

WESTERN AUSTRALIAN OBESITY THINK-TANK

**BACKGROUND PAPER
PERTH WA**

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WA OBESITY THINK-TANK BACKGROUND PAPER

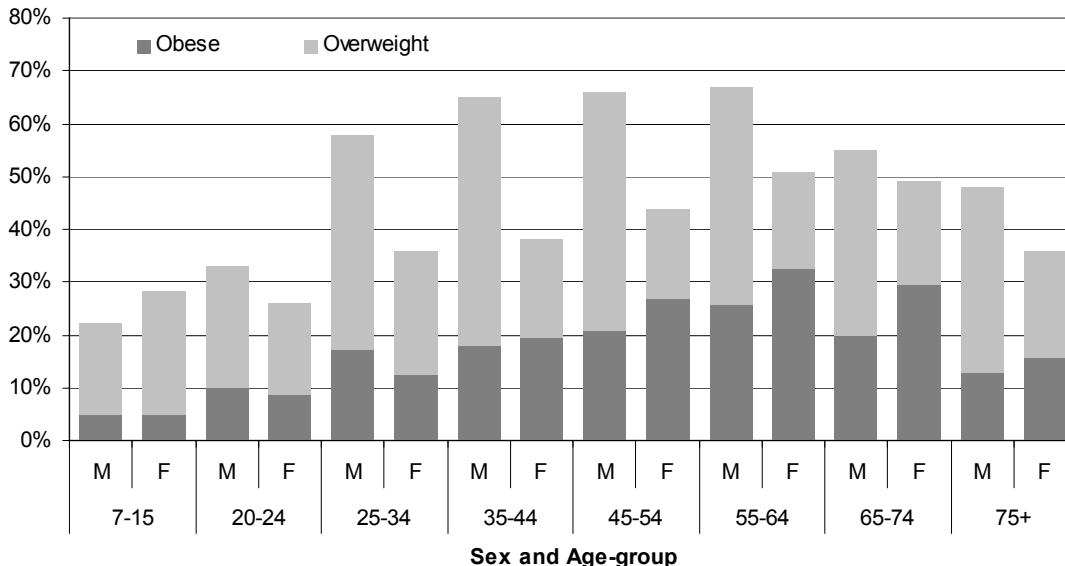
1 Definition of Overweight and Obesity

The internationally accepted method of defining overweight and obesity is via the Body Mass Index (BMI) where overweight in adults is categorised as 25kg/m^2 and obese as 30kg/m^2 .¹ Definitions for overweight and obesity for children and adolescents (2 to 18 years) are guided by age and sex specific BMI thresholds based on normalised data collected in 2000 from Europe, North and South America, and East Asia.² BMI is not a perfect measure as it can inappropriately classify people with high muscle density as overweight, and the cut-offs for overweight and obesity do not work well for some non-European races.^{3 4} The NHMRC recommends combining BMI with waist measurements for the clinical management of overweight and obesity and adjudges waist measurements of 94 cm and 80 cm in men and women respectively to indicate overweight and measurements of 102 cm and 88 cm to indicate obesity.³ However it is generally accepted that BMI remains useful to predict total body fat at a population level and as such most prevalence data remains firmly based upon BMI thresholds.

2 Prevalence of Overweight and Obesity in WA

Overweight and obesity in Western Australia are very similar to Australia overall.^{5 6} It can be extrapolated from state and national data that approximately 800,000 West Australians are overweight (52% of all males and 39% of all females) including approximately 320,000 who are obese (15% of all males and 17% of all females). The greatest proportion of *overweight* are men aged 25–64 years, but the greatest proportion of *obese* are women aged 45–64 years, as illustrated in Figure 1.⁶⁻⁸ Data from 2003 suggest that 22% of West Australian boys are overweight and 28% of girls, including 4.9% of boys and girls respectively who are obese.⁹

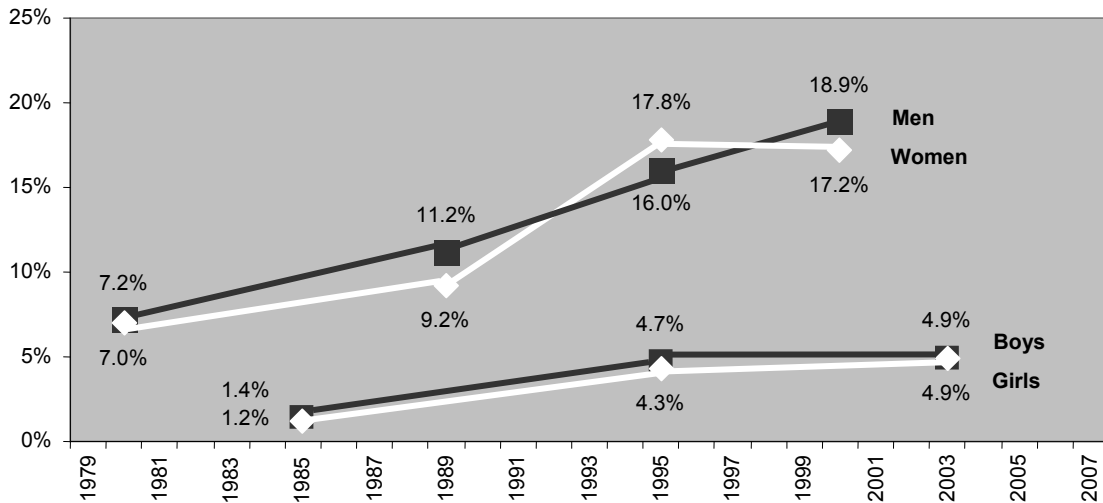
Figure 1: Estimated proportion of overweight and obese West Australians by sex and age-group for 2005, from various state and national surveys⁶⁻⁹



3 Prevalence Trends of Overweight and Obesity

Since the 1980s the proportion of Australian adults who are *obese* has more than doubled, and the proportion of children has tripled.^{6 9-11} Over this time there has been an average annual increase in the prevalence of obesity of around 0.5% for adults and 0.2% for children. If current trends continue, the next twenty years will see nearly two-thirds of Western Australian adults and one-third of children become overweight, including around 30% of adults and 10% of children become obese.

Figure 2: Trends in prevalence of obesity for West Australia adults and children from various state and national surveys^{5, 8-10}



4 Health Impacts of Overweight and Obesity

There is robust evidence to suggest that overweight and obesity are associated with increased risk of morbidity and premature mortality due to metabolic complications, complications arising from the excess weight itself on body functions, or both.^{3 12} There appears to be a fairly linear relationship between overweight and mortality (see Figure 3).

Figure 3: Mortality risk for ages 20–39 years by Body Mass Index (source: NHMRC, 2003)

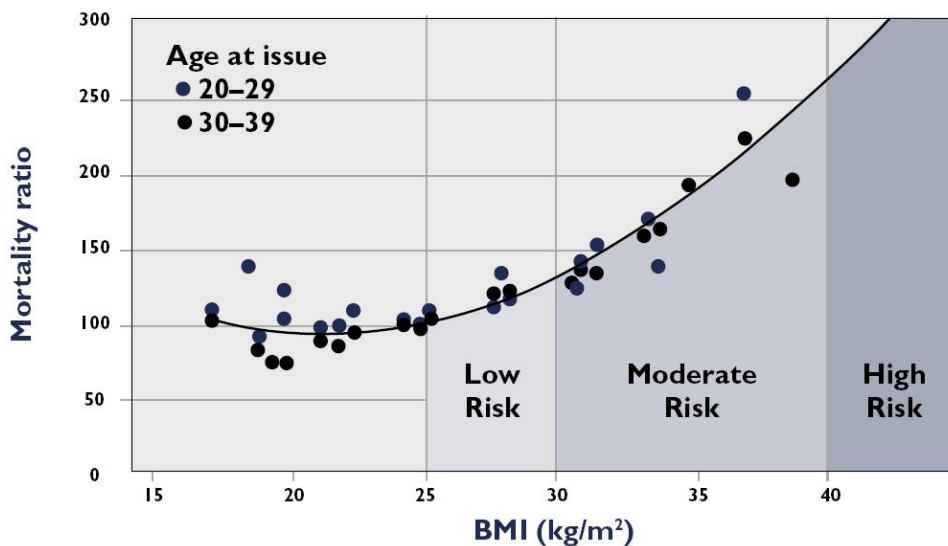


Table 1 below provides an outline of health problems for which overweight and obesity places individuals at elevated risk. A range of health problems also once associated only with adults are now being observed in obese children.

Table 1: Increased health risks associated with overweight and obesity for adults and children

	Risk Increase	
	Adults ^{3 12}	Children ¹³
PHYSIOLOGICAL HEALTH		
Insulin resistance and type two diabetes	Great	Great
Cardiovascular diseases	Great	Great
• Hypertension	Great	Great
• Coronary heart disease	Moderate	-
• Stroke	Moderate	-
• Peripheral arterial disease	Slight	-
Dyslipidaemia	Great	Great
Sleep apnoea	Great	Great
Gall bladder disease	Great	-
Fatty liver disease (non-alcoholic)	Great	-
Asthma	Great	-
Osteoarthritis	Moderate	-
Hyperuricemia and gout	Moderate	-
Impaired fertility	Slight	-
Musculoskeletal problems	Slight	
Cancers ¹⁴		
• Esophageus	Moderate	-
• Colon and rectum	Moderate	-
• Liver	Moderate	-
• Gallbladder	Moderate	-
• Kidney	Moderate	-
• Pancreas	Moderate	-
• Stomach	Slight	-
• Prostate (men)	Slight	-
• Breast, uterus, cervix, and ovary (women)	Slight	-
PSYCHOSOCIAL HEALTH		
Depression	Great	Great
Social isolation	Great	Great
Negative physical self-perceptions and low self-worth	Great	Great
Eating disorders	Moderate	Moderate
Poorer gross motor development	-	Slight

Greatly increased risk: 3+ times Moderately increased risk: 2–3 times Slightly increased risk: 1–2 times

5 Direct Costs of Overweight and Obesity

It is currently estimated that 8.6% of the burden of disease in Australia can be directly attributed to overweight and obesity, recently surpassing tobacco smoking as the leading avoidable cause of disease in the nation.⁴ A further 21.5% of disease burden can be attributed to determinants closely related to overweight, including high blood pressure (7.3%), physical inactivity (6.7%), high blood cholesterol (6.1%), and lack of fruit and vegetable consumption (1.4%).⁴ In 2005 the direct financial cost of obesity to Australia was estimated as **\$3.767 billion**, including lost productivity (43%), health system costs (23%), carer costs (21%), taxation and welfare costs (10%), and other costs (1%).⁶ Accounting for the personal net costs of lost wellbeing, a further \$17.2 billion can be added, bring the total estimated cost to **\$20.0 billion**.⁶ Based upon population share, the cost to Western Australia is likely to have totalled \$2 billion in 2005, including \$88 million to the health system and \$170 million to industry.

6 Causes of Overweight and Obesity

Bodyweight is regulated by numerous overlapping physiological mechanisms that maintain balance between energy intake and energy expenditure, such that obesity is a multifactorial condition with genetic and environmental predictors.¹⁵⁻¹⁷ Parental obesity has been strongly associated with childhood obesity via both longitudinal and cross-sectional studies.¹⁸⁻²² These studies are poor at controlling for environment factors, but separated twin and adoption studies suggest at least 50% of the tendency towards obesity is inherited.²³⁻²⁵ Six genetic mutations appearing in childhood have also been identified as potential markers for obesity.²⁶⁻²⁸ As such, genetic factors are important predictors of childhood obesity. Yet the rapid rise in the proportion of Australians in the total population who have become obese in the past twenty years is not satisfactorily explained by genetics alone; changing environmental factors that affect energy expenditure through decreased physical activity, and energy intake through increased consumption of foods, are likely to have played a much more significant role.³

The NHMRC suggests that the relative contributions of environmental and genetic factors are likely to vary according to degree of overweight. For instance morbidly obese individuals (BMI 40+) are highly likely to suffer from a genetic defect, with environment playing a permissive role only. Conversely for those moderately overweight or obese, environment is likely to play the dominant role with genetic predisposition contributing only a little.³

6.1 Energy Consumption

Trends

Between 1983 and 1995 the dietary energy intake of Australian adults increased by an average 4%.²⁹ Between 1985 and 2001 the mean dietary energy intake of West Australian children increased by 7.5%.⁹ The major shift predominantly appears to have come about

due to greater total consumption of carbohydrates (including sugars) (+9.5%), and not fats (-1.3%).⁹

Fruit and Vegetable Consumption

In Western Australia fruit and vegetable consumption by adults has increased over the last decade while it has decreased for children. The majority of adults and children do not eat the recommended daily intake of fruit and vegetables.^{9 30} Consumption of 'low energy-density' foods such as fruit and vegetables is very important as appetite appears more regulated by total food weight than total energy.³¹

Fast Food Consumption

Nearly three-quarters (74%) of West Australian children eat fast food. The majority (64%) consume fast food once per week, with the remainder (10%) consuming fast food twice or more per week.³⁰ The number of major fast food outlets in Australia doubled between 1992 and 2002 and Australians now purchase fast food on average once every three to four days, with hot chips, burgers, pizzas, and pastries being four of the five most popularly purchased dishes.³² On days when Australians consume fast food, they have approximately 13% greater total energy intakes.^{33 34}

Energy-dense Snack Food Consumption

There has also been a significant shift in foods purchased at supermarkets. Between 1992 and 1997 Australians' consumption of soft drinks steadily increased by 3–5% per annum, with 120L of soft drink being consumed per capita by 1997.^{35 36} Soft drink producers Coca-Cola and Schweppes rank among the top seven food suppliers to the Australian market, supplying the average Australian with one can of soft drink per day.³⁷ This includes between 42–44% of Australian children who consume one or more cups (250mL) of soft drink per day and 22% who drink two or more cups per day.^{38 39} Added sugars contribute approximately 12% to the daily energy consumption of Australian children, with the single largest contributor from the age of 3 years onwards being soft drinks, followed by cordials.⁴⁰

Confectionary producers Arnott's, Cadbury and Nestle are also some of the top seven non-tobacco grocery suppliers to the Australian market,³⁷ helping provide a large majority of Australian school children (93%) with at least one serve of energy-dense snack food in their lunchboxes per day (average 3.1 serves).⁴¹

Food Advertising

It is estimated that the average Australian child is exposed to 6,074 energy-dense food advertisements per year, or 17 per day.⁴² Two authoritative systematic literature reviews have concluded that food advertising has a probable, independent effect on the preferences, purchasing behaviour and consumption of food by children, at both brand and category levels.^{43 44} However a meta-analysis suggests the direct impact of advertising exposure on bodyweight is likely to be small.⁴⁵

Breast Feeding

Approximately 90% of West Australian mothers initiate breastfeeding, however this rapidly declines to 46% of mothers at six months, with less than one per cent exclusively breastfeeding.⁴⁶ There is some evidence to suggest breastfeeding until the age of six months is a protective factor against later obesity. However the mechanisms for this relationship are yet to be satisfactorily explained and the socioeconomic and

environmental factors underlying a mother's decision to breastfeed remain significant confounders.⁴⁷

Parental Supervision

Parents play a critical role in providing healthy food for children and by acting as role models for healthy eating behaviours.^{48 49} Disordered eating in a parent may be associated with excess body weight in the child.¹³ Two-thirds of children nominate their parents as the single greatest influence on healthy eating. While degree of parental control over food choice tend to decrease with age, obese children report greater levels of control in the pre-teen years, suggesting parents who maintain control of their children's eating habits for longer may be helping to instil healthier eating habits. Obese children are more likely to have obese parents acting as poor role models and who are more indifferent to the health risks associated with being overweight.^{13 49}

6.2 Energy Expenditure

It is widely assumed that increased mechanisation, changes in social, cultural, economic and environmental factors and use of modern electronic media have all contributed to decreases in physical activity levels in our modern society.

Current Physical Activity Levels

A 2002 survey of West Australian adults suggested that just over half (55%) reported undertaking physical activity that would be considered sufficient to maintain good health (57% of males and 52% of females).⁵⁰ A 2003 survey of West Australian students indicated that 14% of primary school students participated in no sport, exercise or dance activities, and amongst high-school students one-quarter of males and one-third of females participated in no physical activities outside of school.⁹

Use of Modern Media

Current statistics suggest that at least 98% of Australians watch television, and it is by far their most popular leisure activity.⁵¹ The average Australian adult watches 2.5 hours of television per day and the average child watches between 1.6–2.0 hours.^{9 38 51-53} Children also play computer games on average for just over half an hour per day.⁵¹

Trends in Physical Activity

While these statistics suggest substantial room for improvement, without comparative data from the 1980s and 1990s it is difficult to judge whether there has actually been any decrease in physical activity levels. Indeed while access to television has increased in the past half a century, the amount of time spent watching television per capita may have remained virtually unchanged throughout the intervening period.^{54 55} Furthermore there is robust evidence from a meta-analytic review to suggest that there is virtually no relationship between television viewing and physical activity at all, nor between computer use and physical activity; it appears people have time for both pursuits.^{45 55}

Given the clear increases in energy consumption of West Australians, decreases in physical activity are unnecessary to explain the burgeoning obesity pandemic in the State;

it merely needs to be acknowledged that energy expenditure has not increased at a commensurate rate to energy consumption.

Table 2 below summarises recent trends in obesity-related behaviours. It is apparent from this table that the substantially increased consumption of energy-dense foods and beverages is the most obvious contributor to the current obesity pandemic. However any method of redressing the energy imbalance can work, whether it be a reduction in energy-dense food consumption, an increase in physical activity, or ideally, a combination of the two.

Table 2: Summary of recent trends in bodyweight-related behaviours in Australia

Weight-related behaviour	Adults		Children	
	Current Situation	Recent trends	Current Situation	Recent trends
Total energy consumption ^{9 29 56}	High	Increased	High	Increased substantially
Total fat intake ^{9 29 56}	High	Decreased slightly	High	Stable
Total sugar intake ^{9 29 56}	High	Increased substantially	High	Increased substantially
Sweetened drink intake ⁴⁰	High	Increased substantially	High	Increased substantially
Fast food consumption ³²	Moderate	Increased	Moderate	Increased
Confectionary consumption ⁵⁷	Moderate	Increased	High	Increased substantially
Fruit and vegetable consumption ⁵⁸	Low	Increased slightly	Low	Decreased slightly
Breast fed for 6+ months	-	-	Moderate	Stable
Total physical activity ⁵⁷	Low	Increased slightly	Moderate	Probably stable
Sports participation ⁵⁷	Low	Probably stable	Moderate	Probably stable
Active travel to work & school ⁵⁷	Low	Decreased	Low	Decreased
Total sedentary behaviours ⁵⁷	High	Probably stable	High	Probably stable
Television viewing ^{54 55 59}	High	Probably stable	High	Probably stable
Leisure-time computer use ^{45 54 55}	Moderate	Probably stable	High	Probably stable

7 Groups At Risk of Overweight and Obesity

7.1 Critical Periods for Abnormal Weight Gain

Pre-natal

There is robust evidence that in-utero development has permanent effects on later growth and energy reduction, potentially reflecting an interaction of genetic and postnatal environmental factors.^{47 57 60}

BMI rebound at 5-7 years

BMI begins to increase rapidly after a period of reduced adiposity during pre-school years, possibly due to changing food and activity patterns as a result of exposure to other children and school. Early and rapid weight rebound often precedes the development of obesity in adulthood. However this association may not be independent of the level of BMI in early childhood and the evidence is far from clear. If BMI rebound *is* related to adult obesity, it could provide a useful tool for detection of at risk individual who would benefit from early intervention.^{47 57 60}

Adolescence

Period of increased autonomy which is often associated with irregular meals, changed food habits and periods of inactivity during leisure combined with physiological changes which promote increased fat deposition, particularly in females. Up to 80% of overweight adolescents will become obese adults. However evidence of adolescence being a crucial period remains equivocal as most studies do not have child obesity data thereby making it difficult to distinguish overweight present in adolescence and overweight onset in adolescence.^{47 57 60}

Early adulthood

Early adulthood usually correlates to a period of marked reduction in physical activity. In women this usually occurs between the ages of 15–19 years but in men it may be as late as the early 30s.^{57 60}

Pregnancy

Excessive weight gain during pregnancy often results in retention of weight after delivery, particularly with early cessation of breastfeeding. This pattern is often repeated after each pregnancy.^{57 60}

Menopause

Weight generally increases with age but menopausal women are particularly prone to rapid weight gain. The mechanisms for this are uncertain, but the loss of the menstrual cycle does affect food intake and reduces the metabolic rate slightly.^{57 60}

7.2 High Risk Groups⁵⁷

Family history of overweight

There is robust evidence to suggest that given the same environment, some people are more prone to depositing fat due to genetically predisposition.

Certain ethnic minorities

Recent migrants to Australia and their children from southern Mediterranean countries and the Middle East are noted to be more likely to be obese.

Socioeconomically disadvantaged

There is an inverse relationship between income and education level and obesity, which is more pronounced in women and children. Less educated people appear more indifferent to healthy diets and regular exercise.

Recent successful weight reducers

Successful weight loss is usually followed by the regain of one-third to one-half of the weight loss over the following year. Behavioural and biological processes are thought to drive body weight back to baseline levels.

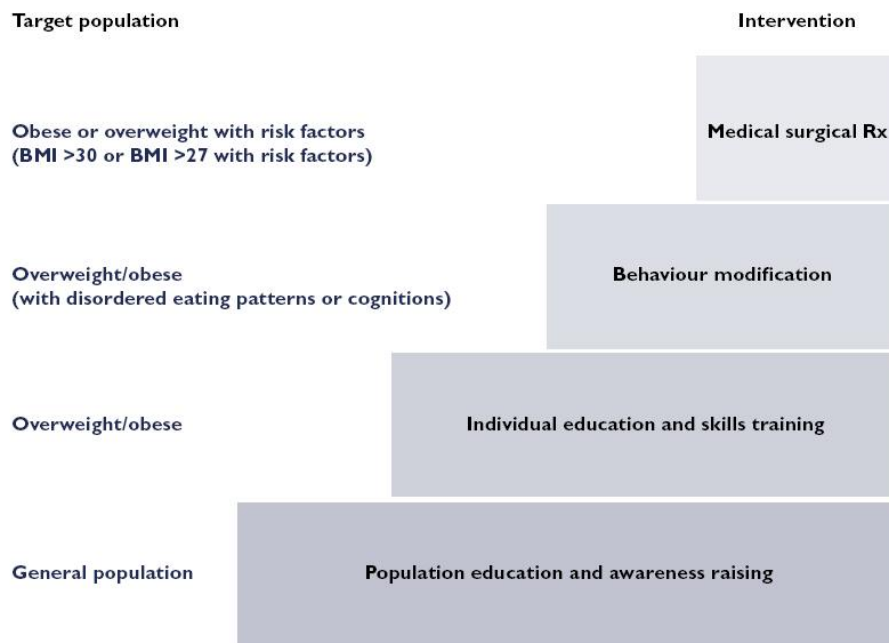
Recent past smokers

Smoking depresses appetite and increases basal metabolic rate. Recent quitters often gain 5–7 kg.

8 Evidence-based Interventions

Most literature regarding interventions to reduce overweight and obesity revolve around the treatment of individuals. However the NHMRC recommends a stepped model for the management of overweight and obesity with the major emphasis placed upon raising awareness and educating the general public, followed by progressively intensive treatments for those increasingly overweight and obese, as seen in Figure 4 below.³

Figure 4: The NHMRC stepped model for clinical management of overweight and obesity³



Clinical Interventions

Dietary, exercise and behavioural counselling treatments for adult obesity appear to produce modest weight loss (about 4–6 kg) compared with no treatment. Weight loss drugs (e.g., Sibutramine and Orlistat), used in conjunction with diet or exercise programs, also produce 3–6 kg of weight loss, but effects often do not last after the drug is stopped; most long-term follow-up studies suggest that initial weight lost gradually returns. For adults with severe obesity surgery is highly effective. Gastric surgery results in 25–44 kg weight loss up to two years post intervention and 20 kg loss up to eight years later.^{3 31 61} Surgery for children and adolescents is only recommended as a last resort for those with co-morbidities.¹³

School-based Interventions

Most childhood interventions referred to school-based programs, which are considered good intervention sites because the vast majority of children attend such. There have been a significant number of reviews published that assess the merits of various school interventions to reduce the incidence of overweight and obesity in children. Many studies

found no effect and unfortunately most studies that did find an effect were characterised by poor methodological design. All reviews have concluded there is insufficient evidence to suggest the consistent characteristics of an effective, school-based intervention.^{31 47 62} Studies that focused on combining dietary and physical activity approaches did not significantly improve BMI, but some studies that focussed on dietary or physical activities alone showed a small but positive impact on BMI status.⁶³ Overall, interventions targeting physical activity appear to have smaller impact than those targeting nutrition, which may not be surprising given that for the average 8-year-old child one can of soft drink represents nearly 10% of required daily energy intake, whereas 10% of energy expenditure equates to 2.5 hours of extra walking.³¹ The most effective interventions appear to target straight-forward messages like “watch less TV” and “drink less soft drink”.⁶⁴ However, it should be noted that those school-based programs that found a significant improvement yielded very modest gains in BMI maintenance or reduction, and doubt about the clinical significance of such programs has been raised.^{31 65}

Worksite-based Interventions

Worksites are similarly considered a good intervention target for the adult population because they allow access to the majority of the adult population, and workplaces are one of the few settings that are successful at recruiting males into health promotion programs.⁷¹ Much like school interventions, there remains insufficient evidence of what works well for a worksite intervention, but what little evidence that is available recommends combining healthy eating and exercise programs on the worksite, providing convenient and affordable healthy foods onsite, and encouraging stair use over elevators.^{57 62 63}

Community-wide Interventions

No community-wide interventions appear to have been successful at reducing or stabilising rates of overweight and obesity. There is wide agreement within the literature that in order to tackle such at a community level, action needs to be broad, comprehensive and multifaceted to address the wide range of factors contributing to weight gain.^{12 57 66} There is also widespread recognition that individual treatments are appropriate for those already overweight and obese but ‘upstream’ approaches are very important for prevention and further weight gain within the population as a whole.^{3 31 47}

Policy-based Interventions

There is a considerable body of evidence from tobacco control showing that environmental and policy interventions are effective in preventing chronic disease risk factors. It is therefore assumed, but yet to be tested, that obesity can be reduced through systematic and sustained implementation of environmental and policy interventions.⁶⁷ Policy interventions such as imposing restrictions on TV food advertising are generally considered to have great potential but due to a limited evidence-base there remains high uncertainty over whether or not such would prove effective in the least.³¹ The literature urges that high risk (low evidence based) interventions should be implemented with rigorous evaluation strategies in place and modified accordingly in the future.^{31 57 62 63}

A summary of the evidence-base for a variety of interventions is displayed in Table 3 below. The largest effect size is for surgery, but this is obviously not suitable for any but the morbidly obese. Most other interventions have only a modest potential to impact upon overweight and obesity. However even interventions with modest effect sizes will impact upon a considerable number of people if aimed at the population level. Furthermore, the greater the number of interventions implemented, the greater the likely cumulative effect.

Table 3: Assessment of Overweight and Obesity Interventions by Evidence of Efficacy and Effect Size

	Evidence	Effect Size
PERSONAL INTERVENTIONS ^{3 31 61}		
Surgery	Sufficient	Large
Pharmacology	Limited	Modest
Behavioural counselling	Sufficient	Modest
Calorie reduced diets	Sufficient	Modest
Low glycaemic index (GI) diet	Insufficient	Modest
Physical activity	Sufficient	Modest
Diet plus physical activity	Sufficient	Modest
Targeted family-based interventions	Sufficient	Modest
SCHOOL-BASED INTERVENTIONS		
Increased frequency of Physical Education ⁴⁷	Limited	Modest
High intensity Physical Education ⁴⁷	Limited	Modest
Promote healthy eating ⁶³	Insufficient	Potentially modest
Healthy school food policies ⁶⁸	Insufficient	Potentially modest
Promotion of diet and exercise ⁶²	Limited	Potentially modest
Promotion of reduced TV viewing ^{31 64}	Inconclusive	Modest
Promotion of reduced soft drink consumption ⁶⁴	Limited	Modest
Promotion of walking or cycling to school ³¹	Weak	Potentially modest
WORKSITE INTERVENTIONS		
Promote exercise and healthy diet ^{57 62 63}	Insufficient	Potentially modest
Convenient, subsidised healthy canteen food ⁶²	Limited	Modest
Prompts for stair over elevator use ^{57 69}	Limited	Modest
POLICY INTERVENTIONS ³¹		
Energy-dense food levy	Limited	Large
Food packaging size restrictions	Insufficient	Large
Improved food labelling	Limited	Modest

Food advertising restrictions	Limited	Modest
ENVIRONMENT⁵⁷		
Provision of recreational spaces	Limited	Modest
Urban planning conducive to walking	Limited	Modest
Provision of foot and cycle paths	Limited	Modest
SOCIAL MARKETING⁶²		
Mass media food education campaigns	Limited	Modest
Mass media physical activity campaigns	Limited	Modest
Promote breast feeding	Insufficient	Modest

9 The NSW Multifactorial Strategy

A good example of a multifactorial strategy to combat overweight and obesity is supplied by the NSW Health document entitled “Best options for promoting healthy weight and preventing weight gain in NSW”.⁵⁷ The document outlines three areas of a multifactorial strategy, as outlined in Table 4 below.

Table 4: The NSW Health multifactorial strategy to combat overweight and obesity

<p><u>Community Attitudes and Capacity:</u></p> <ul style="list-style-type: none"> • Social marketing and mass media campaigns <p><u>Environment and Policy</u></p> <ul style="list-style-type: none"> • Monitoring and surveillance • Changes to the food supply and physical environments • Leadership <p><u>Service Capacity</u></p> <ul style="list-style-type: none"> • Workforce development and collaboration (schools & health services) <p>Achievement of these goals via:</p> <ol style="list-style-type: none"> 1. social marketing campaigns; 2. a media information and briefing strategy; 3. a broad workforce development strategy for government and community sectors; and 4. collaboration with the food industry to address issues of food supply, labelling and food marketing issues.

This level of activity is beyond the scope of the health sector in isolation, but the health industry is well placed to take a leadership role by providing management, coordination and specialised expertise.

10 References

1. World Health Organization. *Diet, Nutrition and the Prevention of Chronic Diseases*. Geneva: World Health Organization Technical Report Series 916, 2003.
2. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320(7244):1240-3.
3. NHMRC. Clinical practice guidelines for the management of overweight and obesity in adults. Canberra: National Health and Medical Research Council, 2003.
4. Australian Institute for Health and Welfare. *Australia's Health 2006*. Canberra: AIHW, 2006.
5. Australian Institute of Health and Welfare. Are all Australians gaining weight? Differentials in overweight and obesity among adults, 1989-90 to 2001. Canberra: AIHW Bulletin Issue 11, December, 2003.
6. Access Economics. The economic costs of obesity. Canberra: Access Economics Pty Ltd; Prepared for Diabetes Australia, October, 2006.
7. Australian Bureau of Statistics. Changes in health: a snapshot, 2004-05. Canberra: ABS cat. no. 4832.0.55.001, 2006.
8. Barr, Cameron, Shaw, Zimmet. The Australian Diabetes Obesity and Lifestyle Study (AusDiab): Five-year follow-up. Western Australian results. Melbourne: International Diabetes Institute, 2005.
9. Hands B, Parker H, Glasson C, Brinkman S, Read H. Physical activity and Nutrition Levels in Western Australian Children and Adolescents: Report. Perth, Western Australia: Western Australian Government, 2004.
10. International Diabetes Institute. Tracking the accelerating epidemic: Its causes and outcomes. Melbourne: The Australian Diabetes, Obesity and Lifestyle study (AusDiab 2005), 2006.
11. Magarey AM, Daniels LA, Boulton TJ. 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(11):561-4.
12. World Health Organization. Global strategy on diet, physical activity and health. Fifty-seventh World Health Assembly: WHO, 2004.
13. NHMRC. Clinical practice guidelines for management of overweight and obesity in children and adolescents. Canberra: National Health and Medical Research Council, 2003.
14. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of U.S. adults. *N Engl J Med* 2003;348(17):1625-38.
15. Lustig RH. The neuroendocrinology of childhood obesity. *Pediatr Clin North Am* 2001;48(4):909-30.
16. Kiess W, Galler A, Reich A, Muller G, Kapellen T, Deutscher J, et al. Clinical aspects of obesity in childhood and adolescence. *Obes Rev* 2001;2(1):29-36.
17. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. *Lancet* 2002;360(9331):473-82.
18. Magarey AM, Daniels LA, Boulton TJ, Cockington RA. Does fat intake predict adiposity in healthy children and adolescents aged 2-15 y? A longitudinal analysis. *Eur J Clin Nutr* 2001;55(6):471-81.
19. Parsons TJ, Power C, Manor O. Fetal and early life growth and body mass index from birth to early adulthood in 1958 British cohort: longitudinal study. *BMJ* 2001;323(7325):1331-5.
20. Safer DL, Agras WS, Bryson S, Hammer LD. Early body mass index and other anthropometric relationships between parents and children. *Int J Obes Relat Metab Disord* 2001;25(10):1532-6.
21. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med* 1997;337(13):869-73.
22. Reilly JJ, Jackson DM, Montgomery C, Kelly LA, Slater C, Grant S, et al. Total energy expenditure and physical activity in young Scottish children: mixed longitudinal study. *Lancet* 2004;363(9404):211-2.
23. Koeppen-Schomerus G, Wardle J, Plomin R. A genetic analysis of weight and overweight in 4-year-old twin pairs. *Int J Obes Relat Metab Disord* 2001;25(6):838-44.
24. Barsh GS, Farooqi IS, O'Rahilly S. Genetics of body-weight regulation. *Nature* 2000;404(6778):644-51.
25. Perusse L, Bouchard C. Role of genetic factors in childhood obesity and in susceptibility to dietary variations. *Ann Med* 1999;31 Suppl 1:19-25.

26. Farooqi IS, O'Rahilly S. Recent advances in the genetics of severe childhood obesity. *Arch Dis Child* 2000;83(1):31-4.
27. Clement K, Vaisse C, Lahlou N, Cabrol S, Pelloux V, Cassuto D, et al. A mutation in the human leptin receptor gene causes obesity and pituitary dysfunction. *Nature* 1998;392(6674):398-401.
28. Moran O, Phillip M. Leptin: obesity, diabetes and other peripheral effects--a review. *Pediatr Diabetes* 2003;4(2):101-9.
29. Cook T, Rutishauser I, Alsopp R. The Bridging Study - comparing results from the 1983, 1985 and 1995 Australian national nutrition surveys. Canberra: Commonwealth Department of Health and Aged Care, 2001.
30. Daly A, Roberts L. Child Health Survey: An Overview. Perth: Department of Health WA, 2002.
31. Haby M, Vos T, Carter R, Moodie M, Marwick A, Magnus A, et al. A new approach to assessing the health benefit from obesity interventions in children and adolescents: the Assessing Cost-effectiveness in Obesity project. *International Journal of Obesity* 2006;30:1463-1475.
32. Mangosi S, Gardiner S. Fast food and eating out in Australia, fifth edition, 2003-2005. Sydney: BIS Schrapnel, 2003.
33. Burns C, Jackson M, Gibbons C, Stoney RM. Foods prepared outside the home: association with selected nutrients and body mass index in adult Australians. *Public Health Nutr* 2002;5(3):441-8.
34. Bowman SA, Gortmaker SL, Ebbeling CB, Pereira MA, Ludwig DS. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* 2004;113(1 Pt 1):112-8.
35. Australian Soft Drink Association. The Australian Non-Alcoholic Beverages Sector: Australian Soft Drinks Association, 2003.
36. Australian Bureau of Statistics. 4315.0 Light beer, wine & soft drink consumption continues to grow: Australian Bureau of Statistics, 1997.
37. AC Nielsen. Top-10 grocery suppliers account for one-third of packaged grocery sales, 2003.
38. NSW Department of Health. New South Wales Child Health Survey 2001. *NSW Public Health Bulletin* 2002;13(S4).
39. Australian Bureau of Statistics and Department of Health and Aged Care. National Nutrition Survey of Foods Eaten in Australia 1995. ABS Cat. no. 4804.0. Canberra: ABS, 1998.
40. Somerset SM. Refined sugar intake in Australian children. *Public Health Nutr* 2003;6(8):809-13.
41. Sanigorski AM, Bell AC, Kremer PJ, Swinburn BA. Lunchbox contents of Australian school children: room for improvement. *Eur J Clin Nutr* 2005.
42. Carter O. The weighty issue of television food advertising and childhood obesity in Australia. *Health Promotion Journal of Australia* 2006;17:5-11.
43. Coon KA, Tucker KL. Television and children's consumption patterns. A review of the literature. *Minerva Pediatr* 2002;54(5):423-36.
44. Hastings G, Stead M, McDermott L, Forsyth A, MacKintosh A, Rayner M, et al. Review of Research on the Effects of Food Promotion to Children: Final Report. Prepared for the Food Standards Authority. Glasgow: University of Strathclyde, 2003.
45. Marshall S, Biddle SJH, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. *International Journal of Obesity* 2004;28(10):1238-1246.
46. Binns C, Graham K. Project report of the Perth Infant Feeding Study Mark II (2002-2004). Canberra: Commonwealth Department of Health and Ageing, 2005.
47. Daniels S, Arnett D, Eckel R, Gidding S, Hayman L, Kumanyika S, et al. Overweight in Children and Adolescents: Pathophysiology, Consequences, Prevention and Treatment. *Circulation* 2005;111:1999-2012.
48. Margarey A, Gehling R, Haigh R, Daniels LA. Key elements for the nutrition component of child overweight management interventions in five- to nine-year-old children. *Nutrition and Dietetics* 2004;61(3):183-184.
49. Jefferson A. Breaking down barriers: Examining health promotion behaviour in the family. Kellogg's Family Health Study. *Nutrition Bulletin* 2006;31:60-64.
50. McCormack G, Milligan R, Giles-Corti B, Clarkson J. Physical activity levels of Western Australian adults 2002. Results from the Adult Physical Activity Survey and Pedometer Study. Perth: Premier's Physical Activity Taskforce, 2003.

51. Australian Bureau of Statistics. 4901.0 Children's Participation in Cultural & Leisure Activities, Australia. Canberra: Australian Bureau of Statistics, 2004.
52. Wake M, Hesketh K, Waters E. Television, computer use and body mass index in Australian primary school children. *J Paediatr Child Health* 2003;39(2):130-4.
53. AC Nielsen. Australian Television Facts. North Sydney: AC Nielsen, 1997.
54. Carter O. Changes in obesity, sedentary behaviours and Perth children's television viewing from 1960 to 2003. *Aust NZ J Public Health* 2005;29(2):187-8.
55. Biddle SJ, Gorely T, Marshall SJ, Murdey I, Cameron N. Physical activity and sedentary behaviours in youth: issues and controversies. *Journal of the Royal Society for the Promotion of Health* 2004;124(1):29-33.
56. Department of Community Services and Health. National Dietary Survey of School Children. Canberra: Australian Government Publishing Service, 1989.
57. NSW Centre for Public Health Nutrition. Best options for promoting healthy weight and preventing weight gain in NSW. Sydney: Prepared for the NSW Department of Health, 2005.
58. Draper G, Unwin E, Serafina S, Somerford P, Price S. Health Measures 2005: A report on the health of the people of Western Australia. Perth: Department of Health, WA, 2005.
59. Nash A. The Impact of Television on Secondary School Children: a study of the effects of television on the out of school activities of secondary school children in Perth, Western Australia [Presented in partial fulfilment of the requirements for the degree of Master of Education]. University of Western Australia, 1961.
60. World Health Organization. *Obesity: preventing and managing the global epidemic*. Geneva: World Health Organization Technical Report Series 894, 1998.
61. Jain A. Treating obesity in individuals and population. *BMJ* 2005;331:1387-90.
62. Katz D, O'Connell M, Yeh M-C, Nawaz H, Njike V, Andersen L, et al. Public health strategies for preventing and controlling overweight and obesity in school and worksite settings. *Recommendations and Reports 54(RR10): 1-12*. Atlanta: Centers for Disease Control, 2005.
63. Summerbell C, Waters E, Edmunds L, Kelly S, Brown T, Campbell K. Interventions for preventing obesity in children (review). *The Cochrane Database of Systematic Reviews* 2005;Issue 3. Art. No.: CD001871.pub2. DOI: 10.1002/14651858.CD001871.pub2.
64. Doak C, Visscher T, Renders C, Seidell J. The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obesity Reviews* 2006;7:111-136.
65. Thomas H. Obesity prevention programs for children and youth: why are their results so modest? *Health Education Research* 2006;21(6):783-795.
66. National Obesity Taskforce. Healthy weight for Adults and Older Australians: A national action agenda to address overweight and obesity in adults and older Australians 2006-2010. Canberra: Commonwealth of Australia, 2006.
67. Brownson R, Haire-Joshu D, Luke D. Shaping the context of health: a review of environmental and policy approaches in the prevention of chronic diseases. *Annual Review of Public Health* 2006;27:341-370.
68. Cleland V, Worsley A, Crawford D. What are grade 5 and 6 children buying from school canteens and what do parents and teachers think about it? *Nutr. Diet.* 2004;61:145-50.
69. Dolan M, Weiss L, Lewis R, Pietrobelli A, Heo M, Faith MS. 'Take the stairs instead of the escalator': effect of environmental prompts on community stair use and implications for a national 'Small Steps' campaign. *Obes Res* 2006;7(25-32).