

Contemporary approaches to the prevention and management of paediatric obesity: an Australian focus

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Globally, 124 million children and adolescents aged 5–19 years are affected by obesity, with prevalence rates highest (> 20%) in Polynesia and Micronesia, the Middle East, North Africa, the Caribbean and the United States.¹ Of the 34 member countries of the Organisation for Economic Co-operation and Development, obesity prevalence is highest in the US, with Australia ranking fifth for girls and eighth for boys.¹

In Australia in 2015, the prevalence of overweight and obesity (combined) in primary school children had plateaued at 22.9% (including 7.1% with obesity), although not in secondary school students (21.7% overweight, additional 5.8% obesity).² Further, the prevalence of severe or morbid obesity has increased in this age group.³ There are also growing socio-economic inequalities in Australian prevalence rates, with overweight and obesity continuing to increase among children in families with lower socio-economic status^{2,4} (Box 1).

Among Aboriginal children the prevalence of overweight and obesity is generally higher,⁵ with similar patterns to non-Aboriginal children in that the prevalence of overweight and obesity increases with age. There is some evidence that the prevalence of obesity is lower in Aboriginal children living in remote areas compared with urban centres.⁶ The cultural diversity of the Australian population means that a range of factors may influence the prevalence of obesity, including social and cultural norms regarding weight, dietary practices and physical activity. Also, in under-resourced communities, among refugees and culturally diverse populations, logistical problems in measurement and concerns that many studies may miss children living in transitory conditions or non-private dwellings⁶ highlight the fact that further research is needed into understanding the risk factors that affect obesity in these subpopulations.

A 2016 report used the Global Burden of Disease prevalence estimates for overweight and obesity for children aged 5–17 years, as well as estimates of the prevalence of several obesity-related comorbidities, to project forward to 2025 on the assumption that no effective intervention is implemented to modify the trend.⁷ The authors estimated that in 2025 there would be 12 million children with impaired glucose tolerance, 4 million with type 2 diabetes, 27 million with hypertension and 38 million with hepatic steatosis.

The main behavioural risk factors for obesity are the over-consumption of energy-dense, nutrient-poor foods and a lack of physical activity.⁸ There is emerging evidence that poor sleep quality and duration,⁹ as well as high amounts of sedentary time (ie, sitting),¹⁰ play a role. Such obesity-conducive behaviour is influenced by a range of individual level factors including biology, genetics and psychology. These individual level factors are nested within families, the community and the local environment, as well as the broader economic, political and social environment (Box 2). Each of these levels or sectors needs to be considered in addressing the issue of obesity in children and adolescents. In this narrative

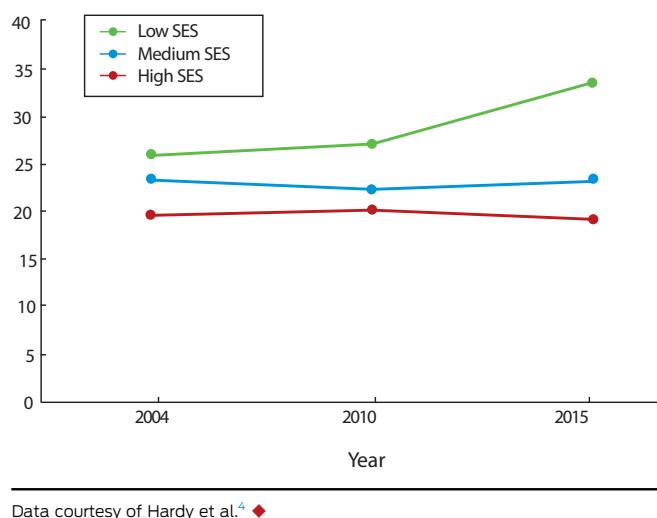
Summary

- Of the 34 member countries of the Organisation for Economic Co-operation and Development, obesity prevalence is highest in the United States, with Australia ranking fifth for girls and eighth for boys. Curbing the problem is achievable and can be realised through a combination of smart governance across many sectors, community initiatives, the support of individual efforts, and clinical leadership.
- At 5 years of age, one in five Australian children are already affected by overweight or obesity; obesity prevention strategies must therefore start before this age. There is strong evidence that reducing screen time and promoting breastfeeding in 0–2-year-olds are effective interventions in the early years.
- The main behavioural risk factors for obesity are overconsumption of energy-dense, nutrient-poor foods and a lack of physical activity. Emerging evidence suggests poor sleep quality and duration and high amounts of sedentary time also play a role.
- Systems-based policy actions may change long term obesity prevalence in children by targeting the food environment through nutrition labelling, healthy foods in schools, restricted unhealthy food marketing to children, and fiscal policies to reduce consumption of harmful foods and sugar-sweetened beverages.
- Macro-environmental factors influence obesity risk. Public transport policy and the built environment (proximity to parks, bike paths, green space, schools and shops) influence play time spent outdoors, walking and cycling. Greater access to parks and playgrounds and active commuting are associated with lower body mass index.
- Australian interventions have largely employed individual level approaches. These are important, but of limited effectiveness unless priority is also given to policies that reduce obesity-conducive environments.
- Clinicians can provide anticipatory guidance to support healthy weight and weight-related behaviours, including weight monitoring, early feeding and children's diets, physical activity opportunities, and limited sedentary and screen time.
- Investigations in children with obesity usually include liver function tests and measuring fasting glucose, lipid and possibly insulin levels. As obesity can be associated with micronutrient deficiencies, it may be prudent to check full blood count and iron, vitamin B12 and vitamin D levels. Endocrinological assessment is usually not needed. Second line investigations may include liver ultrasound, oral glucose tolerance testing and sleep study.
- Traditional treatment of child and adolescent obesity has focused on family-based, multicomponent (diet, physical activity and behaviour change) interventions, although these lead to small and often short term weight reductions (mean, –1.45 kg; 95% CI, 1.88 to –1.02). Nevertheless, these principles remain core interventions in children and adolescents with obesity.
- A very low energy diet should be considered in adolescents with severe obesity or obesity-related comorbidities, and for adolescents who have not achieved weight loss following a more conventional dietary approach.
- Pharmacotherapy confers only small reductions in weight; for example, effect size for metformin is –3.90 kg (95% CI, –5.86 to –1.94).
- Bariatric surgery should be considered in adolescents over 15 years of age with severe obesity (body mass index > 40 kg/m², or > 35 kg/m² in the presence of severe complications).

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Podcast with Louise Baur available at <https://www.mja.com.au/podcasts>

1 Prevalence of overweight and obesity for school-age children in New South Wales, Australia, according to socio-economic status (SES)



review, we consider the prevention of obesity in this age group, as well as the management of children and adolescents already affected by obesity, highlighting current and potential intervention approaches.

Search criteria

This narrative review is based on data from systematic reviews, review papers, reports, evidence summaries and individual studies known to the authors. Other studies were identified by a search of the Cochrane Library and a MEDLINE search of English language papers published up to 2017 using search terms "obesity"

and "child" or "adolescent", and further refined using such terms as "bariatric surgery", "behaviour therapy", "diet", "drug therapy", "exercise", "health promotion", "physical activity", "prevention" and "weight maintenance". Reference lists of key articles were also checked to identify additional papers of interest. We searched the World Health Organization website for reports on child obesity. We also searched for clinical guidelines on the management of child and adolescent obesity. For the latter to be considered, they needed to be developed or endorsed by a national health professional body or government agency.

WHO recommendations

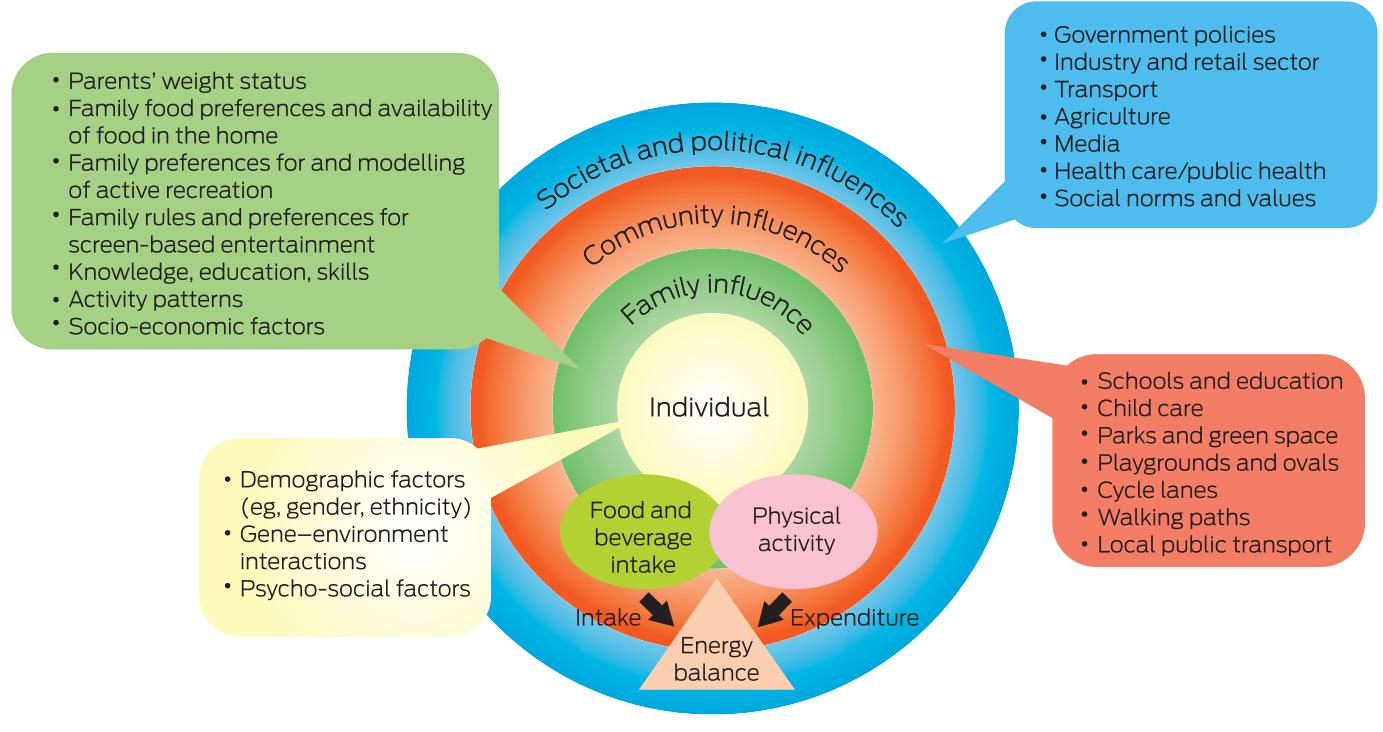
The WHO has recommended that a coordinated effort is needed to address the epidemic of obesity and, in 2014, it established the Commission on Ending Childhood Obesity. The Commission's 2016 final report outlined six key areas of action (Box 3), five focusing on obesity prevention and one on treatment.⁸ The subsequent implementation plan provides a guide for policy makers and a recommended suite of actions.¹¹ We discuss several of these recommendations below, as well as some additional approaches. An overall summary of the evidence for interventions designed to reduce obesity-conducive behaviour in children and adolescents is presented in Box 4.¹²

Prevention of obesity in children and adolescents

Pre-conception and antenatal period

Obesity risk can be passed from one generation to the next and maternal obesity can have an adverse influence on fetal development and later offspring weight status.¹³ It has therefore been recommended that achieving a healthy weight before pregnancy, and a healthy weight gain during pregnancy, may contribute to obesity prevention in childhood.^{8,14} However, there is limited

2 Sectors of influence for childhood obesity prevention



3 Six key areas of action from the World Health Organization Commission on Ending Childhood Obesity report⁸

- Integrate and strengthen guidance for non-communicable disease prevention with current guidance for pre-conception and antenatal care to reduce the risk of childhood obesity.
- Provide guidance on, and support for, healthy diet, sleep and physical activity in early childhood to ensure children grow appropriately and develop healthy habits.
- Implement comprehensive programs that promote the intake of healthy foods and reduce the intake of unhealthy foods and sugar-sweetened beverages by children and adolescents.
- Implement comprehensive programs that promote physical activity and reduce sedentary behaviours in children and adolescents.
- Implement comprehensive programs that promote healthy school environments, health and nutrition literacy, and physical activity in school-age children and adolescents.
- Provide family-based, multicomponent, lifestyle weight management services for children and young people with obesity. ♦

evidence for effectiveness of interventions that target gestational or maternal weight gain on offspring obesity, suggesting that there should be a focus on the pre-conception and post partum periods.¹⁵ Prevention and management of hyperglycaemia and gestational hypertension may be important. Several clinical trials have shown that improved diabetes control results in decreased neonatal adiposity;¹⁶ however, there is no clear evidence of an effect on body mass index (BMI) in later childhood.

Prevention in the early years (0–5 years of age)

In Australia, one in five children is already affected by overweight or obesity at 5 years of age;¹⁷ obesity prevention strategies that start

before 5 years are therefore necessary. As shown in Box 4, interventions targeting a reduction in screen time and promotion of breastfeeding in 0–2-year-olds have the strongest level of evidence of effectiveness in the early years. A 2016 systematic review¹⁸ assessed the effectiveness of interventions in the 0–2 year age group. Interventions were typically focused on individual and family level factors and had components which provided guidance to parents on breastfeeding and appropriate complementary feeding, healthy diet, sleep and physical activity.¹⁸ Interventions in the first 2 years have been trialled in Australia and New Zealand, with mixed success in reducing BMI at 18–24 months in the intervention groups.^{19–22} A prospective individual participant meta-analysis of these specific studies is underway.²³ The Sydney-

4 Evidence for interventions designed to reduce obesity-conducive behaviour*

| Setting | Children 0–5 years | Children 5–12 years | Adolescents 13–18 years |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Home and family | <p>Strong evidence for interventions in reducing screen time and for improving breastfeeding in 0–2-year-olds</p> <p>Moderate evidence for behaviour change and skill building for parents of 3–5-year-olds</p> <p>Weak to moderate evidence for interventions promoting family meals, improving skills in cooking and shopping</p> | <p>Strong evidence for interventions that reduce screen time and encourage water consumption (especially with high parent involvement)</p> | |
| Child care and pre-school | <p>Weak to moderate evidence for programs with parental involvement in improving diets, physical activity and encouraging water consumption</p> | <p>Not applicable</p> | <p>Not applicable</p> |
| School | <p>Not applicable</p> | <p>Strong evidence for physical activity interventions with a home component, and combined physical activity and diet interventions with a community and home component</p> <p>Moderate evidence for physical activity during breaks and before/after school, increasing physical education lesson time and playground equipment, restricting availability of energy-dense, nutrient-poor foods, increasing availability of healthy foods, sedentary behaviour interventions with parental involvement</p> <p>Emerging evidence for healthy school canteens and food provision, interventions reducing portion size, and healthy food policies</p> | <p>Lack of evidence for consistently effective interventions</p> <p>Moderate evidence for educational interventions on food intake</p> |
| Community | <p>Lack of evidence</p> | <p>Moderate evidence for active travel (cycling or walking) to school</p> <p>Moderate evidence for community-based physical activity and diet programs that include a school component</p> | |
| Health services | <p>Strong evidence for treatment/management (but not prevention) of paediatric overweight/obesity with modest improvements in body mass index</p> | | |
| Policy | <p>Emerging evidence for policies that aim to reduce the consumption of sugar-sweetened beverages</p> <p>Emerging evidence for regulation to reduce marketing of energy-dense, nutrient-poor foods</p> | | |

* Adapted from Bauman et al.¹² Recent systematic reviews were assessed for quality using the AMSTAR (Assessing the Methodological Quality of Systematic Reviews) criteria (https://amstar.ca/Amstar_Checklist.php) and this was used to assign an evidence level of strong, moderate, weak, emerging or lack of evidence. ♦

based Healthy Beginnings Trial found that home visits by nurses to new mothers in the first 2 years led to a BMI reduction of 0.29 kg/m² (95% CI, –0.55 to –0.02; $P = 0.04$) in the intervention group at age 2 years compared with the control group, with a higher proportion of children in the intervention group growing within the healthy weight range, as well as showing improvement in several obesity-conducive behaviours.^{19,24} Internationally, this was the first study to show this effect on BMI in early childhood. However, longer follow-up showed that the effects were not sustained at 5 years of age without further intervention, suggesting that obesity prevention programs need to be maintained throughout early childhood.²⁵

Early care and education settings are avenues for obesity prevention in the pre-school-age group. However, evidence for child care or pre-school interventions to reduce obesity-conducive behaviours is weak to moderate (Box 4). A systematic review of 43 interventions in such settings, conducted between 2010 and 2015, provided tentative evidence that comprehensive, multicomponent, multilevel interventions, with parental engagement, were more likely to be effective in helping children maintain or achieve healthy weights.²⁶

School-based and community-based obesity prevention

For older children, schools are a focal point for obesity prevention strategies.⁸ Although there is moderate to strong evidence for improvements in levels of physical activity and eating behaviour with some school-based interventions (Box 4), there is limited effectiveness of prevention programs in schools in reducing BMI. A systematic review assessing 41 school-based studies concluded that interventions with combined diet and physical activity components and a home element have the greatest impact (supported by Box 4); however, estimates on differences in the change in BMI between the intervention and control groups were modest, ranging from –0.33 kg/m² to 0.05 kg/m².²⁷ There remains a large gap in the literature regarding successful school-based interventions for adolescents and strategies that involve parents to a greater degree in order to influence the home environment.²⁸

A review of community-based childhood obesity prevention programs in high-income countries showed very few interventions for childhood obesity that were exclusively based in a community setting — most involved additional settings such as school, home and primary care.²⁹ There is moderate evidence for community interventions that include a physical activity or active transport component for reducing obesity-conducive behaviour (Box 4),¹² suggesting the important role of communities in facilitating active lifestyles.

Focusing on the upstream determinants of obesity

From a public health prevention perspective, tackling the upstream determinants of obesity — those which operate at the macro level and include government policies and global forces — must be key to obesity prevention. Systems-based policy actions that target the food environment have the potential to produce long term changes to the prevalence of obesity and overweight in children.³⁰ These include effective nutrition labelling, initiatives to make healthy foods available in schools, restrictions on unhealthy food marketing to children, as well as fiscal policies to reduce consumption of harmful foods and sugar-sweetened beverages.^{30,31}

In Mexico, a tax on sugar-sweetened beverages, introduced in January 2014, was associated with an average 6% relative decrease in purchases of taxed beverages in the following year.³² The magnitude of these changes was greater in lower income

households.³³ A US study identified this approach as the single most cost-effective intervention which would save an estimated \$55 for every \$1 invested over a 10-year period.³⁴ Concerns have been expressed by industry and lobby groups that nutrition should be a matter of individual responsibility and that a sugar-sweetened beverage tax would be regressive and have a differential impact on people on low incomes. However, a study which modelled the impact of a 20% tax on sugar-sweetened beverages in Australia estimated that it would likely reduce purchasing and consumption, leading to health gains and health care expenditure savings across all quintiles of socio-economic deprivation.³⁵ A tax implemented in the United Kingdom in April 2018 prompted manufacturers to reformulate their products in advance of the levy.³⁶

Another potential policy action is to limit the exposure of children to the marketing of energy-dense, nutrient-poor foods. This has been identified as a highly cost-effective strategy, potentially saving an estimated \$38 for every \$1 invested.³⁴ Australian studies have shown that public attitudes are changing in this area, with growing support for government intervention to regulate food advertising and implement other regulatory policies, especially those targeting children.³⁷

There are several other upstream macro-environmental factors that influence obesity risk. Both public transport policy and the built environment — including proximity to parks, playgrounds, bike paths, green space, schools and shops — influence such factors as play time spent outdoors, walkability and active commuting to school (eg, walking or cycling).³⁸ Longitudinal and cross-sectional studies have shown that greater neighbourhood park and playground access and active commuting are associated with lower BMI.^{39,40}

In Australia, existing interventions and strategies have largely employed individual level, downstream approaches, mainly to influence behaviour change in order to prevent obesity. Although these are important within a suite of actions across the life course, the documented effect sizes mean that strong downstream commitment alone will not resolve childhood obesity. Priority must be given to policies that address broader obesity-conducive environments. It is here where bold actions, particularly at a national level, are urgently needed.

Clinic-based anticipatory guidance for obesity prevention

Although these broader approaches to obesity prevention are fundamental to tackling obesity, clinicians can also provide anticipatory guidance to families, children, adolescents and prospective parents in order to support healthy weight and weight-related behaviour^{41,42} (Box 5). These include providing weight monitoring, giving guidance on early feeding and children's diets,⁴³ reviewing physical activity opportunities, and recommending limited sedentary and screen time.⁴⁴

Management of child and adolescent obesity

While prevention of obesity in children and adolescents is vital, so too is the effective management of those already affected. In Australia, children and adolescents with obesity present frequently to primary, secondary and tertiary care services at rates that are higher than expected from the background prevalence of obesity.^{45,46} However, the primary reason for presentation is usually not obesity.^{45,46} Barriers to paediatric weight management experienced by medical practitioners include difficulties in raising the issue, uncertainty about advice to offer, lack of referral pathways, reduced local service capacity, a relative lack of

5 Anticipatory guidance and prevention in clinic settings for children and adolescents⁴¹⁻⁴⁴

Before and during pregnancy

- Encourage prospective parents to maintain a healthy weight before conception
- Encourage pregnant women to avoid excessive weight gain during pregnancy
- Monitor type 2 diabetes and hypertension during pregnancy and control of gestational diabetes

For infants and young children

- Encourage breastfeeding, including exclusive breastfeeding for 6 months followed by continued breastfeeding
- Assist parents to recognise cues of hunger and satiety, and provide responsive feeding
- Provide anticipatory guidance on child nutrition for parents, aligned with child's developmental stages
- Introduce solid foods around 6 months of age
- Fruits, vegetables and iron-fortified cereals as first foods and a variety of other foods introduced subsequently providing a balanced diet

Avoid unhealthy energy-dense snacks

- Monitor weight, ensuring children avoid rapid or excessive weight gain
- Recommend restricting screen time for children aged under 2 years and limiting to less than 1 hour each day for children aged 2–5 years
- Provide regular opportunities for supervised floor-based play and "tummy time" for infants
- Establish habits of daily physical activity and play for toddlers and pre-schoolers
- Recognise sleep cues and encourage adequate sleep

School-age children and adolescents

- Monitor weight and maintain correct growth velocity
- Encourage parents to model healthy dietary intake and patterns, physical activity and limited screen time
- Encourage family meals in which parents and children eat together
- Encourage children to eat a healthy breakfast daily
- Discourage eating meals or snacks while watching TV/screens

Limit energy-dense, nutrient-poor foods

- Restrict availability of discretionary foods at home and limit eating out
- Involve children and adolescents in planning, shopping and preparing meals
- Avoid sugar-sweetened beverages; limit fruit juice and encourage water and milk as main drinks
- Encourage daily physical activity (at least 1 hour of moderate to vigorous physical activity daily) and active transport (cycling, walking)
- Limit the amount of time children spend on screens, and other sedentary behaviours, to fewer than 2 hours per day
- Encourage healthy sleep routines and sleep duration ◆

confidence in managing patients with obesity, and a need for further training.^{46,47}

Weight stigma and obesity management

People with obesity can experience a range of forms of weight stigmatisation, including within the health system and by health professionals.^{48,49} This can lead to a variety of negative social, psychological and physical health consequences. In 2017, the American Academy of Pediatrics recommended several practice-level strategies to address weight stigma in the clinical care of young people.⁴⁸ These include role modelling by medical practitioners of supportive and unbiased behaviours towards children and families with obesity; using appropriate language and neutral word choices, such as "unhealthy weight", "BMI" or "weight", in place of words perceived to be stigmatising or blaming, such as "obese", "extremely obese" or "fat"; creating safe and welcoming practice environments; ensuring good clinical documentation; and having an empathetic approach to behaviour change counselling.⁴⁸

Routine growth assessment

Growth assessment should be a part of standard paediatric clinical practice. The more routine this is, the easier it will be to recognise abnormal growth patterns, raise the issue of obesity if present via discussion of the growth chart, and plan management. In children

aged over 2 years, height and weight should be measured and BMI calculated and plotted against BMI-for-age reference charts.⁴² Measurement of waist circumference provides some information about central fat distribution, with a waist-to-height ratio > 0.5 being useful in predicting cardiometabolic risk.⁴²

Clinical investigations

Clinical investigations of potential obesity-associated complications are warranted in most adolescents with obesity, and in all patients with severe obesity, with clinical signs or history suggestive of complications (eg, acanthosis nigricans), or with a familial risk of cardiometabolic disease. Investigations normally include liver function tests and measuring fasting glucose, lipid and possibly insulin levels.^{42,50} Because obesity can be associated with micronutrient deficiencies, it may be prudent to check full blood count and iron, vitamin B12 and vitamin D levels. More specialised assessment is usually not needed, unless there is evidence of endocrine or genetic disease, such as short stature, poor linear growth, developmental delay, hirsutism or menstrual irregularities.

Second line investigations may include liver ultrasound or an oral glucose tolerance test. When obstructive sleep apnoea is suspected, referral for a sleep study is warranted. A range of other investigations, including markers of low grade inflammation, are

potentially useful in assessing childhood obesity but are not yet recommended for routine assessment.

The 2013 National Health and Medical Research Council (NHMRC) clinical practice guidelines⁴² and other reviews⁵⁰ provide further details about clinical history taking and examination, and potential investigations.

Conventional treatment

Family-based behavioural change interventions. Traditionally, treatment of child and adolescent obesity has focused on family-based, multicomponent (diet, physical activity and behaviour change) interventions. A 2017 systematic review reporting on 70 trials in children aged 6–11 years found that such interventions led to small and often short term reductions in weight and BMI when compared with a no treatment or usual care control group (mean difference weight, – 1.45 kg [95% CI, – 1.88 to – 1.02 kg]; BMI, – 0.53 kg/m² [95% CI, – 0.82 to – 0.24 kg/m²]) at the longest follow-up.⁵¹ A separate systematic review of 44 intervention trials in adolescents aged 12–17 years also showed reductions in weight and BMI (mean difference weight, – 3.67 kg [95% CI, – 5.21 to – 2.13 kg]; BMI, – 1.18 kg/m² [95% CI, – 1.67 to – 0.69 kg/m²]).⁵² In adolescents, the weight outcomes for intervention versus control groups persisted to 18–24 months from baseline.

In both Cochrane reviews, there were reductions in body fat percentage, waist circumference and total fat mass.^{51,52} Improvements in quality of life were also noted in adolescents, with dietary and physical activity outcomes in both age groups being inconsistent for the included studies.

A separate systematic review reported on cardiometabolic outcomes from behaviour change interventions in children and adolescents with obesity, showing reductions in fasting insulin (mean difference, – 55 pmol/L; 95% CI, – 71 to – 39 pmol/L), low density lipoprotein cholesterol (– 0.30 mmol/L; 95% CI, – 0.45 to – 0.15 mmol/L), triglycerides (– 0.15 mmol/L; 95% CI, – 0.24 to – 0.07 mmol/L) and blood pressure up to 12 months from baseline.⁵³

There are often challenges in implementing these findings in usual clinical practice.⁴⁹ For example, compared with the situation in clinical trials, it may not be possible to review patients as frequently, there may not be the same level of specialist expertise available, and patients may have other comorbidities or be more socially disadvantaged. Treatment fidelity and treatment adherence are thus potentially compromised.

Despite these difficulties, the principles of obesity management in children are well established (Box 6).

6 Key management principles for children and adolescents with obesity^{49,50}

- An empathetic approach, employing non-stigmatising language
- Use body mass index for age charts
- Assess and manage comorbidities
- A family focus
- A developmentally appropriate approach
- Support long term behavioural change (see Box 7)
- Strategies for long term weight maintenance
- In patients with moderate to severe obesity, more intense dietary interventions (eg, very low energy diet) may be indicated
- In adolescents with moderate to severe obesity, consider other therapies, including pharmacotherapy and bariatric surgery

Behaviour change strategies. Appropriate strategies to treat paediatric obesity should facilitate behaviour change and family involvement to improve diet, physical activity, screen time and sleep (Box 7). Emerging evidence also suggests that digital technologies, including mobile health, should be considered as an alternative or adjunct to traditional lifestyle therapy.⁵⁴ However, more evidence is required in this area.

The NHMRC clinical practice guidelines⁴² and other reviews⁵⁰ provide detailed outlines of these treatment components. Some state health departments have additional online resources to support and upskill clinicians.⁵⁵

Non-conventional treatment

More intensive dietary approaches. A very low energy diet (VLED) should be considered in adolescents with severe obesity or obesity-related comorbidities, or in adolescents who have not achieved weight loss following a more conventional dietary approach.⁴² A VLED is usually an intensive, short term, strict calorie restriction (< 800 kcal/day) typically achieved using formulated meal replacements such as shakes and bars to ensure nutritional adequacy.⁵⁶ In adolescents, VLEDs can induce safe short term weight loss and improvements in metabolic risk factors.^{57,58} The strict nature of the diet requires intensive monitoring by health professionals.

Pharmacotherapy. A 2016 systematic review of trials of drug interventions in paediatric obesity identified 11 trials of metformin, four of orlistat and one of combined metformin–fluoxetine, as well

7 Behaviour change strategies for the management of children and adolescents with obesity^{50–52}

Behaviour modification techniques

- Goal setting
- Stimulus control (modifying or restricting environmental influences)
- Self-monitoring

Behaviour modification approaches

- Family-centred
- Achievable
- Individualised to suit age, lifestyle and family

Dietary change strategies

- Appropriate fruit and vegetable intake (two and five serves, respectively)
- Reduction in discretionary foods
- Healthy snack options
- Breakfast daily
- Appropriate portion sizes
- Water as the main drink

Physical activity and screen time recommendations

- Participation in physical activity for at least 1 hour per day
- No more than 1 hour per day of screen time for 2–5-year-olds
- No more than 2 hours per day of screen time for 5–17-year-olds

Sleep recommendations

- Appropriate sleep duration (ie, 10–12 hours a night for under-12-year-olds; 8–10 hours a night for over-12-year-olds)
- Earlier bed time may be needed
- Bedroom screen time restrictions

as ongoing trials of metformin, topiramate and glucagon-like peptide-1 receptor agonists.⁵⁹ All were undertaken in the context of support for behavioural change. Overall there were small reductions in weight compared with placebo (effect size for metformin, -3.90 kg [95% CI, -5.86 to -1.94 kg]; for orlistat, -2.48 kg [95% CI, -4.31 to -0.65 kg]). The most commonly reported adverse events in the orlistat and metformin trials were gastrointestinal, such as diarrhoea, mild abdominal pain or discomfort, and fatty stools (orlistat specific). Thus, in adolescents with obesity, there are currently only limited drug therapy options, with use often being off-label.

Bariatric surgery. There is one randomised controlled trial of bariatric surgery in adolescents: an Australian study of 50 patients aged 14–18 years who received either laparoscopic adjustable gastric banding or a lifestyle program.⁶⁰ At 2 years, the surgery group had marked reductions in weight (mean weight loss, 34.6 kg [95% CI, 30.2 – 39.0 kg]) compared with the lifestyle group (mean weight loss, 3.0 kg [95% CI, 2.1 – 8.1 kg]). The prospective US Teen-Longitudinal Assessment of Bariatric Surgery⁶¹ enrolled 242 patients, with 67% undergoing Roux-en-Y gastric bypass, 28% laparoscopic sleeve gastrectomy and 6% laparoscopic adjustable gastric banding. At 3 years, there was a 27% (95% CI, 25 – 29%) mean weight loss, and marked improvement in both cardiometabolic complications and quality of life measures. However, 13% had undergone one or more further intra-abdominal procedures.

The current Australian and New Zealand recommendations for bariatric surgery in adolescents⁶² are that surgery should be considered in adolescents (minimum age, 15 years) with severe obesity ($\text{BMI} > 40\text{ kg/m}^2$, or $> 35\text{ kg/m}^2$ in the presence of severe complications), following at least 6 months of multidisciplinary therapy, and where the adolescent and family are motivated and the adolescent provides informed consent. A challenge for health care systems in Australia is how to ensure equitable access to appropriate bariatric surgery services for affected adolescents.

Paediatric obesity and health service delivery considerations

There is strong evidence that treatment of paediatric obesity leads to some improvements in BMI as well as in obesity-related complications (Box 4).¹² However, resourcing constraints prevent such interventions from being accessible and deliverable, at scale, in most health systems. The 2016 WHO report called for leadership to: "Develop and support appropriate weight management services for children and adolescents ... that are family-based, multicomponent (including nutrition, physical activity and psychosocial support) and delivered by multi-professional teams

with appropriate training and resources, as part of Universal Health Coverage".⁸

In Australia, there are few well evaluated models of care for the treatment of paediatric obesity, and there are no clear referral pathways from primary to secondary and tertiary level services in most health districts. There is also marked variability across the states in terms of availability of community-based child weight management programs. In November 2015 in New South Wales, "tackling childhood obesity" was named as one of 12 Premier's Priorities. The resultant focus from the state government has provided opportunities for the development and delivery of a range of free online clinical resources and training modules for health professionals, as well as the initiation of additional services to treat childhood obesity. The Healthy Kids for Professionals website provides access to the Weight4KIDS e-learning program and other clinical resources.⁵⁵

Conclusion

Our narrative review of the literature shows that child and adolescent obesity is a complex problem involving many levels of influence. In terms of obesity prevention, there needs to be integrated action from pre-conception, through pregnancy and early childhood, and across the age and developmental spectrum. Several strategies outside the health sector hold promise for influencing obesity on a population scale. These include fiscal policies to reduce consumption of sugar-sweetened beverages, the strict regulation of unhealthy food marketing to children, public transport policies to promote active transport, and urban planning approaches that support active communities. Effective treatment of children and adolescents with established obesity is also required. While the basic principles of management are well recognised — including family-based, behavioural change, as well as adjunctive therapies for older children with more severe obesity — major challenges in delivering services, at scale, in often resource-constrained environments remain. Coordinated health care pathways are required in each health region, linking primary care through to tertiary care services, which include bariatric surgery for older adolescents. Overall, curbing the problem of obesity is achievable and can be realised through a combination of smart governance across many sectors, community initiatives, the support of individual efforts, and clinical leadership.

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