

Review Article

Child and adolescent obesity in the 21st century: an Australian perspective

Louise A Baur BSc(Med), MBBS, PhD, FRACP

University of Sydney School of Paediatrics & Child Health, The Children's Hospital at Westmead, Westmead, NSW, Australia

The early 21st century has seen the development of a global epidemic of obesity in both developed and developing countries. In Australia at least one in five children and adolescents are overweight or obese, with rapid rises in prevalence apparently continuing. Similar trends are seen in other countries. Child and adolescent obesity is associated with both immediate and long-term medical and psychosocial problems, including a clustering of risk factors for the development of cardiovascular disease and diabetes. Thus, obesity poses a major health problem for the paediatric population. Major environmental and societal changes have led to a decrease in physical activity, a rise in sedentary behaviour and the consumption of high fat and high-energy foods, all in turn influencing the development of obesity. Effective management involves a multimodal approach with a developmentally aware approach, involvement of the family, a focus on healthy food choices, incorporation of physical activity and a decrease in sedentary behaviour all being important. Ultimately, however, the obesity epidemic requires a major focus on primary prevention. Australia has a national strategy for the prevention of overweight and obesity that depends upon intersectoral and intergovernmental cooperation, supported by adequate resourcing and significant community ownership.

Key words: Australia, body mass index, complications, management, obesity, overweight, prevalence, prevention.

Obesity: a global problem

The World Health Organization describes obesity as 'one of today's most blatantly visible – yet most neglected – public health problems' and further comments that 'an escalating global epidemic of overweight and obesity – 'globesity' – is taking over many parts of the world'.¹ In 2000, 8.2% of the world's adult population was obese.² While obesity is a very common problem in industrialised countries, it is increasingly recognised as a major health problem in developing countries and countries undergoing economic transition.³

Childhood obesity is also prevalent

Obesity affects children and adolescents. Until recently, there has been confusion in international published work about the definition of obesity in childhood, making comparisons of childhood obesity rates difficult. In 1999 the International Obesity Task Force recommended that children and adolescents be categorised as overweight or obese on the basis of their calculated body mass index (BMI; weight/height²).⁴ Subsequently, Cole *et al.* determined new values of BMI to define overweight among children, using six large nationally representative data sets drawn from population surveys.⁵ Using the data from each country, centile curves of BMI were drawn that at age 18 years passed through the points of 25 kg/m² and 30 kg/m². The curves from each country were then averaged to provide age- and gender-specific BMI cut offs to define overweight and obesity.

These cut-off points correspond to the adult cut-off points for overweight and obesity, based on the BMI when health risks rise steeply.⁶

Table 1 shows the prevalence rates for overweight and obesity in different countries, as determined using the new international definition.^{5,7,8} Rates vary greatly, reflecting environmental and ethnic/genetic variations between countries, as well as differences in the timing of studies. Importantly, more recent surveys show higher prevalence rates than do studies carried out two or more decades ago. This is clearly seen when comparing two time periods for both the USA and Australia. In the USA the prevalence of obesity in children and adolescents doubled between the 1976–1980 and 1988–1994 collection periods.⁸ During the 10 years from 1985 the prevalence of overweight in Australian children and adolescents almost doubled and that of obesity more than tripled.⁷ In both these countries obesity has become one of the most common chronic diseases in childhood, if not the most common. These countries are by no means unique.

Correspondence address: Louise A Baur, Associate Professor, University of Sydney, Discipline of Paediatrics & Child Health, The Children's Hospital at Westmead, Locked Bag 4001, Westmead, NSW 2145 Australia.
Tel: +61 2 9845 3393; Fax: +61 2 9845 3389
Email: louiseb3@chw.edu.au

Table 1. Percentage of overweight and obese children and adolescents in selected countries

Country	Year	Boys overweight & obese (%) [*]	Boys obese (%) [†]	Girls overweight & obese (%) [*]	Girls obese (%) [†]
Netherlands	1980	5.5	0.3	6.5	0.3
Brazil	1989	4.7	0.1	15.2	2.0
Great Britain	1978–1993	9.6	0.9	11.7	1.2
Hong Kong	1993	11.7	3.1	9.8	1.8
Singapore	1993	10.5	1.7	7.0	1.0
Australia‡	1985	10.7	1.4	11.8	1.2
Australia‡	1995	19.5	4.5	21.1	5.3
USA§	1976–1980	14.9	3.4	15.1	4.3
USA§	1988–1994	22.1	7.0	24.0	8.2

^{*}% Overweight & obese corresponds to the reference values of Cole *et al.* equivalent to adult BMI of 25 kg/m² or more.⁵

[†]% Obese corresponds to the reference values of Cole *et al.* equivalent to adult BMI of 30 kg/m² or more.⁵ Data adapted from Cole *et al.*⁵

‡Magarey *et al.*⁷

§Flegal *et al.*⁸

Developing countries and countries and communities undergoing economic transition are also seeing a rise in overweight and obesity in their paediatric populations. In the 1993 China Health and Nutrition Survey, 3.4% and 3.6% of children were overweight and obese, respectively (note: a different definition was used from that used in Table 1).⁹ However, by 2000 the estimated rate of overweight and obesity in urban Chinese children was 23% (12.1% overweight, 11.9% obese).¹⁰ Rises in childhood obesity prevalence rates in the past two decades have been documented in many other countries including Thailand and Taiwan.^{11,12} Such data suggest that there have been rapid changes in obesity prevalence in the child and adolescent populations at a global level.

Consequences of obesity in childhood and adolescence

Is the rising prevalence of overweight and obesity in childhood and adolescence of concern? Certainly, there is clear evidence that it is associated with a range of health problems. The most common consequences of obesity in childhood and adolescence are those related to psychosocial dysfunction and social isolation.^{13,14} Cross-sectional studies consistently show an inverse relationship between weight and both global self-esteem and body-esteem in adolescents, although not in pre-adolescent children.¹⁴ In adolescent girls, excess weight (as measured by BMI) is significantly related to body dissatisfaction, drive for thinness and bulimia.¹⁵ In developed societies, women who were overweight in late adolescence and early adulthood are more likely to have lower family incomes, higher rates of poverty and lower rates of marriage.¹⁶

Orthopaedic complications are also well recognised in obese children. For example, obese pre-adolescent children have wide, flat feet with increased static and dynamic plantar pressures.¹⁷ Otherwise rare orthopaedic problems also occur with greater frequency in obese children, including slipped femoral capital epiphyses and tibia vara.¹⁸

Hepatic complications of obesity may also be present, particularly non-alcoholic steatohepatosis.¹⁹ Gastroesophageal reflux and gastric emptying disturbances are further complications and appear to be a consequence of raised intra-abdominal pressure due to increased abdominal fat. Obesity is also the major cause of gallstones in children without other medical problems.¹³

Obstructive sleep apnoea is another increasingly recognised complication of childhood obesity. It is associated with both adenotonsillar hypertrophy and hyperinsulinaemia.²⁰

Obesity, especially central obesity, in childhood is also associated with risk factors for heart disease and diabetes. Dyslipidaemia is frequently present, the lipoprotein pattern being characterised by raised levels of triglycerides and total and low-density lipoprotein (LDL) cholesterol and reduced levels of high-density lipoprotein (HDL) cholesterol.²¹ This is particularly related to the presence of increased intra-abdominal fat.²² Hypertension is also commonly seen in obese children as are hyperinsulinaemia and insulin resistance.²³ Type 2 diabetes mellitus, while still uncommon in children in most countries, has nevertheless increased dramatically in prevalence in recent years. A US report has shown that the incidence of type 2 diabetes has risen from 4% of paediatric diabetic cases in 1990 to approximately 20% a decade later.²⁴ Several studies have found that overweight and obese children and adolescents, especially those of non-European ancestry, are at greatest risk of the development of type 2 diabetes. Blood lipid and lipoprotein concentrations, insulin concentrations and blood pressure all appear to track from childhood into young adulthood, with obesity at baseline being a significant predictor of adult values.^{13,23}

The most significant long-term consequence of childhood obesity is its persistence into adulthood, with all the attendant health risks. This is more likely with the onset of obesity in late childhood or adolescence and with increased severity of obesity.²⁵ Overweight in adolescence has also

been shown to have a significant association with long-term mortality and morbidity. In a 55 year follow-up of adolescent school children, Must *et al.* showed that overweight in adolescence was associated with an increase in mortality from coronary heart disease in men and an increase in morbidity for several conditions in both men and women, even independent of adult weight status.²⁶

Thus, overweight and obesity in childhood and adolescence are associated with a range of psychosocial and medical complications that are both immediate and long-term. This makes effective prevention and management vital.

What is causing this epidemic of obesity?

Obesity is a complex condition with genetic, metabolic, behavioural and environmental factors all contributing to its development. However, the dramatic increase in the prevalence of obesity in the past few decades can only be due to significant changes in lifestyle influencing children and adults alike. Exactly what these changes are is still poorly understood.

The association between television viewing and obesity in childhood and adolescence has been demonstrated in both cross-sectional and longitudinal studies.^{27,28} Of particular interest is the finding in the prospective studies that television viewing is associated with an increased incidence of new cases of obesity, as well as a decrease in remission rates of established obesity.²⁸ These effects presumably have their impact through changes in food intake and physical activity.

The increased prevalence of obesity in recent decades may have resulted, at least in part, from changes in dietary intake, such as, an increase in the consumption of high-fat foods or in sugar-containing drinks.^{29,30} In a 12 month prospective study, Eck *et al.* showed that early school-age children at high-risk for the development of obesity gained marginally more weight, and consumed a slightly larger proportion of energy from fat than did children at low-risk of obesity.³¹ Ludwig *et al.* showed that consumption of soda drinks (soft-drinks) at baseline was associated with increased weight gain over the next 19 months in young adolescents.³⁰ In young children, parental influence on food selection is strong although the influence of television viewing may be significant.²⁹ In older children and adolescents, peer influence is also important. Less desirable meal patterns, such as, frequent snacking, also appear to be related to the presence of established obesity.

In the prospective study of low- and high-risk children, Eck *et al.* found that the high-risk group, who gained more weight during the 12 month study, had slightly lower levels of total physical activity than did the low-risk group,³¹ suggesting a pattern of physical activity that may predispose the at-risk child to the development of obesity. Sedentary behaviour is not merely the inverse of being physically active – they are different, although interlinked, behaviours. One of the ways in which television viewing may have its association with obesity in childhood is through the

encouragement of sedentary behaviour. As yet, however, there are no clear data linking viewing of interactive videos, computers, or other ‘small-screen’ time with the development of obesity, although they are likely to be significantly associated.

In developing countries and economies undergoing transition, many of the same factors may be influencing the development of obesity. Dietary changes that have accompanied modernization include an increase in the consumption of fat, added sugar and animal products in the diet and a decrease in total cereal intake and fibre.³ Changes in activity level have also occurred as a result of an increase in household labour-saving devices and a rise in television and motor vehicle ownership.³

Thus, the rise of sedentary pursuits (e.g. television viewing, video games, computer use), an increase in the use of the motor car for transport, a decrease in physical activity and an increase in the consumption of high fat and energy dense foods are likely to be the major factors in this epidemic of obesity.⁶ The early 21st century in industrialised communities provides an environment that is highly conducive to obesity.

Management of childhood obesity

In tackling the problem of obesity, it is important to effectively manage overweight and established obesity. The evidence to support effective intervention is reasonably limited and may not be easily generalisable to other clinical locations.³² However, it is clear that a multimodal approach is required, with family involvement, dietary intervention and exercise all being important.

It is important to initially clarify the aims of therapy when dealing with an obese child or adolescent. With regard to change in weight, amelioration of weight gain, rather than substantial weight loss, may be appropriate. Indeed, in younger children, weight maintenance during a growth spurt may be the most achievable approach. In effect, children may be able to ‘grow in’ to an appropriate weight for height. Education about the nature of obesity, including the realization that it is a chronic disorder of energy balance, is also important, as the need for long-term changes in behaviour will then be more readily apparent. Small, achievable goals are important (e.g. one walk per week, cut down TV viewing from 4 to 3 h per day).

Families influence food and activity habits and thus effective therapy of obesity must take this into account. Parental involvement in treatment programs is necessary for successful weight-loss both in young children as well as in adolescents. Several studies have now shown that long-term maintenance of weight-loss (i.e. from 2 to 10 years) can be achieved when the intervention is family based.^{33,34} These results suggest that long-term weight control ‘success’ in childhood obesity is associated with such factors as the amount of weight the parent loses in the initial phase, the use of reinforcement techniques, such as parental praise and a change in eating habits, such as eating meals at home or a

moderate reduction in fat intake.^{33,34} Such findings imply that altered food patterns within the whole family, as well as parental reinforcement and support of the child, are important factors in outcome success.

A developmentally appropriate approach is vital. An important Israeli study has shown that treatment of pre-adolescent obesity with the parents as the exclusive agents of lifestyle change is more effective than a child-centred approach.^{35,36} There have been few controlled studies of the management of adolescent obesity, although studies suggest that it may be most effectively managed when separate sessions are provided for both the adolescent patient and parent.³⁷

Dietary management in obesity essentially involves education about healthy nutrition and appropriate food choices. Long-term outcome studies support the view that a moderate restriction in fat intake in the initial phase of therapy is necessary for sustained treatment outcome.³⁴ Furthermore, restrictive dieting may interfere with growth in childhood or encourage the development of a diet-culture mentality. The focus should be on behaviour change and moderate fat restriction, rather than on calorie counting or a diet prescription.

In a further study, Epstein *et al.* showed that participation in an exercise program during treatment is a predictor of maintained non-obesity.³⁸ The type of exercise employed (i.e. 'lifestyle' exercise vs programmed aerobic exercise) also appears to be important for sustained weight loss; while both forms of exercise help promote weight loss in the initial phase, the child or adolescent is more likely to continue long-term with the 'lifestyle' form of exercise.³⁸ Obese children may not enjoy group physical activities, such as school sports, because their performance may not be as good as their leaner peers and in such circumstances individual exercise programs may be more appropriate. A further controlled study has looked at the effect of targeting inactivity. Epstein and Roemmich showed that 2 year outcome was most successful for children who were placed in a group in which sedentary behaviour was targeted (e.g. decreasing television viewing times) rather than in those children who were in groups where they were encouraged to increase their level of exercise.³⁹

There have been few studies looking at the effectiveness of different types of interventions, such as group programs, interventions delivered in the community, primary care practitioner interventions and shared-care programs.⁴⁰ Likewise, more information is needed on the role of drug therapy, hospitalization, very low calorie diets, obesity surgery and other such therapies in the management of morbid obesity in childhood and adolescence. These all require further research.

Obesity prevention: an Australian view

The magnitude of the problem of obesity in most industrialised countries means that, to prevent further increases in prevalence, population-level strategies must be applied.⁶ Interventions focusing on simply educating individuals and

communities about behaviour change have had limited or no success. Instead, there is an urgent need to produce an environment that supports healthy eating and physical activity throughout the community. This requires a commitment from many sectors of society. Potential environmental strategies could include creating opportunities for planned and incidental activity in community environments, promoting the use of public transport, encouraging private and public sector food services to provide healthy food choices, improving the labelling of food products and providing economic incentives for the production and distribution of fruit and vegetables.

Australia was the first country in the world to develop a national strategy for the prevention of obesity. The 1997 document *Acting on Australia's Weight: A Strategy for the Prevention of Overweight and Obesity in Australia* has rightly identified school children as an important target group for obesity prevention.⁴¹ Successful school-based prevention programs have been established in the past although they have been difficult to sustain in the long term.⁴² However, interventions will also need to occur at regional, state and national levels. Some examples of the sorts of interventions that are needed include:

1. Providing opportunities for structured and unstructured forms of physical activity at schools, child care centres and after school care centres.
2. Training school teachers and child care workers in such areas as basic motor skills instruction, physical fitness and nutrition.
3. Working with local councils for improved cycle-ways, safe parks and other places for children to safely play outdoors.
4. Regulation of the type and amount of food advertisements to which children are exposed.
5. Providing economic incentives for the production and distribution of fruit and vegetables.
6. Working with food manufacturers to improve food labelling and to improve the ranges of healthy low-fat products available.

Such interventions will require intersectoral and inter-governmental cooperation, supported by adequate resourcing and significant community ownership.

Research priorities relevant to child and adolescent obesity

The obesity epidemic in childhood has implications for research in the following areas:

1. Regular population monitoring in order to track trends in the prevalence of overweight and obesity in childhood and adolescence.
2. An improved understanding of the forces promoting the development of obesity in childhood and adolescence.
3. Effective approaches to the clinical management of overweight and obesity in childhood and adolescence.
4. Effective population level strategies for the prevention of overweight and obesity.

References

1. World Health Organization. Nutrition. Accessed April 2002. Available from: URL: <http://www.who.int/nut/obs/htm>
2. World Health Organization. Global database on obesity and body mass index. Accessed April 2002. Available from: URL: http://www.who.int/nut/db_bmi.htm
3. Popkin BM. The nutrition transition and obesity in the developing world. *J Nutr* 2001; 131: 871S–873S.
4. Bellizzi MC, Dietz WH. Workshop on childhood obesity: summary of the discussion. *Am J Clin Nutr* 1999; 70: 173S–175S.
5. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; 320: 1–6.
6. World Health Organisation. Obesity. Preventing and Managing the Global Epidemic. Report of a WHO Consultation on Obesity. Geneva: World Health Organisation, 1998 (WHO/NUT/NCD/98.1).
7. Magarey AM, Daniels LA, Boulton TJC. Prevalence of overweight and obesity in Australian children and adolescents: reassessment of 1985 and 1995 data against new standard international definitions. *Med J Aust* 2001; 174: 561–564.
8. Flegal KM, Ogden CL, Wei R, Kuczmarski RL, Johnson CL. Prevalence of overweight in US children: comparison of US growth charts from the Centers for Disease Control and Prevention with other reference values for body mass index. *Am J Clin Nutr* 2001; 73: 1086–1093.
9. Wang J, Thornton JC, Russell M, Burastero S, Heymsfield S, Pierson RN. Asians have lower body mass index (BMI) but higher percent body fat than do whites: comparisons of anthropometric measurements. *Am J Clin Nutr* 1994; 60: 23–28.
10. Chunming C. Fat intake and nutritional status of children in China. *Am J Clin Nutr* 2002; 72: 1368S–1372S.
11. Sakamoto N, Wansorn S, Tontisirin K, Marui E. A social epidemiological study of obesity among preschool children in Thailand. *Int J Obes Relat Metab Disord* 2001; 25: 389–394.
12. Chu NF. Prevalence and trends of obesity among school children in Taiwan – the Taipei Children Heart Study. *Int J Obes Relat Metab Disord* 2001; 25: 170–176.
13. Must A, Strauss A. Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord* 1999; 23: S2–S11.
14. French SA, Story M, Perry CL. Self-esteem and obesity in children and adolescents: a literature review. *Obes Res* 1995; 3: 479–490.
15. Freidman MA, Wilfley DE, Pike KM, Streigel-Moore RH, Rodin J. The relationship between weight and psychological functioning among adolescent girls. *Obes Res* 1995; 3: 57–62.
16. Gortmaker SL, Must A, Perrin JM, Sobol AM, Dietz WH. Social and economic consequences of overweight in adolescence and young adulthood. *N Engl J Med* 1993; 329: 1008–1012.
17. Dowling AM, Steel JR, Baur LA. Does obesity influence foot structure and plantar pressure patterns in prepubescent children? *Int J Obes Relat Metab Disord* 2001; 25: 845–852.
18. Dietz WH, Gross WL, Kirkpatrick JA. Blount disease (tibia vara): Another skeletal disorder associated with childhood obesity. *J Pediatr* 1982; 101: 735–737.
19. Noguchi H, Tazawa Y, Nishinomiya F, Takada G. The relationship between serum transaminase activities and fatty liver in children with simple obesity. *Acta Paediatr Jpn* 1995; 37: 621–625.
20. de la Eva RC, Baur LA, Donaghue K, Waters KA. Metabolic correlates in obstructive sleep apnoea. *J Pediatr* 2002; 140: 654–659.
21. Freedman DS, Dietz WH, Srinivasan SR, Berenson GS. The relation of overweight to cardiovascular risk factors among children and adolescents: The Bogalusa Heart Study. *Pediatrics* 1999; 103: 1175–1182.
22. Garnett SP, Cowell CT, Baur LA, Fay RA, Lee J, Coakley J, Peat JK, Boulton TJ. Is birth size related to abdominal fat in childhood? *Int J Obes Relat Metab Disord* 2001; 25: 1667–1673.
23. Srinivasan SR, Bao W, Wattigney WA, Berenson GS. Adolescent overweight is associated with adult overweight and multiple cardiovascular risk factors: the Bogalusa heart study. *Metabolism* 1996; 45: 235–240.
24. Anonymous. Type 2 diabetes in children and adolescents. *Diabetes Care* 2000; 23: 381–389.
25. Guo SS, Chumlea WC. Tracking of body mass index in children in relation to overweight in adulthood. *Am J Clin Nutr* 1999; 70: 145S–148S.
26. Must A, Jacques PF, Dallal GE, Bajema CJ, Dietz WH. Long-term morbidity and mortality of overweight adolescents. *N Engl J Med* 1992; 327: 1350–1355.
27. Dietz WH, Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. *Pediatrics* 1985; 75: 807–812.
28. Gortmaker SL, Dietz WH, Cheung LWY. Inactivity, diet and the fattening of America. *J Am Diet Assoc* 1990; 90: 1247–1255.
29. Lissner L, Heitmann BL. Dietary fat and obesity: evidence from epidemiology. *Eur J Clin Nutr* 1995; 49: 79–90.
30. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 2001; 357: 505–508.
31. Eck LH, Klesges RC, Hanson CL, Slawson D. Children at familial risk of obesity: an examination of dietary intake, physical activity and weight status. *Int J Obes Relat Metab Disord* 1992; 16: 71–78.
32. Glenny A-M, O'Meara S, Melville A, Sheldon TA, Wilson C. The treatment and prevention of obesity: a systematic review of the literature. *Int J Obes Relat Metab Disord* 1997; 21: 715–737.
33. Epstein LH, Valoski A, Wing RR, McCurley J. Ten-year follow-up of behavioural, family-based treatment for obese children. *JAMA* 1990; 264: 2519–2523.
34. Nuutinen O, Knip M. Predictors of weight reduction in obese children. *Eur J Clin Nutr* 1992; 46: 785–794.
35. Golan M, Weizman A, Apter A, Fainaru M. Parents as the exclusive agents of change in the treatment of childhood obesity. *Am J Clin Nutr* 1998; 67: 1130–1135.
36. Golan M, Fainaru M, Weizman A. Role of behaviour modification in the treatment of childhood obesity with the parents as the exclusive agents of change. *Int J Obes Relat Metab Disord* 1998; 22: 1217–1224.
37. Brownell KD, Kelman JH, Stunkard AJ. Treatment of obese children with and without their mothers: Changes in weight and blood pressure. *Pediatrics* 1993; 71: 515–523.
38. Epstein LH, Wing RR, Koeske R, Ossip D, Beck S. A comparison of lifestyle change and programmed exercise on weight and fitness changes in obese children. *Behav Ther* 1982; 13: 651–665.
39. Epstein LH, Roemmich JN. Reducing sedentary behavior: role in modifying physical activity. *Exerc Sport Sci Rev* 2001; 29: 103–108.
40. Harvey EL, Glenny A, Kirk SFL, Summerbell CD. Improving health professionals' management and the organisation of care for overweight and obese people (Cochrane review). In: *The Cochrane Library*, 2. Oxford: Update Software, 1999.
41. Australian National Health and Medical Research Council. *Acting on Australia's Weight. A Strategic Plan for the Prevention of Overweight and Obesity*. Canberra: Commonwealth Department of Health and Family Services, 1997.
42. Dwyer T. Policies and programs in nutrition and physical fitness in Australia. *Am J Clin Nutr* 1989; 49: 1030–1034.