Overweight and obesity in Australia: the 1999–2000 Australian Diabetes, Obesity and Lifestyle Study (AusDiab)

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ABSTRACT

Objective: To measure the prevalence of obesity in Australian adults and to examine the associations of obesity with socioeconomic and lifestyle factors.

Design: AusDiab, a cross-sectional study conducted between May 1999 and December 2000, involved participants from 42 randomly selected districts throughout Australia.

Participants: Of 20 347 eligible people aged ⩾25 years who completed a household interview, 11 247 attended the physical examination at local survey sites (response rate, 55%).

Main outcome measures: Overweight and obesity defined by body mass index (BMI; kg/m^2) and waist circumference (cm); sociodemographic factors (including smoking, physical activity and television viewing time).

Results: The prevalence of overweight and obesity (BMI ⩾25.0 kg/m^2; waist circumference ⩾80.0 cm [women] or ⩾94.0 cm [men]) in both sexes was almost 60%, defined by either BMI or waist circumference. The prevalence of obesity was 2.5 times higher than in 1980. Using waist circumference, the prevalence of obesity was higher in women than men (34.1% v 26.8%; $P < 0.01$). Lower educational status, higher television viewing time and lower physical activity time were each strongly associated with obesity, with television viewing time showing a stronger relationship than physical activity time.

Conclusions: The prevalence of obesity in Australia has more than doubled in the past 20 years. Strong positive associations between obesity and each of television viewing time and lower physical activity time confirm the influence of sedentary lifestyles on obesity, and underline the potential benefits of reducing sedentary behaviour, as well as increasing physical activity, to curb the obesity epidemic.

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THE PREVALENCE of overweight and obesity is increasing at an alarming rate worldwide.[1] In the United States, for example, the prevalence of obesity rose from 15.0% to 30.9% between 1980 and 2000.[2] Similar findings have been reported from developing countries.[3]

Obesity is the most obvious manifestation of the global epidemic of sedentary lifestyles and excessive energy intake. Associations have been observed between obesity and type 2 diabetes, cardiovascular disease, some cancers and arthritis, each of which has major morbidity, mortality and socio-economic costs. In Australia, the prevalence of diabetes in 2000 was found to be 7.4%, more than twice the estimate for 1981.[4]

In Australia, national obesity prevalence data have been reported previously.[5,6] In the 1995 National Nutrition Survey, 45% of men and 29% of women were found to be overweight, and a further 18% of men and women were classified as obese.[6]

The recent Australian Diabetes, Obesity and Lifestyle Study (AusDiab) yielded a large population-based sample. Here we report the magnitude of the obesity epidemic in Australia, together with an examination of the association of obesity with lifestyle-related factors.

METHODS

Sample selection

The AusDiab study methods are described in detail elsewhere.[7] A stratified cluster sample was drawn from 42 randomly selected Census Collector Districts across Australia (six in each of the six States and the Northern Territory). Those districts containing fewer than 100 people aged 25 years and over, those classified as 100% rural, or those in which 10% or more of the population

1: Age-specific prevalence (%) of (A) overweight and (B) obesity defined by body mass index (BMI) (n = 11 067) and by waist circumference (n = 11 059) among Australian adults

	25–34 y	35–44 y	45–54 y	55–64 y	65–74 y	75+ y	Total
A	**Age-specific prevalence (%) of overweight**						
BMI*							
Men	43.7	46.8	51.1	48.9	53.6	50.8	48.2
Women	22.6	25.7	32.1	35.4	37.4	36.4	29.9
Total	33.5	36.3	41.7	42.2	44.8	42.4	39.0
Waist circumference†							
Men	26.6	25.7	31.0	31.0	30.7	27.5	28.5
Women	19.6	21.8	21.5	25.6	27.7	22.8	22.6
Total	23.3	23.8	26.3	28.3	29.1	24.7	25.5
B	**Age-specific prevalence (%) of obesity**						
BMI‡							
Men	17.4	17.8	20.8	25.5	19.9	12.7	19.3
Women	12.4	19.5	26.9	32.8	29.4	15.6	22.2
Total	15.0	18.6	23.8	29.1	25.1	14.4	20.8
Waist circumference§							
Men	14.0	24.9	27.6	36.0	40.7	36.5	26.8
Women	17.2	25.8	38.3	48.0	51.2	42.3	34.1
Total	15.5	25.4	32.9	42.0	46.5	39.9	30.5

* Overweight defined as a BMI of 25.0–29.9 kg/m^2.
† Overweight defined as a waist circumference of 94.0–101.9 cm in men and 80.0–87.9 cm in women.
‡ Obesity defined as a BMI of ⩾ 30.0 kg/m^2.
§ Obesity defined as a waist circumference of ⩾ 102.0 cm men and ⩾ 88.0 cm in women.

were Aboriginals or Torres Strait Islanders, were excluded. Within each district, all homes were approached, and all usual residents aged 25 years and over were invited to take part in the survey.

The survey, conducted between May 1999 and December 2000, involved a short household interview, followed by a biomedical examination at a local survey centre.

Householders not available at the initial interview were approached again on up to four more occasions. Household questionnaires were completed in 67% of the households (n = 11 479) that could be contacted and contained at least one eligible person. A total of 20 347 eligible individuals were interviewed in these 11 479 households. The final survey sample (those attending the biomedical examination) included 11 247 adults (5049 men and 6198 women), representing 55% of those completing the household interview.

Body mass index

Height was measured to the nearest 0.5 cm without shoes, using a stadiometer. Weight was measured to the nearest 0.1 kg using a mechanical beam balance, after removal of shoes and excess clothing. Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. Those with a BMI of 25.0–29.9 kg/m^2 were classified as overweight, while those with a BMI ⩾ 30.0 kg/m^2 were classified as obese.[1]

Waist circumference

Waist circumference was measured halfway between the lower border of the ribs and the iliac crest on a horizontal plane. Two measurements to the nearest 0.5 cm were recorded. If the measurements varied by more than 2 cm, a third measurement was taken. The mean of the two closest measurements was calculated. Men with a waist circumference 94.0–101.9 cm and women with a waist circumference 80.0–87.9 cm were classified as overweight. Men with a waist circumference ⩾ 102.0 cm and women with a waist circumference ⩾ 88.0 cm were classified as obese.[1]

Potential risk factors

Data on education, country of birth, household income, occupation, smoking and physical activity and television viewing habits were obtained by questionnaire.

Occupation, as defined by the Australian Standard Classification of Occupations (ASCO), was divided into five skill levels (see footnotes to Box 3 and Box 4).[8]

The time spent watching TV and/or videos, as well as physical activity time, was estimated for the previous week. Total physical activity time for the previous week was calculated as the sum of the time spent walking (if continuous and for 10 minutes or more) or performing moderate physical activity, plus double the time spent in vigorous physical activity. Each of these activity types was truncated to 14 hours and the total time was truncated to 28 hours. Gardening, household chores and occupational physical activity were excluded. Quintiles of physical activity and television viewing were calculated separately for men and women. Self-report measures to assess physical activity[9] and television viewing[10] have been validated previously.

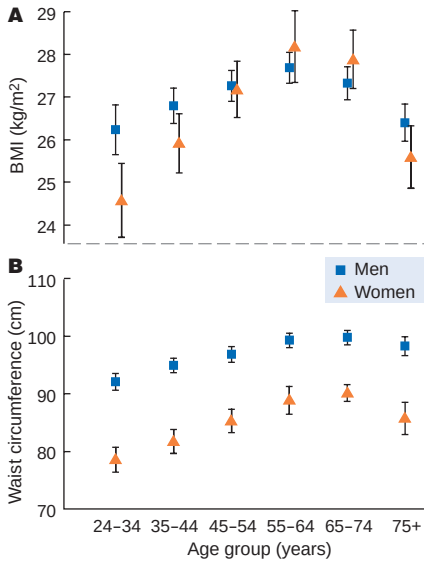
Trend analysis

To study the prevalence of obesity over time, the AusDiab data were compared with earlier Australian national surveys. For consistency with the 1980 National Heart Foundation (NHF) Survey, the AusDiab data were confined to capital city participants aged 25–64 years.

Ethical approval

The ethics committee of the International Diabetes Institute approved the study design, and all subjects provided written consent to participate.

2: Mean body mass index (BMI) (A) and mean waist circumference (B) by age group for Australian men and women (bars = 95% CIs)



Statistical analysis

To account for the clustering and stratification of the survey design, and to adjust for non-response, the data were weighted to match the age and sex distribution of the 1998 estimated residential population of Australia aged ⩾ 25 years, unless otherwise stated. The weighting factor was based on the probability of selection in each cluster. Therefore, all prevalences relate to the total 1998 Australian population aged ⩾25 years, with the exception of figures presented for the change in the prevalence of obesity between 1980 and 2000, which have been age-standardised to the 1991 Australian population aged ⩾25 years. The 1980 figures are based on data collected during the NHF Risk Factor Prevalence Survey.[5]

Prevalences and 95% confidence intervals were calculated using Stata Statistical Software,[11] accounting for the clustered and stratified nature of the survey. Logistic regression[11] was used to analyse associations between obesity and each of the potential risk factors. For participants living in family units, total household income was recorded, with individual incomes calculated using a modified version of the Organisation for Economic Cooperation and

3: Association between obesity (measured using body mass index [BMI]* [*n* = 4996] and waist circumference* [*n* = 4984]) and potential risk factors among Australian men

	Body mass index		Waist circumference	
	n	Adjusted odds ratio† (95% CI)	*n*	Adjusted odds ratio† (95% CI)
Smoking status				
Non/ex-smoker	4048	1.00	4041	1.00
Smoker	865	0.71 (0.48–1.04)	860	0.63 (0.51–0.78)‡
Physical activity§				
Lowest quintile	946	1.00	946	1.00
Highest quintile	1021	0.70 (0.46–1.06)	1022	0.56 (0.42–0.75)‡
Television viewing¶				
Lowest quintile	784	1.00	783	1.00
Highest quintile	1094	1.86 (1.30–2.67)‡	1093	1.97 (1.48–2.63)‡
Education				
University/Further education	2089	1.00	2086	1.00
Completed high school	901	1.14 (0.92–1.42)	900	0.93 (0.69–1.27)
Some high school completed	1693	2.19 (1.6–3.01)‡	1684	1.65 (1.17–2.33)‡
Primary school/never attended school	309	2.40 (1.59–3.61)‡	310	2.31 (1.69–3.15)‡
Country of birth				
Australia/New Zealand	3727	1.00	3713	1.00
United Kingdom/Northern Ireland	612	0.92 (0.65–1.29)	611	0.89 (0.68–1.16)
Rest of world	653	0.85 (0.67–1.08)	656	0.60 (0.40–0.92)‡
Weekly income (A$)				
1500+	502	1.00	502	1.00
800–1499	1541	1.18 (0.80–1.74)	1533	1.30 (0.93–1.81)
600–799	1162	1.12 (0.78–1.60)	1157	1.29 (0.91–1.82)
400–599	1133	1.07 (0.77–1.50)	1134	1.23 (0.84–1.80)
200–399	571	1.06 (0.70–1.62)	573	0.97 (0.69–1.36)
0–199	37	0.68 (0.22–2.07)	36	0.51 (0.17–1.54)
Occupation**				
Skill level 1	1243	1.00	1244	1.00
Skill level 2	540	0.65 (0.46–0.93)‡	534	0.74 (0.49–1.14)
Skill level 3	658	0.48 (0.32–0.72)‡	659	0.43 (0.26–0.70)‡
Skill level 4	604	0.95 (0.63–1.43)	602	0.84 (0.58–1.21)
Skill level 5	304	0.93 (0.52–1.63)	304	0.92 (0.46–1.84)
Others	1629	0.56 (0.35–0.89)‡	1623	1.07 (0.66–1.72)

* Obesity defined as BMI ⩾ 30 kg/m^2, or waist circumference ⩾ 102 cm.
† Model adjusted for age and all other risk factors in the table.
‡ Significantly different from reference ($P < 0.05$).
§ Quintiles of physical activity: < 30 minutes = lowest, ⩾ 550 minutes = highest.
¶ Quintiles of television viewing: < 300 minutes = lowest, ⩾ 1260 minutes = highest.
** Skill levels: 1 — managers, administrators and professionals; 2 — associate professionals; 3 — tradespersons, advanced clerical and service workers; 4 — intermediate clerical, sales and service workers, intermediate production and transport workers; 5 — elementary clerical, sales and service workers and labourers; and others — students, retirees, pensioners and unemployed.

Development (OECD) equivalence scale[12] to adjust for the number of adults and children in the household. For all other participants, individual income was recorded.

RESULTS

Prevalence of overweight and obesity

The prevalence rates for overweight and obesity were 39.0% (95% CI, 37.7–40.3) and 20.8% (95% CI, 18.4–23.1), respectively, defined by BMI, and 30.5% (95% CI, 26.4–34.5) and 25.5% (95% CI, 23.8–27.2) by waist circumference (Box 1). By either measure, approximately 60% of the population was overweight or obese. The prevalence of obesity by waist circumference was higher in women (34.1%) than in men (26.8%) ($P < 0.01$). Using BMI, however, the difference was not significant.

The prevalence of obesity defined by BMI showed a steady increase up to the age group 55–64 years, after which the prevalence fell. The corresponding peak in the prevalence of obesity defined by waist circumference occurred at an older age (65–74 years). Mean BMI and waist circumference were 26.9 kg/m^2 (95% CI, 26.6–27.2 kg/m^2) and 96.0 cm (95.0–97.0 cm), respectively, for men, and 26.4 kg/m^2 (25.9–26.9 kg/m^2) and 84.2 cm (82.4–85.9 cm) for women. Mean BMI and waist circumference according to age group are shown in Box 2; it is apparent that, for BMI, the increase with age was much more pronounced in women than men, while, for waist circumference, the association with age was similar between the sexes. The age-standardised prevalence of obesity defined by BMI has risen from 7.1% in 1980 to 18.4% in 2000.

Obesity and potential risk factors

The associations between obesity and potential risk factors are shown in Boxes 3 and 4, with television viewing time strongly associated with obesity in both sexes. Physical activity time was related to obesity defined by BMI or waist circumference in women, while in men it was only associated with obesity defined by waist circumference. Lower educational attainment was consistently predictive of obesity in each sex.

4: Association between obesity (measured using body mass index [BMI]* [*n* = 6071] and waist circumference* [*n* = 6075]) and each of the potential risk factors among Australian women

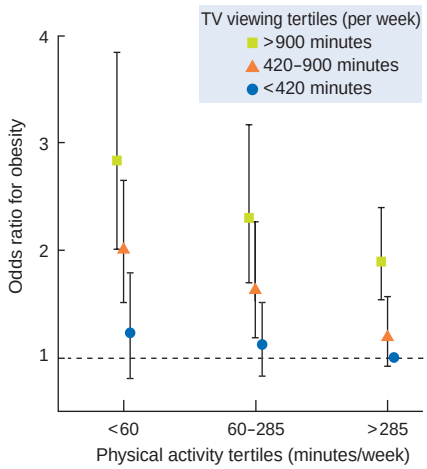
	Body mass index		Waist circumference	
	n	Adjusted odds ratio† (95% CI)	*n*	Adjusted odds ratio† (95% CI)
Smoking status				
Non/ex-smoker	5123	1.00	5128	1.00
Smoker	857	0.70 (0.51–0.97)‡	858	1.03 (0.76–1.39)
Physical activity§				
Lowest quintile	1254	1.00	1255	1.00
Highest quintile	1221	0.47 (0.31–0.72)‡	1221	0.53 (0.34–0.80)‡
Television viewing¶				
Lowest quintile	992	1.00	994	1.00
Highest quintile	1292	1.82 (1.19–2.76)‡	1295	2.27 (1.55–3.32)‡
Education				
University/Further education	1985	1.00	1985	1.00
Completed high school	1185	1.04 (0.77–1.40)	1185	1.31 (1.01–1.70)‡
Some high school completed	2481	1.48 (1.19–1.83)‡	2487	1.47 (1.19–1.82)‡
Primary school/never attended school	419	2.12 (1.18–3.80)‡	417	2.68 (1.64–4.36)‡
Country of birth				
Australia/New Zealand	4672	1.00	4677	1.00
United Kingdom/Northern Ireland	644	0.95 (0.68–1.34)	646	1.01 (0.69–1.49)
Rest of world	754	0.80 (0.66–0.97)‡	751	0.72 (0.57–0.92)‡
Weekly income (A$)				
1500+	1034	1.00	1034	1.00
800–1499	2046	0.85 (0.67–1.08)	2046	0.93 (0.74–1.19)
600–799	1270	0.87 (0.66–1.15)	1274	0.79 (0.62–1.02)
400–599	1064	0.57 (0.40–0.82)‡	1062	0.62 (0.46–0.83)‡
200–399	499	0.67 (0.48–0.93)‡	501	0.59 (0.37–0.94)‡
0–199	20	0.63 (0.19–2.11)	20	0.46 (0.13–1.65)
Occupation**				
Skill level 1	990	1.00	989	1.00
Skill level 2	390	0.82 (0.41–1.65)	389	0.80 (0.48–1.34)
Skill level 3	354	0.88 (0.55–1.40)	355	0.93 (0.58–1.48)
Skill level 4	886	1.11 (0.72–1.71)	884	0.74 (0.53–1.05)
Skill level 5	549	0.84 (0.45–1.57)	551	0.90 (0.60–1.36)
Others	2869	0.94 (0.54–1.63)	2874	1.08 (0.71–1.64)

* Obesity defined as BMI ⩾ 30 kg/m^2, or waist circumference ⩾ 88 cm.
† Model adjusted for age and all other risk factors in the table.
‡ Significantly different from reference ($P < 0.05$).
§ Quintiles of physical activity: < 20 minutes = lowest, ⩾ 390 minutes = highest.
¶ Quintiles of television viewing: < 240 minutes = lowest, ⩾ 1200 minutes = highest.
** Skill levels: 1 — managers, administrators and professionals; 2 — associate professionals; 3 — tradespersons, advanced clerical and service workers; 4 — intermediate clerical, sales and service workers, intermediate production and transport workers; 5 — elementary clerical, sales and service workers and labourers; and others — students, retirees, pensioners and unemployed.

Increasing income increased the risk of obesity in women. Although no such association was significant for men, both the BMI and waist circumference data suggested that middle-income men tended to be more obese than the lowest income group. Men with occupations in skill levels 2 and 3 had the lowest risk of obesity, suggesting a "U"-shaped relationship, although no significant associations between occupation and obesity were observed for women.

Comparing the association of television viewing and physical activity time with obesity, television viewing clearly showed the stronger relationship (Box 5). Within each tertile of physical activity, the odds of being obese were highly dependent on television viewing time. While increased physical activity decreased the odds of obesity among each tertile of television viewing time, its influence was not as strong as that of television viewing time.

5: Odds ratio* for obesity (95% CI)†: television viewing time v physical activity time



* Odds ratios adjusted for age and sex.
† Obesity defined by waist circumference ⩾ 102.0 cm (men) or 88.0 cm (women).

Respondents v non-respondents to the physical examination

A previous analysis of respondents versus non-respondents to the physical examination found small differences in the proportion of English speakers, those born in the United Kingdom and those suspecting they had diabetes ($P < 0.05$).[7]

DISCUSSION

These nationally representative AusDiab data show alarming rates of overweight and obesity. The obesity rates reported here are considerably higher than those of previous Australian urban studies in 1980, 1989 and 1995.[13-15] In 1980, 7.1% of the population aged 25–64 years living in major cities in Australia were obese.[13] Using the same age and geographical restrictions, the prevalence (defined by BMI) in our study was 18.4%, showing a 2.5-fold rise over 20 years. Across the four surveys in the last 20 years, the prevalence appears to have stabilised in men since 1995, but a continuing rise is apparent for women.

The consequences of high rates of overweight and obesity are likely to be profound, with the AusDiab data also showing that Australia now has one of the highest rates of type 2 diabetes in the developed world.[4]

The high prevalence of obesity found is still considerably lower than the reported rate for 1999–2000 from the United States[2] (27.5% in men and 33.4% in women), but comparable with those reported from the UK[16] (17% in men and 21% in women) and (West) Germany[17] (19.4% in men and 20.9% in women), ranking Australia as one of the most severely affected Europid populations.

Waist circumference provides an alternative measure of adiposity that correlates reasonably well with BMI,[18] but appears to be a better indicator of visceral fat, type 2 diabetes and cardiovascular disease.[19] There are few published studies of the age and sex distribution of obesity according to waist circumference. In the second MONICA survey[20] only two centres (Germany, Czech Republic) had higher mean waist circumferences for men than in our study, and four centres (Germany, Czech Republic, Spain and Yugoslavia) had higher mean waist circumferences for women.

The age and sex pattern of BMI is consistent with a number of other studies.[2,21] Both the prevalence of obesity and mean BMI are lower in young women than in young men, but a more rapid rise in BMI in women results in women overtaking men by the age of 35–44 years for obesity prevalence and by age 55–64 years for mean BMI. The impact of age on waist circumference is almost identical for men and for women, suggesting that the factors leading to increasing waist circumference with age are much more similar between men and women than are the factors affecting BMI. Increasing peripheral fat in women related to childbirth and the menopause may well be the critical difference.[1]

We found that physical activity time and television viewing time were the strongest correlates with obesity. Television viewing time showed a significant positive association with both measures of obesity in men and women, after adjustment for physical activity time and other risk factors. A corresponding negative association was seen for increased physical activity time, although it was not a significant predictor of BMI in men. Of particular note is the strength of the relationship of obesity with television viewing time — even those in the top tertile of physical activity showed a high risk of obesity if they were also in the top tertile of television viewing time. This dominant effect of television viewing time has been reported previously in another population-based Australian study.[22] The relative imprecision of recall of physical activity time in comparison with television viewing time may explain part of this finding. Another explanation may be the reduction in incidental (non-structured) physical activity associated with television viewing, which, in an inactive society, has the potential to significantly reduce total energy expenditure.[23] The association between television viewing time and obesity is important for health education and public health programs. While most such programs focus on increasing the time spent engaged in physical activity, it may be more achievable to recommend reducing the time spent in completely sedentary activities such as watching television. Indeed, a recent interventional trial has shown that measures to limit television viewing in children can be effective in controlling obesity.[24]

Together with television viewing time and physical activity time, energy intake

has an important impact on obesity. From 1983 to 1995, Australian data show that there has been a significant increase in energy intake among adults and children.[25] Television viewing itself has been linked to higher energy intake (take-away meals) among women,[26] and this may relate to habits of eating during television viewing.

Of the socioeconomic factors examined, lower educational attainment showed the most consistent relationship with obesity. This finding is supported by other studies,[21] although the cause is not clear. The association of obesity with income was sex specific. In men, minor trends for middle-income groups to be more obese and the least affluent to be thin were observed, although these were not significant. Women, by contrast, showed a strong positive graded association between income and obesity.

When interpreting these results, some caution should be exercised. As the AusDiab study was cross-sectional, causality cannot be determined from the associations observed. For example, obese people may be less active as a consequence of their obesity. This is unlikely to be the entire explanation for the associations reported, as decreased physical activity has been linked to obesity in prospective studies.[27] The level of response to the study should also be considered, as well as the small differences between responders and non-responders.[7] Additionally, even though AusDiab was designed to provide estimates representative of the adult Australian population, the exclusion criteria may have resulted in under-representation of some population groups (eg, Indigenous and rural Australians).

In conclusion, Australia has been shown to have alarming rates of both central and general obesity. This urgently demands action on many levels to prevent further rises in the prevalence of diseases such as type 2 diabetes. The strong relationship we found between obesity and surrogate indices of energy expenditure needs to be confirmed in prospective studies, but suggests that reducing time spent in sedentary activities could be an important target for preventing and treating obesity.

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COMPETING INTERESTS

None identified.

REFERENCES

1. World Health Organization. Obesity — preventing and managing the global epidemic: report of a WHO consultation on obesity. Geneva: WHO, 1998.
2. Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US adults, 1999-2000. *JAMA* 2002; 288: 1723-1727.
3. Hodge A, Dowse G, Toelupe P, et al. Dramatic increase in the prevalence of obesity in Western Samoa over the 13 year period 1978-1991. *Int J Obes Relat Metab Disord* 1994; 18: 419-428.
4. Dunstan DW, Zimmet PZ, Welborn TA, et al. The rising prevalence of diabetes and impaired glucose tolerance: the Australian Diabetes, Obesity and Lifestyle Study. *Diabetes Care* 2002; 25: 829-834.
5. Bennett SA, Magnus P. Trends in cardiovascular risk factors in Australia: results from the National Heart Foundation's Risk Factor Prevalence Study, 1980–1989. *Med J Aust* 1994; 161: 519-527.
6. Australian Bureau of Statistics, Department of Health and Family Services. National Nutrition Survey: selected highlights 1995. Canberra: ABS/DHFS, 1997.
7. Dunstan D, Zimmet P, Welborn T, et al. The Australian Diabetes, Obesity and Lifestyle Study (AusDiab) — methods and response rates. *Diabetes Res Clin Pract* 2002; 57: 119-129.
8. Australian Bureau of Statistics. Australian standard classification of occupations (ASCO). 2nd edition. Canberra: ABS, 1997. (Catalogue No. 1220.0.)
9. Booth ML, Owen N, Bauman A, et al. Relationship between a 14-day recall measure of leisure-time physical activity and a submaximal test of physical work capacity in a population sample of Australian adults. *Res Q Exerc Sport* 1996; 67: 221-227.
10. Salmon J, Owen N, Crawford D, et al. Physical activity and sedentary behavior: a population-based study of barriers, enjoyment, and preference. *Health Psychol.* In press.
11. StataCorp: Stata statistical software, release 6.0. College Station, Tex: StataCorp, 1999.
12. DeVos K, Zaidi M. Equivalence scale sensitivity of poverty statistics for the member states of the European Community. *Review Income Wealth* 1997; 4319-333.
13. National Heart Foundation of Australia. Risk Factor Prevalence Study No. 1 — 1980. Canberra: NHF, 1980.
14. National Heart Foundation and Australian Institute of Health. Risk Factor Prevalence Study No. 3 — 1989. Canberra: NHF/AIH, 1990.
15. Australian Bureau of Statistics, Department of Health and Family Services. National Nutrition Survey: selected highlights 1995. Canberra: ABS/DHFS, 1997.
16. Joint Health Surveys Unit on behalf of the Department of Health. Health Survey for England — cardiovascular disease 1998. London: The Stationery Office, 1999.
17. Bergmann KE, Mensink GB. Anthropometric data and obesity. *Gesundheitswesen* 1999; 61(Suppl): S115-S120.
18. Lean M, Han T, Morrison C. Waist circumference as a measure for indicating need for weight management. *BMJ* 1995; 311: 158-161.
19. Haffner S, Stern M, Hazuda H, et al. Do upper-body and centralized adiposity measure different aspects of regional body-fat distribution? Relationship to non-insulin dependent diabetes mellitus, lipids, and lipoproteins. *Diabetes* 1987; 36: 43-51.
20. Molarius A, Seidell JC, Sans S, et al. Waist and hip circumferences, and waist-hip ratio in 19 populations of the WHO MONICA Project. *Int J Obes Relat Metab Disord* 1999; 23: 116-125.
21. Macdonald SM, Reeder BA, Chen Y, et al. Obesity in Canada: a descriptive analysis. Canadian Heart Health Surveys Research Group. *CMAJ* 1997; 157 Suppl 1: S3-S9.
22. Salmon J, Bauman A, Crawford D, et al. The association between television viewing and overweight among Australian adults participating in varying levels of leisure-time physical activity. *Int J Obes Relat Metab Disord* 2000; 24: 600-606.
23. Buchowski MS, Sun M. Energy expenditure, television viewing and obesity. *Int J Obes Relat Metab Disord* 1996; 20: 236-244.
24. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. *JAMA* 1999; 282: 1561-1567.
25. Cook P, Rutishauser IHE, Seelig M. Comparable data on food and nutrient intake and physical measurements from the 1983, 1985 and 1995 national nutrition surveys. Canberra: Commonwealth Department of Health and Aged Care, 2001.
26. Jeffery RW, French SA. Epidemic obesity in the United States: are fast foods and television viewing contributing? *Am J Public Health* 1998; 88: 277-280.
27. Ching PL, Willett WC, Rimm EB, et al. Activity level and risk of overweight in male health professionals. *Am J Public Health* 1996; 86: 25-30.

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