinical practice guideline for the diagnosis and treatment of pediatric obesity (https://www.pghn.org/DOIx.php?id=10.5223/pghn.2019.22.1.1)

Published by: Committee on Pediatric Obesity of the Korean Society of Pediatric Gastroenterology Hepatology and Nutrition **Last published:** 2019

Online resources

1. WHO: Child growth standards. (https://www.who.int/tools/child-growth-standards/standards) *(external link)*

2. Royal College of Paediatrics and Child Health: growth charts (https://www.rcpch.ac.uk/resources/growth-charts) *(external link)*

3. National Institute on Aging: genetic association database (https://geneticassociationdb.nih.gov) *(external link)*

4. NIH: Genetic and Rare Diseases Information Center: Lipedema (https://rarediseases.info.nih.gov/diseases/10542/lipedema) *(external link)*

5. CDC: tips to help children maintain a healthy weight (https://www.cdc.gov/healthyweight/children/index.html) *(external link)*

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Key articles

- Hampl SE, Hassink SG, Skinner AC, et al. Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity. Pediatrics. 2023 Feb 1;151(2):e2022060640. Full text (https://publications.aap.org/pediatrics/article/151/2/e2022060640/190443/Clinical-Practice-Guideline-for-the-Evaluation-and?autologincheck=redirected) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/36622115?tool=bestpractice.bmj.com)

- Hampl SE, Hassink SG, Skinner AC, et al. Executive summary: clinical practice guideline for the evaluation and treatment of children and adolescents with obesity. Pediatrics. 2023 Feb 1;151(2):2022060641. Full text (https://publications.aap.org/pediatrics/article/151/2/e2022060641/190440/Executive-Summary-Clinical-Practice-Guideline-for) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/36622135?tool=bestpractice.bmj.com)

- Styne DM, Arslanian SA, Connor EL, et al. Pediatric obesity - assessment, treatment, and prevention: an Endocrine Society clinical practice guideline. JCEM. 2017 Mar 1;102(3):709-57. Full text (https://academic.oup.com/jcem/article/102/3/709/2965084) Abstract (http://www.ncbi.nlm.nih.gov/pubmed/28359099?tool=bestpractice.bmj.com)

- US Department of Health and Human Services (HHS) and US Department of Agriculture (USDA). Dietary guidelines for Americans 2020-2025. 9th ed. Dec 2020 [internet publication]. Full text (https://www.dietaryguidelines.gov/resources/2020-2025-dietary-guidelines-online-materials)

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Images

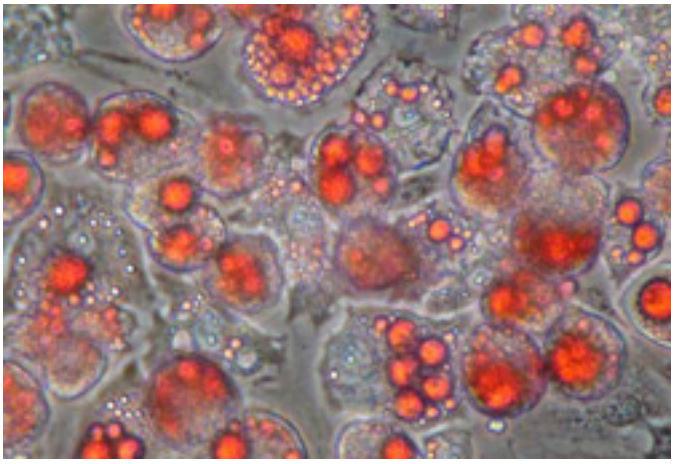

Figure 1: 3T3-L1 adipocytes stained with Oil Red O (ORO). ORO stains lipid droplets red

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This approach is in line with the guidance of the International Bureau of Weights and Measures Service.

Figure 1 – BMJ Best Practice Numeral Style

5-digit numerals: 10,000

4-digit numerals: 1000

numerals < 1: 0.25

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