

Obesity in Children and Adolescents

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The World Health Organization describes obesity as “one of today’s most blatantly visible—yet most neglected—public health problems” and uses the term “globesity” to reflect an “escalating global epidemic of overweight and obesity” (1). The International Obesity Task Force (IOTF) terms obesity the “millennium disease,” highlighting the major international impact of this condition (2). In fact, obesity is now a pandemic, affecting both adults and children in developed and developing countries.

Reports from the IOTF have demonstrated that the paediatric obesity epidemic has spread throughout the world, with some countries in economic transition having prevalence rates higher than those in the United States (3,4). The worldwide prevalence of overweight in children and young people ages 5 to 17 years is approximately 10%, with that of obesity alone being 2 to 3% (3). Certain regions and countries have particularly high rates of paediatric obesity: More than 30% of children and adolescents in the Americas, and approximately 20% of those in Europe, are overweight or obese, with much lower prevalence rates being seen in sub-Saharan Africa and Asia, although in some of these regions rapid changes in prevalence values are being reported.

The increased prevalence of obesity in recent decades in genetically stable populations highlights the central role of recent important environmental trends in the development of the obesity epidemic. Environmental factors that are seen to promote excess weight gain include sedentary lifestyles, a high intake of energy-dense micronutrient-poor foods, a high intake of sugar-sweetened drinks, the heavy marketing of energy-dense foods and fast-food outlets, adverse socioeconomic conditions, and large portion sizes. Factors that protect against obesity include regular physical activity, a high

dietary fiber intake, environments that promote healthy food choices for children, and breast-feeding (5).

CURRENT CONTROVERSIES OR ISSUES

Definition of Obesity

For epidemiological and research purposes, it is useful to have a common definition of obesity. There are different definitions used by various authorities in different countries. Body mass index (BMI), or weight/height², is a simple and cost-effective measure of body fatness in both adulthood and childhood. Although there is some agreement on the BMI cutoff points used to denote overweight and obesity in adults, among children there is insufficient evidence to provide an absolute anthropometric definition of health-related overweight.

Until recently, no standard definitions of overweight and obesity existed for children and adolescents. In the late 1990s, the IOTF recommended that BMI, based on percentile curves that at age 18 pass through the adult cutoff points of 25 kg/m² and 30 kg/m², be used to define overweight and obesity among children and adolescents (6). Subsequently, in 2000, a table of age- and sex-specific cutoff points based upon a compilation of nationally representative cross-sectional growth studies from a number of countries was developed (7). These cutoff points are used in epidemiological research to classify overweight and obesity, and the major advantage of the definition is that it allows international comparison of trends in overweight and obesity. The IOTF definition is not, however, designed for clinical use. Additional limitations are that it is not as yet linked to a definition of extreme overweight, it is not possible to derive a z score to express BMI as a continuous measure for children of different ages, and the definition does not extend to children at ages younger than 24 months.

Another definition in widespread use is based on the revised United States growth charts from the Centers for Disease Control and Prevention (8). In these, the 85th and 95th percentiles on the BMI-for-age charts are used as the

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The authors report no conflicts of interest.

cutoff points for defining “at risk for overweight” and “overweight,” respectively (9). Advantages of such a definition are that it can be readily adapted to clinical use, it accords with conventions used in other growth charts, and the reference population is well documented. Disadvantages include the relatively arbitrary nature of the cutoff points, the use of a US reference population which is potentially bigger than many other populations, and the fact that “obesity,” as such, is not defined.

Additional issues to be considered are the development of a standard definition of abdominal obesity, and the probable need to consider ethnically specific definitions of obesity. In children and young people, waist circumference is correlated with abdominal fat, as well as with cardiovascular risk factors (10). Waist circumference charts have been published for a range of different countries, but as yet there are no internationally accepted criteria for high- or low-risk waist circumference in this age group. Nationally developed waist circumference-for-age charts can be used to monitor clinical progress of an individual patient. A further consideration is that racial and ethnic variations exist in the biological response to excess adiposity. Among adults, Asians generally have a higher percentage body fat for a given BMI, and an associated increased health risk at lower BMI values, compared with Europeans, whereas Pacific populations generally have a lower percentage of body fat and a decreased health risk at the same BMI levels (11,12). Such differences may ultimately require the development of ethnically or racially specific definitions or criteria for obesity, for both adults and children.

Consensus Guidelines

1. For epidemiological studies, it is recommended that the definition developed by the IOTF (7) be used to define overweight and obesity among children and adolescents 2 to 18 years old. The major advantage of this definition is that it allows international comparison of trends in overweight and obesity.
2. For clinical use, BMI for age charts should be used. The decision as to which particular reference chart should be used is for national groups to consider because there are several published charts. A consensus definition on cutoff points to define overweight and obesity has not been reached.

Breast-feeding and Obesity

Breast-feeding has been observed to reduce the prevalence of obesity in later life (13–16). Observational studies suggest that prolonged breast-feeding is associated with a dose-dependent decrease in the risk of overweight. A meta-analysis has shown that the duration of

breast-feeding is inversely associated with the risk of overweight (14): In that study, categorical analysis confirmed the dose response association and 1 month of breast-feeding was associated with a 4% decrease in risk.

In another recent systemic review (17), breast-feeding was associated with a slightly lower mean BMI than formula feeding. However, the effect was abolished after adjustment for socioeconomic status, maternal smoking in pregnancy, and maternal BMI. This review concluded that mean BMI is lower among breast-fed subjects, but the differences are small and are likely to be strongly influenced by publication bias and confounding factors. The authors suggested that promotion of breast-feeding, although important for other reasons, is not likely to reduce mean BMI.

In general, breast-feeding is protective against obesity, although the precise magnitude is unclear. Increased adoption of breast-feeding could form an important part of population strategies to prevent obesity. Breast-feeding affects the intakes of energy and protein, insulin secretion, and modulation of fat deposition and adipocyte development. If the effects of breast-feeding are sustained through either habituation or more complex programming, the association could persist to adult life. The consistency of association with increasing age suggests that the protective effects of early breast-feeding are independent of dietary and physical activity habits that emerge in later life.

Consensus Guidelines

1. Exclusive breast-feeding should be promoted in all newborn infants for its nutritional and other beneficial effects.
2. Breast-feeding may protect against obesity in later life and the duration of breast-feeding is inversely associated with risk of overweight.

Models of Effective Management of Mild to Moderate Obesity

Systematic reviews of the treatment of obesity in children have shown that there are only a limited number of randomised controlled trials to guide clinical decision-making (18,19). Published studies usually have had small samples sizes with varying attrition rates; have measured outcomes almost exclusively in terms of degree of overweight, rather than including broader medical, psychosocial, and behavioural outcomes; and have usually involved fairly homogeneous patient samples managed in a tertiary care setting. Thus, the evidence to support effective intervention is limited and may not be applicable to other clinical settings, and to all countries and all health care systems. Nevertheless, the broad

principles of paediatric obesity management are well established (20–22). These should include the following:

- Family involvement in the process of lifestyle change
- A developmentally appropriate approach
- Long-term behaviour modification
- A reduction in energy intake, through dietary change
- An increase in physical activity
- A decrease in sedentary behaviour

A few studies have looked at the effectiveness, in adult obesity, of different types of interventions or interventions delivered in other settings (eg, primary care, community health centres, and tertiary institutions) (23). When dealing with obese children and adolescents, there is some evidence that time-efficient interventions (eg, group sessions, holiday camps, or mail- and telephone-based behavioural interventions) do at least as well as individual sessions (24,25).

Internationally, no health system has developed a coordinated approach to the provision of paediatric obesity services that is likely to be sustainable, to be equitable, or to have adequate reach. A potential model of such a service, adapted from the model developed by the United Kingdom's National Health Service for treating adult chronic disease, is shown in Figure 1. In this "ideal" model, there is an underpinning base of a primary prevention program. On top of this is a pyramid of care, with 3 levels of service delivery for 3 levels of severity of obesity. Level 1, the base of the pyramid, encompasses the majority of patients who are overweight or have mild obesity and who can be managed largely by themselves and their families in the community, with support from a range of primary care services. Level 2,

for higher risk patients, is the one in which multidisciplinary teams, based either in the community or in acute care facilities, provide high-quality evidence-based care to patients with moderate levels of obesity. The top of the pyramid, level 3, is the one in which highly complex patients require individual case management—this is the province of specialist tertiary paediatric obesity units.

This suggested conceptual model may not be directly applicable to all health systems, but may be useful in considering how clinical services for obese children and adolescents available in most countries could be organised. Challenges facing many countries include the urgent need for a wide range of child health professionals to be trained in the assessment and initial management of paediatric obesity, the relative lack of services at all levels of the pyramid of care, and the apparently ever-increasing numbers of affected individuals and their impact on the health system.

Consensus Guidelines

1. The evidence of effective intervention in the management of mild to moderate obesity in children and adolescents is limited and may not be applicable to all clinical settings, and all health care systems.
2. The broad principles of paediatric obesity management are well established. They include:
 - Family involvement in the process of lifestyle change
 - A developmentally appropriate approach
 - Long-term behaviour modification
 - A reduction in energy intake, through dietary change
 - An increase in physical activity
 - A decrease in sedentary behaviour

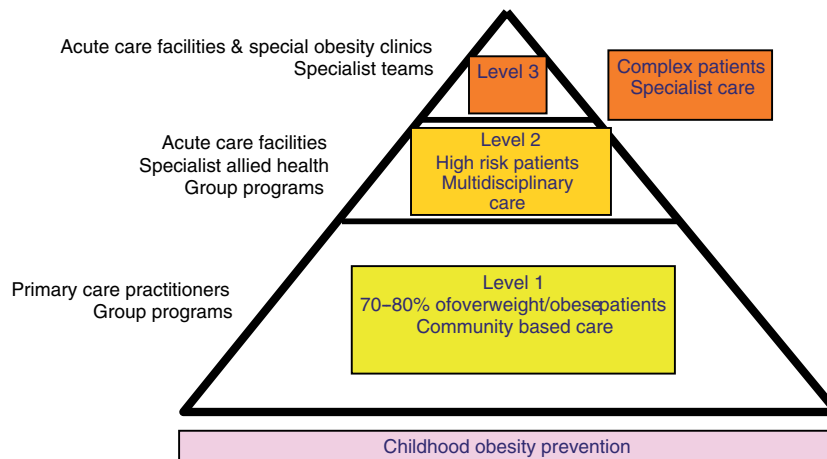


FIG. 1. Chronic disease management pyramid for paediatric overweight and obesity. (Adapted from the United Kingdom National Health Service chronic disease management pyramid of care.)

3. A multidisciplinary team approach, based either in community or in acute care facilities, can provide high-quality evidence-based care for patients with moderate levels of obesity.

Management Approaches in Severe Obesity

There is little evidence to guide the approach to management of patients with more severe obesity. Hospitalization, nonconservative dietary interventions, drug therapy, and for some bariatric surgery are all potential forms of therapy. When used, they should occur in the context of a behavioural weight management program and be restricted to specialist centres with expertise in managing severe obesity.

Both the pancreatic lipase inhibitor orlistat and the serotonin- and noradrenaline-reuptake inhibitor sibutramine have been shown to aid weight loss and limit weight regain in large, placebo-controlled, randomised controlled trials in adults (26,27). However, no pharmacological agents are currently approved for the treatment of paediatric obesity. Two published randomised controlled trials of sibutramine in adolescents have shown that the addition of sibutramine to a comprehensive behavioural program resulted in a significantly greater weight loss at 6 months than in the group who received the behavioural program plus placebo (28,29). In 1 study, hypertension was noted in more than one third of those receiving sibutramine (28). A placebo-controlled, randomised controlled trial of orlistat in adolescents receiving a diet and exercise behavioural program has shown a modest but significant improvement in BMI at 12 months compared with those taking placebo (30).

Recent studies have considered the use of metformin versus placebo in nondiabetic hyperinsulinemic obese adolescents and have shown at least short-term (2–6 months) improvement in body composition and metabolic parameters (31,32). Metformin therapy should be considered in the obese adolescent with significant hyperinsulinemia who has a family history of diabetes.

Bariatric surgery increasingly is seen as an important form of therapy for adults with severe obesity, especially if medical therapy has failed (33). A systematic review of the outcomes of bariatric surgery in adults has shown that the surgery leads to a mean percentage weight loss of 61.2%, with higher weight losses and higher operative mortalities reported for those procedures associated with malabsorption (34).

A US expert consensus report recommends that bariatric surgery should be considered in adolescent patients who are morbidly obese (BMI ≥ 40 kg/m²), have attained skeletal maturity (girls ≥ 13 years, boys ≥ 15 years), have serious obesity-associated comorbidity, and have experienced failure of organised weight loss therapy attempts for at least 6 months (35). Such patients should be

referred to centres with multidisciplinary weight management teams and surgery should be performed in tertiary institutions experienced in bariatric surgery. The varied response to these recommendations highlights the different views on surgical management of severely obese adolescents among the professional communities (36–38).

Consensus Guidelines

1. Minimal evidence exists to guide management of patients with severe obesity. Hospitalization, non-conservative dietary interventions, drug therapy, and bariatric surgery are potential forms of therapy. These interventions should occur in the context of a behavioural weight management program and be restricted to specialist centres with expertise in managing severe obesity.
2. No pharmacological agents are currently approved for the treatment of obesity in children, although studies suggest that orlistat and sibutramine may prove helpful in managing moderate obesity in adolescence. Metformin therapy can be considered in obese adolescents with significant hyperinsulinemia who have a family history of diabetes.
3. Bariatric surgery should be considered in adolescents with severe obesity (BMI ≥ 40 kg/m²). They must have attained skeletal maturity, have obesity-associated comorbidities, and have experienced failure of 6 months of organised weight loss therapy attempts.

Primary Prevention and Population Health Approaches to Prevent Obesity

Effective primary prevention strategies are ultimately required to curb the obesity epidemic. The *Cochrane Review* on the prevention of obesity in children included a number of school-based interventions and noted that the majority of studies were short term (39). Some studies that focused on dietary or physical activity approaches showed a small but positive impact on BMI status, and nearly all included studies resulted in some improvement in diet or physical activity. These findings are supported by a series of systematic reviews looking at interventions around physical activity and nutritional intake in children and young people (40,41).

Interventions simply focusing on educating individuals and communities about behaviour change have had limited or no success in modifying obesity prevalence (3,33). This is because the broader environment in many communities does not support healthy food choices or physically active lifestyles. Upstream factors contributing to obesity in individuals can operate at both a micro- and macroenvironmental level (42).

Consensus Guidelines

1. Effective primary prevention is the key to dealing with the obesity epidemic.
2. Interventions simply focusing on educating individuals and communities about behaviour change have had limited or no success in modifying obesity prevalence.
3. Opportunities exist for a range of prevention strategies in a given community or country. These include town planning policies, regulation of the nature and amount of food marketing directed at children, provision of recreation areas, regulation of food and drinks provided in school cafeterias, improvement of public transport, and other measures to improve intake of vegetables and fruits.

RESEARCH AGENDA

Obesity already has reached an epidemic state in many countries and is a much neglected public health problem. Although the aetiology is multifactorial, it is clearly associated with an increased intake of energy-dense foods and a sedentary lifestyle in many countries. The Federation of International Societies of Paediatric Gastroenterology, Hepatology, and Nutrition (FISPGHAN) and its member societies should take the lead in formulating the various research agendas to tackle this neglected problem in various regions of the world.

First, a uniform definition should be used in any research on obesity among the member societies for overweight and the various grade of obesity. A definition for obesity in children younger than 24 months is urgently needed. A uniformly adopted definition will allow meaningful international comparison of research data.

The international communities should be advocating research into the following:

- Effective treatment strategies, particularly in settings that are likely to be sustainable in different health systems
- Effective management of severe obesity
- Effective management of comorbidities of obesity
- Effective health care service delivery
- Primary prevention approaches for tackling obesity
- Improved assessment methodologies, beyond those offered by self-report, for accurately assessing the role of diet and physical activity in the development of obesity and its comorbidities as well as its prevention and treatment

There are various treatment strategies targeting children and adolescents with problems of overweight and

obesity. It is time for our societies to take a lead to formulate management strategies for the member countries. A commonly agreed-upon research program is urgently needed for FISPGHAN.

CONCLUSIONS

Obesity is recognised as an epidemic of the millennium and is now a pandemic. For epidemiological and research purposes, it is useful to have a common definition for obesity. BMI is a simple and cost-effective measure of obesity fatness in both adulthood and childhood. However, at present there is no international consensus on a definition for overweight and obesity.

Although the evidence to support effective intervention is limited and may not be applicable to all countries and all health care systems, the broad principles of paediatric obesity management are well established and include family involvement, a developmentally appropriate approach, long-term behaviour modification, a reduction in energy intake, an increase in physical activity, and an increase in physical activity. Pharmacological treatment is not recommended for children, although studies have shown the usefulness of orlistat and sibutramine in more severely obese adolescents. Metformin may play a role in the management of hyperinsulinemia in obese, insulin-resistant children and adolescents. Surgical management must be reserved for adolescents with severe obesity who have failed adequate medical treatment and should only be performed in experienced centres with multidisciplinary long-term support provided.

It is commonly agreed that prevention is better than cure. Apart from its nutritional and psychological benefits, breast-feeding also may play a role in the prevention of obesity in later life. Although local community- and school-based programs are important in terms of primary prevention of obesity, the focus needs to be on modification of the more fundamental upstream factors that influence food intake and physical activity, such as urban planning policies or the pricing, availability, and marketing of foods. A commonly agreed-upon research program is urgently needed for various countries around the world and FISPGHAN is in the position to play a leading role.

REFERENCES

1. World Health Organization. <http://www.who.int/nutrition/topics/obesity/en>. Accessed June 2008.
2. International Obesity Task Force. <http://www.ietf.org/millennium.asp>. Accessed June 2008.
3. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. Report of the International Obesity TaskForce Childhood Obesity Working Group. *Obes Rev* 2004;5 (Suppl 1):4–104.
4. Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006;1:11–25.

5. World Health Organization. *Diet, Nutrition, and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation*. WHO Technical Report Series 916. Geneva:WHO 2003.
6. Bellizzi MC, Dietz WH. Workshop on childhood obesity: summary of the discussion. *Am J Clin Nutr* 1999;70:173S–5S.
7. Cole TJ, Bellizzi MC, Flegal KM, et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240–3.
8. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts: United States. *Adv Data* 2000;341:1–27.
9. Himes JH, Dietz WH. Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services. *Am J Clin Nutr* 1994;59:307–16.
10. Maffeis C, Pietrobelli A, Grezzani A, et al. Waist circumference and cardiovascular risk factor in prepubertal children. *Obes Res* 2001;9:179–87.
11. Wang J, Thornton JC, Russell M, et al. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparison of anthropometric measurements. *Am J Clin Nutr* 1994;60:23–8.
12. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; 363:157–163.
13. Owen CG, Martin RM, Whincup PH, et al. Effect of infant feeding on the risk of obesity across the life course: a quantitative review of published evidence. *Pediatrics* 2005;115:1367–77.
14. Arenz S, Ruckerl R, Koletzko B, et al. Breast-feeding and childhood obesity—a systemic review. *Int J Obes Relat Metab Disord* 2004;28:1247–56.
15. Dewey KG. Is breastfeeding protective against child obesity? *J Hum Lact* 2003;19:9–18.
16. Harder T, Bergmann R, Kallischnigg G, et al. Duration of breastfeeding and risk of overweight: a meta-analysis. *Am J Epidemiol* 2005;162:397–403.
17. Owen CG, Martin RM, Whincup PH, et al. The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence. *Am J Clin Nutr* 2005;82:1298–307.
18. Summerbell CD, Ashton V, Campbell KJ, et al. Interventions for treating obesity in children. *Cochrane Database Syst Rev* 2003;3:CD001872.
19. Glenny A-M, O'Meara S, Melville A, et al. The treatment and prevention of obesity: a systematic review of the literature. *Int J Obes* 1997;21:715–37.
20. National Health and Medical Research Council. Clinical practice guidelines for the management of overweight and obesity in children and adolescents 2003. [http://health.gov.au/internet/main/publishing.nsf/Content/obesityguidelines-guidelines-children.html/\\$FILE/children.pdf](http://health.gov.au/internet/main/publishing.nsf/Content/obesityguidelines-guidelines-children.html/$FILE/children.pdf). Accessed June 2008.
21. Scottish Intercollegiate Guidelines Network. Management of obesity in children and young people. No. 69. <http://www.sign.ac.uk/guidelines/fulltext/69/index.html>. Accessed June 2008.
22. Dietz WH, Robinson TN. Clinical practice. Overweight children and adolescents. *N Engl J Med* 2005;352:2100–9.
23. Harvey EL, Glenny A-M, Kirk SF, et al. Improving health professionals' management and the organisation of care for overweight and obese people. *Cochrane Database Syst Rev* 2000;2:CD000984.
24. Braet C, van Winckel M, van Leeuwen K. Follow-up results of different treatment programs for obese children. *Acta Paediatr* 1997;86:397–402.
25. Saelens BE, Sallis JF, Wilfley DE, et al. Behavioral weight control for overweight adolescents initiated in primary care. *Obes Res* 2002;10:22–32.
26. Torgerson JS, Hauptman J, Boldrin MN, et al. XENical in the prevention of diabetes in obese subjects (XENDOS) study: a randomized study of orlistat as an adjunct to lifestyle change for the prevention of type 2 diabetes in obese patients. *Diabetes Care* 2004;27:155–61.
27. James WP, Astrup A, Finer N, et al. Effect of sibutramine on weight maintenance after weight loss: a randomised controlled trial. STORM Study Group. Sibutramine Trial of Obesity Reduction and Maintenance. *Lancet* 2000;356:2119–25.
28. Berkowitz RI, Wadden TA, Tershakovec AM, et al. Behaviour therapy and sibutramine for the treatment of adolescent obesity: a randomized controlled trial. *JAMA* 2003;289:1805–12.
29. Godoy-Matos A, Carraro L, Vieira A, et al. Treatment of obese adolescents with sibutramine: a randomized, double-blind, controlled study. *J Clin Endocrinol Metab* 2005;90:1460–5.
30. Chanoine JP, Hampl S, Jensen C, et al. Effect of orlistat on weight and body composition in obese adolescents: a randomized controlled trial. *JAMA* 2005;293:2873–83.
31. Freemark M, Bursley D. The effects of metformin on body mass index and glucose tolerance in obese adolescents with fasting hyperinsulinaemia and family history of type 2 diabetes. *Pediatrics* 2001;107:e55.
32. Srinivasan S, Ambler GR, Baur LA, et al. Randomized controlled trial of metformin for obesity and insulin resistance in children and adolescents—improvement in body composition and fasting insulin. *J Clin Endocrinol Metab* 2006;91:2074–80.
33. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic*. Report of a WHO Consultation on Obesity. Geneva:WHO; 1998.
34. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA* 2004;292:1724–37.
35. Inge TH, Krebs NF, Garcia VF, et al. Bariatric surgery for severely overweight adolescents: concerns and recommendations. *Pediatrics* 2004;114:217–23.
36. Barlow SE. Bariatric surgery in adolescents: for treatment failures or health care system failures? *Pediatrics* 2004;114:252–3.
37. Wiittigrove AC. Surgery for severely obese adolescents: further insight from the American Society for Bariatric Surgery. *Pediatrics* 2004;114:253–4.
38. Rodgers B. Bariatric surgery for adolescents: a view from the American Pediatric Surgical Association. *Pediatrics* 2004;114:255–6.
39. Summerbell CD, Waters E, Edmunds LD, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005;3:CD001871.
40. Brown T, Kelly S, Summerbell C. Prevention of obesity: a review of interventions. *Obes Rev* 2007;8 (Suppl 1):127–30.
41. Thomas H, Ciliska D, Micucci S, et al. *Effectiveness of Physical Activity Enhancement and Obesity Prevention Programs in Children and Youth*. Hamilton, Ontario, Canada: Effective Public Health Practice Project; 2004.
42. Swinburn B, Egger G, Fezeela R. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritising environmental interventions for obesity. *Prev Med* 1999;29:563–70.