The cost of overweight and obesity in Australia

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ABSTRACT

Objective: To assess and compare health care costs for normal-weight, overweight and obese Australians.

Design, setting and participants: Analysis of 5-year follow-up data from the Australian Diabetes, Obesity and Lifestyle study, collected in 2004–2005. Data were available for 6140 participants aged ⩾ 25 years at baseline.

Main outcome measures: Direct health care cost, direct non-health care cost and government subsidies associated with overweight and obesity, defined by both body mass index (BMI) and waist circumference (WC).

Results: The annual total direct cost (health care and non-health care) per person increased from $1472 (95% CI, $1204–$1740) for those of normal weight to $2788 (95% CI, $2542–$3035) for the obese, however defined (by BMI, WC or both). In 2005, the total direct cost for Australians aged ⩾ 30 years was $6.5 billion (95% CI, $5.8–$7.3 billion) for overweight and $14.5 billion (95% CI, $13.2–$15.7 billion) for obesity. The total excess annual direct cost due to overweight and obesity (above the cost for normal-weight individuals) was $10.7 billion. Overweight and obese individuals also received $35.6 billion (95% CI, $33.4–$38.0 billion) in government subsidies. Comparing costs by weight change since 1999–2000, those who remained obese in 2004–2005 had the highest annual total direct cost. Cost was lower in overweight or obese people who lost weight or reduced WC compared with those who progressed to becoming, or remained, obese.

Conclusion: The total annual direct cost of overweight and obesity in Australia in 2005 was $21 billion, substantially higher than previous estimates. There is financial incentive at both individual and societal levels for overweight and obese people to lose weight and/or reduce WC.

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Australia has one of the highest prevalences of overweight and obesity among developed countries.[1] In 2005, the total direct and indirect cost of obesity (body mass index [BMI] ⩾ 30 kg/m^2) in Australia was estimated as $3.8 billion, $873 million of which was the cost to the health system.[2] In 2008, these figures were revised up to $8.3 billion and $2.0 billion, respectively.[3] These estimates were derived by a "top-down approach" of allocating national health costs to specific diseases attributable to obesity, which may underestimate real cost. As with most reports,[4] costs associated with overweight (BMI, 25–29.9 kg/m^2) were not calculated. Overweight increases the risk of several conditions, including diabetes and cardiovascular disease.[5] A Dutch study suggested that overweight accounted for 69% of direct costs associated with abnormalities of weight.[6] With 40% of the Australian adult population being overweight,[7] costs associated with overweight could be substantial. Furthermore, the impact of abdominal obesity, which is also associated with increased risk of diabetes,[8] is rarely considered in cost analyses of weight abnormalities.

The Australian Diabetes, Obesity and Lifestyle (AusDiab) study is a national population-based study.[9] The baseline AusDiab study was conducted in 1999–2000 and included a physical examination. In the 2004–2005 follow-up survey, a physical examination was again performed and data on health services utilisation and health-related expenditure were also collected. These data provide an opportunity to use the more robust "bottom-up approach", which collects cost data from individuals and extrapolates the cost to society, to assess the costs of overweight and obesity. We used the AusDiab follow-up data to assess and compare costs for people classified as normal weight, overweight or obese based on BMI, waist circumference (WC) or both.

METHODS

Study participants

AusDiab study participants were aged ⩾ 25 years at baseline. Details of the study have been published elsewhere.[9,10] Our analysis included those participants with weight data collected in 1999–2000 and 2004–2005 and cost data in 2004–2005. The weight status of participants was assigned according to BMI alone, WC alone, and a combined definition based on BMI and/or WC. For general weight status according to BMI, normal weight was defined as 18.5–24.9 kg/m^2; overweight as 25.0–29.9 kg/m^2; and obese as ⩾ 30.0 kg/m^2.[11] For abdominal weight status according to WC, normal was defined as < 94 cm for men and < 80 cm for women; overweight as 94–101.9 cm for men and 80–87.9 cm for women; and obese as ⩾ 102 cm for men and ⩾ 88 cm for women.[11] Ethnic-specific WC cut-off points were not used because 94% of participants were born in Australia, New Zealand, Europe or North America, and there were only limited data on ethnicity in the AusDiab cohort.

Costing data

Costing data were available for direct health and non-health care costs and government subsidies. Direct health care costs included ambulatory services, hospitalisation, prescription medication and some medically related consumables (eg, blood glucose self-monitoring meters and strips). Prescription medications for creams, eye drops and inhalers, and non-prescription medications, except for aspirin, were not included. Direct non-health care costs included transport to hospitals, supported accommodation, home service and day centres, and purchase of special food. Government subsidies included payments for the aged pension, disability pension, veteran pension, mobility allowance, sickness allowance and unemployment benefit.

Costing data for medical services and diagnostics were obtained from the Medicare Benefits Schedule and the Australian Medical Association fees list. Costs of medications were obtained from the Schedule of Pharmaceutical Benefits and *MIMS Annual*; costs of diabetes consumables from the National Diabetes Services Scheme; hospital costs from the National Hospital Cost Data Collection; and pensions and allowances data from Centrelink.

In general, AusDiab survey questions on the use of health services and health-related

1 Annual cost per person, by weight status in 2004–2005

Weight status	No.	Mean age (SE)	Annual cost ($) per person (95% CI)			
			Direct health	Direct non-health	Total direct	Government subsidies
General weight status using body mass index (BMI)						
Normal	1943	55.2 (0.3)	1313 (1145–1482)	397 (262–532)	1710 (1464–1956)	2948 (2696–3199)
Overweight	2537	57.4 (0.3)	1559 (1418–1701)	551 (397–705)	2110 (1887–2334)	3737 (3496–3978)
Obese	1660	56.7 (0.3)	2027 (1839–2215)	513 (343–684)	2540 (2275–2805)	4153 (3840–4466)
Abdominal weight status using waist circumference (WC)						
Normal	2012	52.5 (0.3)	1120 (971–1268)	264 (151–377)	1384 (1171–1597)	2585 (2350–2821)
Overweight	1612	57.1 (0.3)	1461 (1289–1633)	411 (258–565)	1872 (1634–2110)	3450 (3160–3740)
Obese	2516	58.6 (0.2)	2093 (1932–2254)	726 (554–898)	2819 (2565–3072)	4507 (4247–4768)
Combined weight status using both BMI and WC*						
Normal	1517	53.9 (0.3)	1177 (990–1364)	295 (160–431)	1472 (1204–1740)	2633 (2360–2906)
Overweight	1992	56.3 (0.3)	1299 (1163–1434)	370 (237–503)	1669 (1473–1865)	3277 (3019–3535)
Obese	2631	58.2 (0.2)	2091 (1931–2251)	698 (533–862)	2788 (2542–3035)	4402 (4150–4654)
Overall	6140	56.5 (0.2)	1608 (1514–1702)	492 (403–581)	2100 (1959–2240)	3600 (3446–3753)

* Normal = BMI, 18.5–24.9 kg/m^2 and WC < 94 cm for men, < 80 cm for women. Overweight = BMI, 25.0–29.9 kg/m^2 and/or WC, 94–101.9 cm for men, 80–87.9 cm for women. Obese = BMI ⩾ 30.0 kg/m^2 and/or WC ⩾ 102 cm for men, ⩾ 88 cm for women. ◆

expenditure were for the previous 12 months. Participants self-reported medication use, and were encouraged to either provide a list from their general practitioner or bring their medication to the AusDiab testing site. The cost of each medication for 12 months was calculated, taking into account the strength and daily dosage, except antibiotics and medications used as required, which were assigned the cost of a single packet of medication. When the strength of a medication was not known, the cost of the lowest available strength was used, and when the number of tablets per day was unknown, the lowest dose was assumed.

Statistical analysis

The annual costs per person for direct health care, direct non-health care and government subsidies were calculated by weight status in 2004–2005 and by weight change between 1999–2000 and 2004–2005. The cost of overweight and obesity to Australia was estimated by multiplying the prevalence of each by the number of people aged ⩾ 30 years in the 2005 Australian population[12] and the annual cost per person. To test whether our results were representative of the Australian population, this cost was compared with that calculated using prevalences of overweight and obesity reported in the 2007–2008 National Health Survey (NHS).[13] Relative to costs for the normal-weight population, excess costs due to overweight and obesity were estimated from a subset of sex- and age-matched participants with: general (BMI-defined) overweight and obesity only; abdominal (WC-defined) overweight and obesity only; and both general and abdominal overweight and obesity.

Statistical analyses were performed using SAS 9.1 for Windows (SAS Institute Inc, Cary, NC, USA).

RESULTS

Characteristics of participants

Of the 11 247 participants examined in the 1999–2000 AusDiab study, data were available in the 2004–2005 follow-up survey for 6140 (54.1% female; mean age, 56.5 years). Based on BMI, 31.6% were normal weight, 41.3% were overweight and 27.0% were obese. The proportions with normal WC, abdominal overweight and abdominal obesity were 32.8%, 26.3%, and 41.0%. When combined definitions (based on BMI and/or WC) were used, 24.7% were normal, 32.4% were overweight and 42.9% were obese.

The 2007–2008 NHS reported similar BMI-based rates for adults aged ⩾ 25 years: normal, 34.1%; overweight, 39.1%; and obese, 26.9%.[13]

Direct costs

The mean annual total direct cost in 2005 was $2100 (95% CI, $1959–$2240) per person. This comprised $1608 (95% CI, $1514–$1702) for direct health care costs and $492 (95% CI, $403–$581) for direct non-health care costs (Box 1).

Based on BMI only, the annual total direct cost per person increased from $1710 (95% CI, $1464–$1956) for those of normal weight to $2110 (95% CI, $1887–$2334) for the overweight and $2540 (95% CI, $2275–$2805) for the obese (Box 1). Similar trends were observed with WC-defined and combined BMI- and WC-defined weight status.

The main contributions to direct health care costs in those with BMI- and WC-defined overweight were prescription medication, hospitalisation and ambulatory services, each accounting for about 32%. For obesity, hospitalisation accounted for 36% of cost, prescription medication for 33%, and ambulatory services for 25%.

Government subsidies

The mean annual payment from government subsidies was $3600 (95% CI, $3446–$3753) per person (Box 1). Based on BMI, government subsidies per person increased from $2948 (95% CI, $2696–$3199) for people of normal weight to $3737 (95% CI, $3496–$3978) for the overweight and $4153 (95% CI, $3840–$4466) for the obese. A similar trend was observed for WC-based weight classification.

Costs according to weight change between 1999–2000 and 2004–2005

Those whose weight, based on both BMI and WC, was normal in 1999–2000 and remained normal in 2004–2005 had the lowest annual direct health care costs (Box 2),

2 Annual cost per person, by weight change between 1999–2000 and 2004–2005

Weight change*	No.	Mean age (SE)	Annual cost ($) per person (95% CI)			
			Direct health	Direct non-health	Total direct	Government subsidies
Remained normal	1260	53.1 (0.4)	1106 (906–1306)	257 (113–402)	1363 (1082–1644)	2412 (2124–2700)
Normal to overweight or obese	566	52.9 (0.5)	1187 (1008–1367)	368 (93–643)	1555 (1217–1893)	2388 (1964–2813)
Remained overweight	1257	56.5 (0.3)	1372 (1173–1570)	319 (173–465)	1691 (1437–1945)	3259 (2934–3583)
Overweight to obese	609	56.5 (0.5)	1965 (1567–2362)	684 (312–1055)	2648 (2079–3218)	3644 (3149–4140)
Remained obese	1958	59.0 (0.3)	2131 (1958–2304)	723 (534–911)	2853 (2575–3131)	4689 (4391–4987)
Overweight or obese† to loss in weight and/or reduced WC	490	59.5 (0.6)	1459 (1162–1756)	523 (225–822)	1982 (1491–2473)	4523 (3944–5102)

BMI = body mass index. WC = waist circumference. * Normal = BMI, 18.5–24.9 kg/m^2 and WC < 94 cm for men, < 80 cm for women. Overweight = BMI, 25.0–29.9 kg/m^2 and/or WC, 94–101.9 cm for men, 80–87.9 cm for women. Obese = BMI ⩾ 30.0 kg/m^2 and/or WC ⩾ 102 cm for men, ⩾ 88 cm for women. † The annual costs per person in the overweight and obese combined group were $1749 for direct health, $557 for direct non-health, $2306 for total direct and $3917 for government subsidies. ◆

followed by those of normal weight who became overweight or obese. Costs were highest for those who were obese in both surveys, and those who progressed from being overweight to obese. Costs for overweight or obese people who lost weight and/or reduced WC were about 30% lower than for those who remained obese. The mean reductions in BMI and WC in this group were 1.4 kg/m^2 and 7.1 cm, respectively.

The pattern was similar with government subsidies, which were $2412 (95% CI, $2124–$2700) per person per year for people who remained normal weight and $4689 (95% CI, $4391–$4987) for those who remained obese. Although direct costs decreased for overweight or obese people who lost weight and/or reduced WC, government subsidies remained high (Box 2).

Cost of overweight and obesity to Australia

In 2005, 12.1 million adults in Australia were aged ⩾ 30 years.[12] Based only on BMI, the total direct cost in Australia in 2005 for overweight or obese people aged ⩾ 30 years was $18.8 billion (95% CI, $16.9–$20.8 billion) — $10.5 billion for the overweight ($7.8 billion direct health and $2.7 billion direct non-health) and $8.3 billion for those who were obese ($6.6 billion direct health and $1.7 billion direct non-health). Furthermore, $18.7 billion (95% CI, $17.5–$19.9 billion) and $13.6 billion (95% CI, $12.5–$14.6 billion) were spent in government subsidies on the overweight and the obese, respectively.

When both BMI and WC were considered, the annual total direct cost was $21.0 billion (95% CI, $19.0–$23.1 billion), comprising $6.5 billion (95% CI, $5.8–$7.3 billion) for overweight and $14.5 billion (95% CI, $13.2–$15.7 billion) for obesity. In addition, $12.8 billion (95% CI, $11.8–$13.9 billion) and $22.8 billion (95% CI, $21.5–$24.1 billion) were spent in government subsidies on overweight and obesity, respectively.

Using 2007–2008 NHS prevalence data, the total direct cost in Australia for BMI-based overweight and obesity (prevalences, 39.1% and 26.9%, respectively) was $18.3 billion, and $17.1 billion based on WC (combined prevalence of overweight and obesity, 57.6%). The respective costs in government subsidies were $31.2 billion and $28.5 billion.

Box 3 shows total and excess costs (above costs for the normal-weight population) according to weight status. Applying this to the 2005 Australian population, the total excess direct cost was $10.0 billion for those with both BMI- and WC-defined overweight and obesity, $190 million for those with only BMI-defined overweight and obesity, and $475 million for those with only WC-defined overweight and obesity. Hence, the total excess annual direct cost for people with a BMI ⩾ 25 kg/m^2 was $10.2 billion, increasing to $10.7 billion when abdominal overweight and obesity were included.

DISCUSSION

The total direct cost of BMI-defined obesity in Australia in 2005 was $8.3 billion, considerably higher than previous estimates. One study in 2005 estimated the annual direct health cost of obesity as $1.1 billion,[14] while another estimated the cost to the health system as $873 million.[2] This difference is likely to be due to different methodology, as our study used a bottom-up approach, whereas previous studies used a top-down approach.

3 Annual cost and excess cost above normal-weight cost per person, for age- and sex-matched participants

Weight status	No.	Mean age (SE)	Annual cost ($) per person (excess cost)			
			Direct health	Direct non-health	Total direct	Government subsidies
Normal weight*	219	55.4 (0.9)	961	209	1170	2251
General overweight and obesity only†	219	55.4 (0.8)	1191 (230)	173 (–36)	1364 (194)	3629 (1378)
Abdominal overweight and obesity only‡	219	55.6 (0.8)	1323 (362)	416 (207)	1739 (569)	2751 (500)
General and abdominal overweight and obesity§	219	55.6 (0.9)	1799 (838)	745 (536)	2544 (1374)	2926 (675)

BMI = body mass index. WC = waist circumference. * BMI, 18.5–24.9 kg/m^2 and WC < 94 cm for men, < 80 cm for women. † BMI ⩾ 25.0 kg/m^2 and WC < 94 cm in men, < 80 cm in women. ‡ BMI, 18.5–24.9 kg/m^2 and WC ⩾ 94 cm in men, ⩾ 80 cm in women. § BMI ⩾ 25.0 kg/m^2 and WC ⩾ 94 cm in men, ⩾ 80 cm in women. ◆

The true cost of weight abnormalities is even greater. Traditionally, studies report only costs associated with obesity and rarely take overweight into account. However, overweight is associated with an increased risk of many comorbidities that increase health care costs related to medications and hospitalisation.[4,15,16] Our study confirmed that direct costs are increased for overweight people, with the total annual cost associated with BMI-defined overweight being $10.5 billion.

Increased abdominal circumference is also associated with an increased risk of cardiometabolic problems. One study suggested that abdominally overweight or obese people with a normal BMI have higher health care costs than those with a normal WC but BMI-defined overweight or obesity.[17] We also observed this for annual total direct cost for abdominal overweight and obesity (Box 3). If overweight and obesity based on both BMI and WC are considered, total annual costs increase to $21.0 billion.

In addition, overweight and obesity are associated with other costs, including government subsidies and indirect costs associated with loss of productivity, early retirement, premature death and carer costs. Our study showed that the average annual cost of government subsidies for the overweight and obese was $3917 per person, with a total annual cost of $35.6 billion. Combined with direct costs, this results in an overall total annual cost of $56.6 billion. We did not collect data on indirect or carer costs, but other studies have estimated that these are considerable. The cost of obesity alone due to loss of productivity was estimated as $637 million in 2005[14] and $3.6 billion in 2008,[3] and carer costs were estimated as $1.9 billion in 2008.[3]

Since most people incur some health care expenditure, we estimated the excess cost associated with weight abnormalities. These excess costs varied according to how weight was defined and were highest for those with both BMI- and WC-defined overweight and obesity, whose annual total direct costs were $1374 higher per person than for normal-weight individuals. Being overweight or obese by any definition resulted in an annual excess direct cost of $10.7 billion.

We also assessed the effect on costs of a change in weight status during the previous 5 years. People who maintained normal weight had the lowest cost. Weight gain was associated with increased costs, and weight loss with a reduction in direct costs but not government subsidies. Some participants who lost weight may have had occult disease at baseline, which could have affected cost estimates. Occult disease that became manifest during the follow-up period would be associated with increased costs, reducing the cost reductions associated with weight loss.

This is the first Australian study on the direct costs associated with both general and abdominal overweight and obesity. The health services utilisation and health expenditure data collected from each participant allowed the use of the more robust bottom-up analytical approach. Physical measurements collected in 1999–2000 and 2004–2005 permitted comparison between those with and without a change in weight status. As there were some differences in mean age for each weight group and because older people generally accumulate higher health costs, the large sample size made it possible to compare age- and sex-matched participants in four weight categories. These analyses confirmed higher costs for the overweight and obese.

The validity of our estimates depends on the representativeness of the 2004–2005 AusDiab cohort. Comparison with baseline characteristics of 1999–2000 AusDiab participants showed no difference in age or prevalence of overweight and obesity in those who did attend for follow-up compared with those who did not, but a lower prevalence of smoking, hypertension and diabetes in the follow-up cohort. If anything, this generally healthier profile may have reduced costs in our study. The representativeness of the AusDiab cohort is further supported by the similar prevalences of BMI-defined weight reported in the 2007–2008 NHS.[13] Furthermore, small differences in prevalences of weight status have only a small impact on total cost estimates. For example, a 1% difference in the prevalence of overweight results in a difference of about $0.3 billion in our overall total direct cost estimate of $10.5 billion.

Costs associated with overweight and obesity are likely to be even higher than our estimates because comprehensive data on indirect costs were not collected in this study. Data on lost productivity due to sick leave and early retirement were only collected for participants with known diabetes before the follow-up survey. The sample size of this group was too small to provide meaningful results when subdivided by weight status.

We found that the direct cost of overweight and obesity in Australia is significantly higher than previous estimates. As the number of overweight and obese adult Australians continues to increase, the direct cost of overweight and obesity will also continue to rise, unless the weight gain trend is halted or reversed. For those who are overweight or obese, losing weight and/or reducing WC is associated with lower costs.

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COMPETING INTERESTS

None identified.

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REFERENCES

1 International Obesity Taskforce. Global prevalence of adult obesity. Updated Jan 2010. http://www.iotf.org/database/documents/GlobalPrevalenceofAdultObesityJanuary2010.pdf (accessed Jan 2010).
2 Access Economics. The economic costs of obesity. Canberra: Diabetes Australia, 2006.
3 Access Economics. The growing cost of obesity in 2008: three years on. Canberra: Diabetes Australia, 2008.
4 Thompson D, Wolf AM. The medical-care cost burden of obesity. *Obes Rev* 2001; 2: 189-197.
5 Ni Mhurchu C, Rodgers A, Pan WH, et al; Asia Pacific Cohort Studies Collaboration. Body mass index and cardiovascular disease in the Asia-Pacific region: an overview of 33 cohorts involving 310 000 participants. *Int J Epidemiol* 2004; 33: 751-758.
6 Seidell JC. The impact of obesity on health status: some implications for health care costs. *Int J Obes Relat Metab Disord* 1995; 19 Suppl 6: S13-S16.
7 Dunstan D, Zimmet P, Welborn T, et al. Diabesity & associated disorders in Australia – 2000: the accelerating epidemic. The Australian Diabetes, Obesity and Lifestyle Study (AusDiab). Melbourne: International Diabetes Institute, 2001.
8 Freemantle N, Holmes J, Hockey A, Kumar S. How strong is the association between abdominal obesity and the incidence of type 2 diabetes? *Int J Clin Pract* 2008; 62: 1391-1396.
9 Barr ELM, Magliano DJ, Zimmet PZ, et al. AusDiab 2005: the Australian Diabetes, Obesity and Lifestyle Study. Tracking the accelerating epidemic: its causes and outcomes. Melbourne: International Diabetes Institute, 2006. http://www.bakeridi.edu.au/Assets/Files/AUSDIAB_REPORT_2005.pdf (accessed Jan 2010).
10 Magliano DJ, Barr EL, Zimmet PZ, et al. Glucose indices, health behaviors, and incidence of diabetes in Australia: the Australian Diabetes, Obesity and Lifestyle Study. *Diabetes Care* 2008; 31: 267-272.
11 World Health Organization. Obesity: preventing and managing the global epidemic. Report of a WHO Consultation. Geneva: WHO, 2000.
12 US Census Bureau, Population Division. International Data Base (IDB). http://www.census.gov/ipc/www/idb/ (accessed Jan 2010).
13 Australian Bureau of Statistics. National Health Survey: summary of results, 2007–2008. Canberra: ABS, 2009. (ABS Cat. No. 4364.0.) http://www.abs.gov.au/ausstats/abs@.nsf/mf/4364.0/ (accessed Jan 2010).
14 Yates J, Murphy C. A cost benefit analysis of weight management strategies. *Asia Pac J Clin Nutr* 2006; 15 Suppl: 74-79.
15 Ni Mhurchu C, Parag V, Nakamura M, et al; Asia Pacific Cohort Studies Collaboration. Body mass index and risk of diabetes mellitus in the Asia-Pacific region. *Asia Pac J Clin Nutr* 2006; 15: 127-133.
16 Whitlock G, Lewington S, Sherliker P, et al; Prospective Studies Collaboration. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet* 2009; 373: 1083-1096.
17 Højgaard B, Gyrd-Hansen D, Olsen KR, et al. Waist circumference and body mass index as predictors of health care costs. *PLoS ONE* 2008; 3: e2619.

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