3. Management and prevention of obesity and its complications in children and adolescents

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Behaviour change involving the whole family is more likely to be successful

The World Health Organization describes the "escalating global epidemic" of obesity as "one of today's most blatantly visible — yet most neglected — public health problems".[1] Studies of obesity prevalence over time show an increase of 2.3–3.3-fold over about 25 years in the United States and 2.0–2.8-fold over 10 years in the United Kingdom.[2]

Current estimates in Australian children and young people indicate that 20%–25% are overweight or obese. The 1995 National Nutrition Survey found that 4.9% of boys and 5.4% of girls were obese, and two other studies in 1997 (the New South Wales Schools Fitness and Physical Activity Survey, and the Health of Young Victorians Study) gave similar results.[3] There is also evidence that, between 1985 and 1995, the rates of overweight have doubled and those of obesity have trebled.[4]

Definition of overweight and obesity

An Australian expert working group has identified body mass index (BMI) as the most appropriate measure of excessive weight in children. BMI is calculated by dividing the weight (kg) by the height squared (m^2).

Rapid changes in BMI occur in normal growth, and BMI varies with age and sex. It rises in the first year of life, then falls during preschool years, before rising again into adolescence. The point at which BMI starts to rise again (usually around 4–6 years of age) is termed "adiposity rebound". Thus, calculated BMI values need to be compared with age and sex reference standards. For clinical use, the expert working group has recommended the BMI-for-age percentile charts developed in the United States by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion.[5] These can be downloaded from the Centers for Disease Control and Prevention website (for boys 2–20 years: <www.cdc.gov/nchs/data/nhnes/growthcharts/set1/chart15.pdf>; for girls 2–20 years <www.cdc.gov/nchs/data/nhanes/growthcharts/set1/chart16.pdf>). BMI greater than the 85th percentile suggests overweight, while

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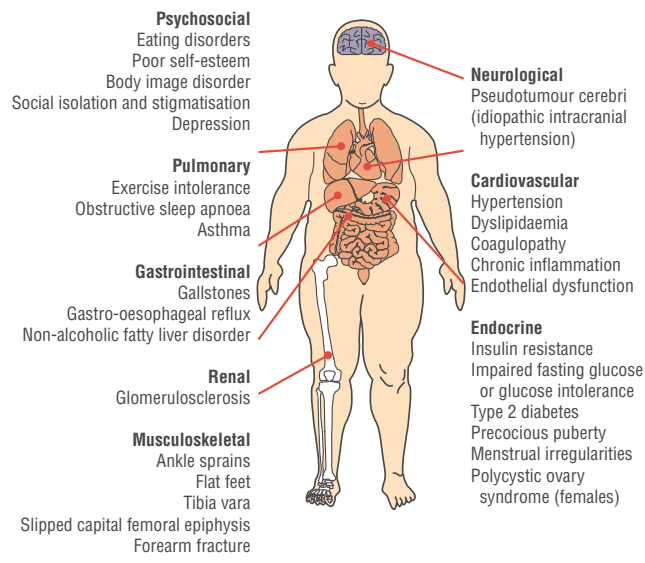**Department of Endocrinology and Diabetes, Royal Children's Hospital, Brisbane, QLD.**
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ABSTRACT

- Obesity in children and adolescents has reached alarming levels — 20%–25% of children and adolescents are overweight or obese, and 4.9% of boys and 5.4% of girls are obese.

- Rates of obesity have increased significantly in Australia from 1985 to 1995, with the prevalence of overweight doubling and obesity trebling.

- Body mass index (related to reference standards for age and sex) is recommended as a practical measure of overweight and obesity in children, and is used in monitoring individual progress in clinical practice.

- Obesity in childhood and adolescence may be associated with a range of medical and psychological complications, and can predispose individuals to serious health problems in adult life, including type 2 diabetes, hypertension, dyslipidaemia and non-alcoholic steatohepatitis.

- Obesity interventions for which there is some evidence include family support, a developmentally appropriate approach, long-term behaviour modification, dietary change, and increased physical activity and decreased sedentary behaviour.

- Prevention of obesity in children and adolescents requires a range of strategies involving changes in both the microenvironment (eg, housing, neighbourhoods, recreational opportunities) and the macroenvironment (eg, food marketing, transport systems, urban planning).

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BMI greater than the 95th percentile suggests obesity. These charts can be used in clinical practice to monitor progress.

Aetiology of obesity: heredity v environment

Genetic factors

Several studies have shown that there is a strong genetic basis to the development of obesity. Obesity appears to be a polygenic disorder, with many genes currently linked or associated with a predisposition to excess adiposity.[6] At least five single-gene mutations causing human obesity that present in childhood have been identified. These are rare and all are associated with severe and very early onset obesity, and should prompt referral for further assessment.

Environmental factors

Sedentary behaviour: Physical inactivity is a major element in the development of obesity in westernised societies — in children and adults alike. International studies have shown that television viewing

1 Complications of obesity in children and adolescents

Psychosocial
Eating disorders
Poor self-esteem
Body image disorder
Social isolation and stigmatisation
Depression

Pulmonary
Exercise intolerance
Obstructive sleep apnoea
Asthma

Gastrointestinal
Gallstones
Gastro-oesophageal reflux
Non-alcoholic fatty liver disorder

Renal
Glomerulosclerosis

Musculoskeletal
Ankle sprains
Flat feet
Tibia vara
Slipped capital femoral epiphysis
Forearm fracture

Neurological
Pseudotumour cerebri
(idiopathic intracranial
hypertension)

Cardiovascular
Hypertension
Dyslipidaemia
Coagulopathy
Chronic inflammation
Endothelial dysfunction

Endocrine
Insulin resistance
Impaired fasting glucose
or glucose intolerance
Type 2 diabetes
Precocious puberty
Menstrual irregularities
Polycystic ovary
syndrome (females)

Adapted from reference 2 (*Lancet* 2002; 360: 475), with permission from Elsevier.

is associated with an increased incidence of new cases of obesity, as well as with a decrease in success rates for obesity intervention.[7] Television viewing exposes children to food marketing, increases opportunities for snacking on high-energy foods and drinks, decreases opportunities for physical activity, and reinforces sedentary behaviour. There are as yet no clear data linking viewing of interactive videos, or using computers or other electronic media, with the development of obesity, although they are likely to be associated.

Dietary intake: The increased prevalence of obesity in recent decades may have partly resulted from an increased consumption of high-fat foods or sweetened drinks, although the evidence for a clear effect of diet is not strong. In young children, parental influence on food selection is strong. In older children and adolescents peer influence is also important. Less desirable meal patterns, such as frequent snacking, also appear to be related to established obesity.

Other risk factors for obesity in childhood and adolescence include:
• Early infant feeding: Breastfeeding is possibly protective for the development of obesity.[8]
• Parental obesity, eating patterns, and attitudes: Parental obesity more than doubles the risk of adult obesity among both obese and non-obese children.[9] Dietary disinhibition in the mothers of preschoolers is associated with subsequent excess weight gain in their daughters,[10] and a 6-year outcome study of children showed that parental dietary disinhibition is associated with greater increases in body fatness.[11] Parents who strongly encourage their children to eat have heavier children.[12]
• Early adiposity rebound: Earlier adiposity rebound is associated with increased body fatness in adolescence.
• Socioeconomic status: In some developed countries, poorer children or those who live in rural settings are more at risk of obesity, whereas in countries undergoing economic transition childhood obesity is associated with a more affluent lifestyle and with living in urban regions.

• Ethnicity: Data from the United States show that there is an increased risk of obesity in Native Americans and Hispanic Americans compared with white Americans, although these differences may be largely related to differences in socioeconomic status.
• Underlying medical disorders: Secondary obesity may occur with medical conditions, including hypothyroidism, hypercortisolism, growth hormone deficiency and hypothalamic damage.
• Prescription drugs: Some drugs may contribute to obesity. These include glucocorticoids, antipsychotic drugs (eg, risperidone) and some antiepileptic medications.

Complications of obesity

Childhood obesity is a chronic paediatric disease with possible immediate and long-term complications involving many body systems (Box 1). The National Health and Medical Research Council (NHMRC) *Clinical practice guidelines for the management of overweight and obesity in children and adolescents*[13] provides a comprehensive review of the complications of childhood and adolescent obesity. We will briefly discuss insulin resistance and type 2 diabetes, and steatohepatitis.

Insulin resistance

Obesity in childhood and adolescence may be associated with insulin resistance. Without appropriate medical intervention, severe obesity and insulin resistance may progress to type 2 diabetes, which now accounts for up to 50% of newly diagnosed diabetes in some paediatric populations (eg, African Americans).[14] Acanthosis nigricans is considered to be a marker of insulin resistance in children and adolescents (Box 2).

Steatohepatitis

Non-alcoholic steatohepatitis (NASH) was first described in 1979 in adults. NASH also occurs in childhood, but is less well characterised. Liver biopsies from obese prepubertal children with NASH may show fatty change, inflammation and fibrosis, with progression to necrosis and cirrhosis.[15] Most cases of paediatric NASH are described in older children and adolescents. Elevated serum transaminase levels should raise suspicion of NASH in an obese child or adolescent. If NASH is suspected, referral to a centre specialising in the management of childhood obesity is recommended.

Assessment of the obese child and adolescent

The decision to further investigate obesity should be based on a combination of adiposity (BMI percentile), presence of complications and other risk factors (including family history and lifestyle factors), and the family's and young person's willingness to undertake lifestyle change (Box 3 and Box 4).

2 Acanthosis nigricans

Acanthosis nigricans — a thickened, pigmented skin lesion in flexures and on the dorsum of hands — is associated with insulin resistance.

Obesity interventions: the evidence

Established obesity in children and adolescents has proven difficult to treat. A recent Cochrane review of the management of obesity in children and adolescents has shown that there are a limited number of randomised controlled trials.[20] Common strategies in the treatment of paediatric obesity for which there is at least some evidence are given in Box 5.

3 Assessment of the obese child or adolescent

History

General history

- Pregnancy details and birthweight, including maternal gestational diabetes
- Early medical history
- Ethnicity

Weight history

- History of development of obesity, including onset and duration
- Pubertal history
- Impact of obesity on the young person's life and on the family

Complication history

- Psychological effects of obesity, including teasing and bullying
- Presence of sleep apnoea/disturbed sleep

Asthma

- Specific symptoms, such as knee or hip pain
- Menstrual history (girls)
- Exercise tolerance

Family's weight and metabolic history

- BMI or BMI percentile for first-degree relatives
- Relative weights of other family members
- Family history, including obesity, type 2 diabetes, cardiovascular and cerebrovascular disease or obstructive sleep apnoea

Lifestyle history

- Daily physical activity, including sports participation
- Daily sedentary activities (eg, TV, video games, computer use)
- Dietary history, including normal meal pattern, fast-food intake and snacks

Examination

- Height
- Weight
- Waist circumference*
- Pubertal stage (according to Tanner)[16,17]
- Blood pressure (use appropriate-sized cuff and age norms)[18]
- Acanthosis nigricans (Box 2)
- Hepatomegaly

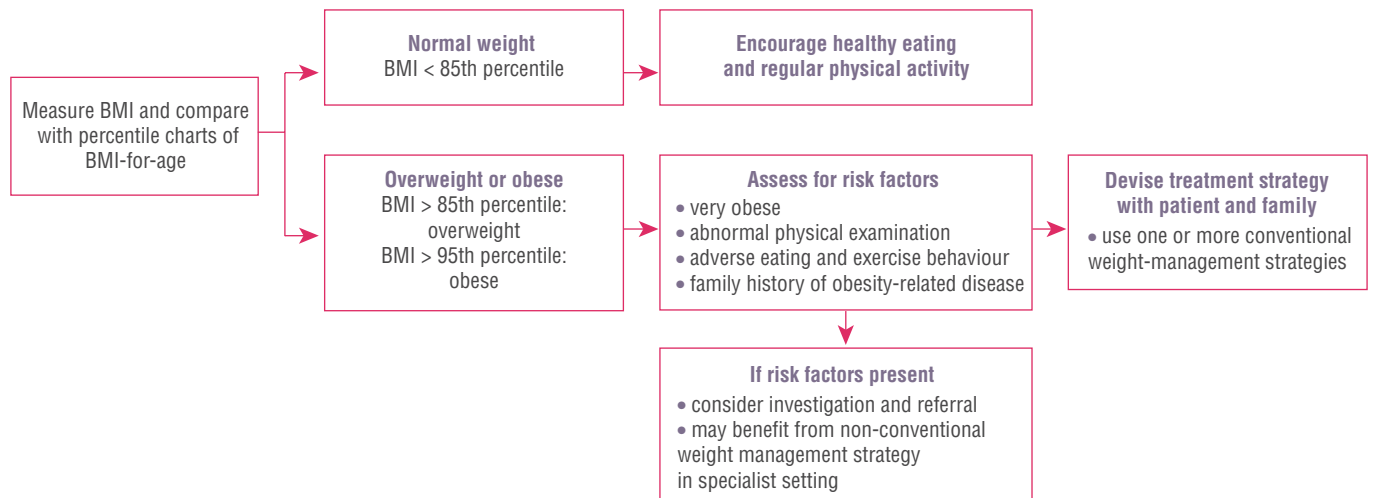- Striae, intertrigo
- Gait and mobility

Physical examination findings requiring further assessment:[†]

- Short stature
- Abnormal physical stigmata
- Associated intellectual disability
- Visual disturbance and headache (may be a sign of central nervous system lesion)

*Waist circumference can be used as a proxy for abdominal obesity, with its increased risk of metabolic complications. There are no specific cut-off points for waist circumference for age to categorise abdominal obesity in children and adolescents. However, if the waist circumference of a child or adolescent falls above the acceptable waist circumference cut-off points for adults[19] (increased risk: men > 94 cm, women > 80 cm), then the child can be readily classified as having abdominal obesity. This imperfect, but practical, approach will, of course, lead to an underestimation of abdominal obesity in paediatric patients. Waist circumference may be most useful in clinical assessment of individual patients when measured serially and used to monitor change over time.

† For most overweight children, investigations are not necessary. However, if a child or adolescent is very obese, has a family history of metabolic disease, or a history and examination suggesting the presence of complications of obesity, then a fasting lipid profile, fasting levels of insulin and glucose, and liver function tests (to assess the presence of non-alcoholic steatohepatitis) should be considered. Endocrinological tests are not required, unless there is other evidence of endocrine disease or short stature. Consider referral for review at a specialist centre.

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4 Assessment and management of the obese child or adolescent

Measure BMI and compare with percentile charts of BMI-for-age

→ **Normal weight**
BMI < 85th percentile
→ **Encourage healthy eating and regular physical activity**

→ **Overweight or obese**
BMI > 85th percentile: overweight
BMI > 95th percentile: obese
→ **Assess for risk factors**
- very obese
- abnormal physical examination
- adverse eating and exercise behaviour
- family history of obesity-related disease
→ **Devise treatment strategy with patient and family**
- use one or more conventional weight-management strategies

If risk factors present
- consider investigation and referral
- may benefit from non-conventional weight management strategy in specialist setting

Conventional management of childhood obesity

Family involvement

Treatment programs for obesity should take into account the influence of the child's family on food choices and level of physical activity. Studies on long-term maintenance of weight loss have shown the importance of altered food habits within the whole family, support for the child, and parental praise for changed eating behaviour and physical activity.[21]

Developmentally appropriate approach

Treatment of preadolescent obesity with parents as the exclusive agents of lifestyle change appears more effective than targeting the child alone.[22] There has been some success with separate sessions for adolescents and parents and structured programs flexible enough to allow input from adolescents.[23] There have even been short-term positive outcomes with a phone- and email-based program for adolescent weight management.[24]

Dietary change

There is some concern that rigid restriction or control of a child's food intake may trigger disordered eating or, in the young child, reduction in linear height growth. Less prescriptive, lower-energy diets are now used, with an emphasis on all members of the family moving to healthier eating patterns.[25] The aim is to provide a flexible program to help the family and the child to make sustainable changes in food choices and eating habits. In general, dietary interventions should emphasise energy reduction, lower-fat food choices, increased vegetable and fruit intake, healthier snacks and decreased portion sizes. Water should be used as the main beverage, and drinks with high sugar content, including soft drinks and fruit drinks, should be limited. The effect of these interventions should be a reduction in total energy intake by reducing the energy density of the diet. Changes in eating habits, shopping practices and types of food for the whole family will support a child's ability to self-regulate his or her food intake.

Increased physical activity and decreased sedentary behaviour

Enhanced physical activity (both planned and incidental/lifestyle) is an important component of weight management programs for obese children, although, as with dietary intake, there is no evidence as to the most effective physical activity prescription. In a study of the long-term

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5 Conventional management of childhood obesity

Family involvement

- Behaviour change needs to involve the whole family, and provide support for the child

Developmentally appropriate approach

- *Preadolescent children:* Focus on parents as the agents of change

- *Adolescents:* Parents and adolescents attend separate sessions

Dietary change

- Avoid severe food restriction

- Reduce energy intake

- Reduce portion size

- Select foods with lower fat content and low glycaemic index

- Increase vegetable and fruit intake

- Reduce high-sugar foods and drinks

- Use water as the main beverage

Increased physical activity

- Incidental activity

- Lifestyle activity

- Exercise programs

- Active transport (walking, cycling)

Decreased sedentary behaviour

- Reduce time spent watching television, playing computer games, using other electronic media

- Encourage alternatives to motorised transport

Behaviour modification

- Build confidence

- Assess readiness for change

- Change habits associated with eating and physical activity

- Set realistic goals for lifestyle change

Active transport for the whole family (photo courtesy of TravelSmart Australia).

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effectiveness of physical activity interventions, the lifestyle exercise group maintained better weight than the programmed exercise group.[26] There is some evidence that a reduction in sedentary behaviour is an effective component of a weight management program for obese children.[27]

Behaviour modification

Behaviour modification is a component of most weight management programs. A variety of different behaviour modification strategies have been used in obesity treatment studies (Box 5).[28]

Intervention type and setting

Several types of interventions have been used to treat childhood obesity: individual counselling sessions, group programs, and sessions given by different types of healthcare professionals.[2] Interventions have been conducted in different settings, including primary care, community health centres, tertiary institutions and holiday camps. There is some evidence for the effectiveness of group programs, holiday camps and email- and phone-based behavioural interventions.[24]

Non-conventional management of childhood obesity

Very low calorie diets

In general, very low calorie diets, whether they involve normal food items or non-food substitutes, produce rapid weight loss in adolescents. This may be of benefit when there is significant medical comorbidity, but should be conducted in a specialised centre.[13] Very low calorie diets are never indicated for children.

Drug therapy

Sibutramine (Reductil, Abbott): Berkowitz et al[29] performed a randomised controlled trial of sibutramine in 82 adolescents with BMI 32–44. The addition of sibutramine to a comprehensive behavioural program induced significantly more weight loss than the behavioural program and placebo; however, 23/82 required a lower dose and 10/82 ceased treatment because of hypertension.

Orlistat (Xenical, Roche): Short-term studies of orlistat in obese adolescents showed good tolerability and weight loss.[30]

- The NHMRC guidelines[13] suggest that use of both sibutramine and orlistat in obese adolescents with complications should take place only in a specialist centre, and only when there is a reasonable expectation of benefit over risk.

Case study — a 5-year-old overweight child

A mother brings her 5-year-old daughter to you because of concerns about the girl's significant overweight. The girl is an only child who lives with her mother and maternal great-grandmother and has no contact with her father.

The mother's pregnancy was complicated by gestational diabetes and hypertension. The child's birthweight was 3.7 kg.

The child's past medical history has been unremarkable, apart from mild asthma (currently not requiring treatment). The mother has made some unsuccessful attempts to modify the child's dietary intake over the past two or more years.

Several family members are obese, including the mother, maternal aunt, maternal grandmother and many family members on the father's side of the family. There is also a family history of type 2 diabetes (mother had gestational diabetes; maternal great-grandmother has type 2 diabetes).

The girl is in pre-school and has swimming and judo lessons each week, but otherwise plays quietly on her own as no playmates live nearby. She does not watch much television, although the TV is on while the family eats.

Her dietary intake includes three serves of fruit juice per day, a large-size serve for the evening meal, very few vegetables and some high-fat snacks during the day.

The girl appears well and happy. Her weight is 36.2 kg (> 97th percentile); height, 111.2 cm (75th percentile); and BMI, 29.3 kg/m² (> 95th percentile for age). Her waist circumference is 80 cm. Apart from obesity, there are no abnormal findings on examination. Her blood pressure is 100/60 mmHg.

Management

You arrange to see the mother, on her own, initially monthly, to support her in making whole-family lifestyle changes.

- The mother makes several sustainable changes to her daughter's food intake (water as a beverage; smaller-sized serves for the evening meal; healthier snack options, including cut-up raw fruit and vegetables).

- The family no longer watches television while eating the evening meal.

- The family buys a dog, and the child and her mother take it for regular walks.

- The child commences school and thus has more opportunities for regular play with her peers.

At the 15-month review, the girl's weight is now 37.4 kg (still > 97th percentile, but only a 1.2 kg weight gain in 15 months); height, 119.9 cm (75th percentile); and BMI, 26.0 kg/m² (> 95th percentile, a 3.2-unit decrease). Her waist circumference remains at 80 cm. While still obese, the girl's rate of weight gain has decreased and her BMI has fallen dramatically.

You continue to see the mother on a 2- to 3-monthly basis to provide further support for long-term lifestyle change.

Metformin: Two recent, small controlled trials of the use of metformin in adolescents with hyperinsulinaemia and obesity but no diabetes found that the metformin group had a reduction in hyperinsulinaemia and a modest weight loss compared with the non-metformin group.[31,32]

- The NHMRC guidelines[13] state that metformin has a potential role in therapy in these adolescents, and that metformin therapy should be considered in obese adolescents with significant hyper-insulinaemia and a family history of diabetes.

Obesity (bariatric) surgery

- The NHMRC guidelines[13] consider bariatric surgery as a last possible option in a severely obese adolescent with obesity-related comorbidity. Assessment for suitability and continuing postoperative care in an experienced weight-management service would be mandatory.

Prevention of obesity

A recently published Cochrane review of interventions for preventing obesity in children concluded that there are "limited high quality data on the effectiveness of prevention programs".[33] However, the published studies do highlight the potential of combining a reduction in sedentary behaviour and an increase in physical activity, as well as the utility of a school-based setting.

The randomised-controlled-trial approach may be inappropriate for large-scale or comprehensive obesity-prevention studies. New approaches to assessing the effectiveness of "real world" obesity-prevention interventions are being developed. Several community-based interventions aimed at preventing obesity and incorporating such approaches are currently under way in a number of countries, including Australia and New Zealand.

Swinburn et al[34] introduced the concept of the obesogenicity of modern environments, with the influences promoting the develop-

ment of obesity operating on micro- and macroenvironmental levels, and having physical, economic, political and sociocultural aspects. Elements in the microenvironment that influence physical activity and food intake include settings where people live, work and study; community facilities (shopping malls, clubs, churches); food retailers and outlets (supermarkets, canteens, lunch bars, restaurants); recreational facilities (parks, pools, gyms); type of neighbourhood (street safety, cycle paths, footpaths); and access to local primary healthcare.

At the macroenvironmental level (ie, beyond the sphere of influence of individuals) factors affecting dietary intake and physical activity include food production, importation, marketing and distribution; urban and rural development (town planning); transport systems

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Evidence-based practice tips

- Parents influence food choices and other eating behaviours in their children. Disordered eating in a parent may be associated with excess body weight in the child (**III-3**).[10,11]

- The prevalence of type 2 diabetes is increasing in children and adolescents, particularly in certain ethnic groups. This increase appears associated with high levels of obesity in these populations (**III-2**).[14]

- There is short-term evidence that reducing sedentary behaviours in obese children is as effective for weight management as increased activity (**III-3**).[27]

- There is some limited evidence that a weight management program for children and adolescents can be delivered in a variety of settings and achieve similar outcomes. The majority of such programs use a group format (**III-3**).[2]

Levels of evidence (I–IV) are derived from the National Health and Medical Research Council's system for assessing evidence.[35]

"Walking School Bus", a supervised walk-to-school group of primary school students, escorted by parent volunteers (photo courtesy of TravelSmart WA's Walking School Bus program).

(public transport); and health systems. Assessing the environment of a given community using this framework indicates the opportunities for preventive strategies. As yet, there are few successful examples of multifaceted, large-scale interventions to guide obesity-prevention programs. Such interventions need to be supported by adequate resourcing and significant community ownership.

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