Inequalities in bariatric surgery in Australia: findings from 49 364 obese participants in a prospective cohort study

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Abstract

Objectives: To investigate variation, and quantify socioeconomic inequalities, in the uptake of primary bariatric surgery in an obese population.

Design, setting and participants: Prospective population-based cohort study of 49 364 individuals aged 45–74 years with body mass index (BMI) ⩾ 30 kg/m^2. Data from questionnaires (distributed from 1 January 2006 to 31 December 2008) were linked to hospital and death data to 30 June 2010. The sample was drawn from the 45 and Up Study (approximately 10% of New South Wales population aged 45 included, response rate approximately 18%).

Main outcome measures: Rates of bariatric surgery and adjusted rate ratios (RRs) in relation to health and sociodemographic characteristics.

Results: Over 111 757 person-years (py) of follow-up, 312 participants had bariatric surgery, a rate of 27.92 per 10 000 py (95% CI, 24.91–31.19). Rates were highest in women, those living in major cities and those with diabetes, and increased significantly with a higher BMI and number of chronic health conditions. Adjusted RRs were 5.27 (95% CI, 3.18–8.73) for those with annual household income ⩾ $70 000 versus those with household income < $20 000, and 4.01 (95% CI, 2.41–6.67) for those living in areas in the least disadvantaged quintile versus those in the most disadvantaged quintile. Having versus not having private health insurance (age- and sex-adjusted RR, 9.25; 95% CI, 5.70–15.00) partially explained the observed inequalities.

Conclusions: Bariatric surgery has been shown to be cost-effective in treating severe obesity and associated illnesses. While bariatric surgery rates in Australia are higher in those with health problems, large socioeconomic inequalities are apparent. Our findings suggest these procedures are largely available to those who can afford private health insurance and associated out-of-pocket costs, with poor access in populations who are most in need. Continuing inequalities in access are likely to exacerbate existing inequalities in obesity and related health problems.

Obesity is a major public health challenge for Australia. In the 2007–08 National Health Survey, 24% of Australian adults were reported to be obese and a further 37% overweight.[1] Obesity rates are growing and the continuing increase in severe obesity is of particular concern.[2,3] It is a major risk factor for type 2 diabetes and a range of other chronic diseases, including cardiovascular, digestive and musculoskeletal disorders,[4] as well as overall mortality.[5]

Clinical guidelines recommend bariatric surgery for those with a body mass index (BMI) over 40 kg/m^2, or BMI over 35 kg/m^2 and comorbid conditions, after non-surgical options have failed.[6,7] This surgery is more effective than non-surgical interventions for the treatment of severe obesity, and it is cost-effective. In addition to substantial weight loss, bariatric surgery can lead to improvements in comorbid conditions including lipid abnormalities, obstructive sleep apnoea and joint disease.[8-11] Of particular note is its effectiveness in treating type 2 diabetes,[12,13] with one recent trial showing remission rates of 75%–95% within 2 years after surgery.[13]

Bariatric surgery procedures have been listed on the Medicare Benefits Schedule (MBS) since 1992. Admissions for this surgery rose from 535 to around 17 000 between 1998–1999 and 2007–2008.[14] Notably, most of this surgery is carried out in private hospitals and incurs substantial out-of-pocket costs,[14] while obesity is concentrated among those of lower socioeconomic status (SES).[15] This suggests that groups that are most likely to need surgery are the least likely to have it. However, despite equity concerns,[16] there are no published data to date in Australia on the extent of variation in bariatric surgery by health status, SES and other key factors among those potentially eligible for the procedure. In this study, we investigate variation in primary bariatric surgery rates in an obese population, quantify socioeconomic inequalities in rates of surgery and examine the extent to which holding private health insurance (PHI) explains these inequalities.

Methods

We used data from the 45 and Up Study, a cohort study involving 266 848 men and women aged 45 years and over from New South Wales. Study participants were randomly sampled from the Medicare enrolment database. More than 10% of the NSW population aged 45 years and over is included in the cohort (response rate of about 18%).[17] Participants received a baseline questionnaire (between 1 January 2006 and 31 December 2008) and gave signed consent for follow-up, including linkage to routine health databases. The study is described in detail elsewhere,[17] and questionnaires can be viewed at http://www.45andup.org.au.

Questionnaire data were linked to death data from the NSW Registry of Births, Deaths and Marriages (to 30 June 2010) and to hospital data from the NSW Admitted Patient Data Collection (APDC) from 1 July 2000 to 30 June 2010. The NSW APDC includes records of all hospitalisations in NSW, including reasons for admission (coded using ICD-10-AM) and procedures performed (coded using the Australian Classification of Health Interventions).[18] Data were linked probabilistically by the Centre for Health Record Linkage (http://www.cherel.org.au).

The current study included only participants who were obese (BMI ⩾ 30 kg/m^2), with BMI calculated from weight and height as self-reported on the questionnaire. We excluded anyone who had had previous bariatric surgery recorded in the APDC (ie,

1 Primary bariatric surgery rates and rate ratios in relation to demographic and health characteristics at baseline in 49 364 participants with body mass index ⩾ 30 kg/m²

Characteristics	No. of participants	No. of primary bariatric procedures/person-years	Surgery rate per 10 000 person-years	Rate ratio* (95% CI)
Total sample	49 364	312/111 757	27.92	—
Body mass index				
30–32.49 kg/m²†	22 389	19/51 094	3.72	1.00
32.5–34.99 kg/m²	12 356	51/27 932	18.26	4.78 (2.80–8.16)
35–37.49 kg/m²	6 830	62/15 371	40.34	10.37 (6.11–17.58)
37.5–39.99 kg/m²	3 554	53/7 998	66.27	16.61 (9.58–28.77)
40–42.49 kg/m²	2 119	47/4 695	100.11	25.73 (14.3–46.01)
42.5–44.99 kg/m²	1 133	31/2 517	123.18	31.36 (16.6–59.16)
45–50 kg/m²	983	49/2 152	227.77	64.38 (33.4–123.93)
Male†	22 254	71/50 597	14.03	1.00
Female	27 110	241/61 160	39.41	2.72 (2.04–3.62)
Age group (years)				
45–49†	7 390	69/16 701	41.32	1.00
50–54	9 493	105/21 653	48.49	1.20 (0.87–1.65)
55–59	10 753	60/24 483	24.51	0.60 (0.42–0.86)
60–64	9 529	56/21 501	26.05	0.66 (0.46–0.95)
65–69	7 503	17/16 847	10.09	0.25 (0.15–0.44)
70–74	4 696	5/10 575	4.73	0.12 (0.05–0.30)
Area of residence				
Major city†	19 628	157/44 208	35.51	1.00
Inner regional	18 639	108/42 122	25.64	0.72 (0.56–0.92)
More remote	11 058	46/25 342	18.15	0.50 (0.36–0.70)
Born in Australia or New Zealand†	40 296	263/91 127	28.86	1.00
Other country of birth	8 656	48/19 628	24.46	0.95 (0.69–1.30)
Not married†	11 444	61/25 899	23.55	1.00
Married or de facto	37 625	251/85 288	29.43	1.33 (0.99–1.78)
Self-rated health				
Excellent, very good or good†	37 619	205/85 548	23.96	1.00
Fair or poor	10 172	101/22 726	44.44	2.08 (1.58–2.74)
Never diagnosed with diabetes†	41 603	229/94 277	24.29	1.00
Diagnosed with diabetes	7 761	83/17 481	47.48	2.88 (2.04–4.06)
Other chronic conditions				
None†	14 553	75/33 373	22.47	1.00
One	19 583	134/44 518	30.10	1.55 (1.16–2.06)
Two	10 347	69/23 236	29.70	1.66 (1.17–2.36)
Three or more	4 881	34/10 631	31.98	1.91 (1.26–2.91)
Current smoker†	3 722	12/8 530	14.07	1.00
Past smoker	20 290	135/45 999	29.35	2.82 (1.53–5.20)
Never smoked	25 212	165/56 895	29.00	2.30 (1.25–4.21)
Physical activity‡				
1st tertile (low)†	19 077	155/42 837	36.18	1.00
2nd tertile	15 988	85/36 426	23.34	0.60 (0.44–0.81)
3rd tertile (high)	13 454	69/30 694	22.48	0.61 (0.44–0.84)
Alcohol consumption (drinks per week)				
0†	18 469	153/41 612	36.77	1.00
1–14	22 688	130/51 303	25.34	0.74 (0.57–0.96)
15 or more	7 308	25/16 653	15.01	0.61 (0.38–0.97)

* Adjusted for age and sex. † Reference category. ‡ Based on number of weekly sessions of walking and moderate and vigorous activity, weighted for intensity. ◆

between July 2000 and recruitment). The outcome was incident primary bariatric surgery for obesity, defined as the first bariatric surgery procedure recorded after recruitment, identified from the procedure fields in the APDC. Procedures included adjustable gastric banding or gastroplasty (procedure code 30511) or gastric bypass (30512). Partial gastrectomy (30518) may also be used for the treatment of obesity, but we did not include this as it is mostly used for other indications, and our sample included only two such procedures. Participants were followed from the date of recruitment to either the date of admission for bariatric surgery,

2 Primary bariatric surgery rates and rate ratios in relation to socioeconomic characteristics at baseline in 49 364 participants with body mass index ⩾ 30 kg/m²

Socioeconomic characteristics	No. of participants	No. of primary bariatric procedures/person-years	Surgery rate per 10 000 person-years	Rate ratio* (95% CI)
Household income				
<$20 000†	9 636	27/22 142	12.19	1.00
$20 000–$29 999	4 619	18/10 641	16.92	1.31 (0.72–2.39)
$30 000–$39 999	3 894	19/8 831	21.52	1.58 (0.87–2.85)
$40 000–$49 999	3 701	25/8 352	29.94	2.09 (1.20–3.62)
$50 000–$69 999	5 753	55/12 998	42.32	2.86 (1.78–4.58)
⩾ $70 000	11 904	123/26 134	47.07	3.25 (2.11–5.03)
Declined to answer or missing data	9 857	45/22 662	19.86	1.37 (0.85–2.22)
Education				
No qualifications†	6 653	25/15 293	16.35	1.00
Intermediate certificate	11 792	58/26 916	21.55	1.14 (0.71–1.82)
Higher school certificate	4 640	28/10 470	26.74	1.42 (0.82–2.44)
Trade or apprenticeship	5 794	22/13 113	16.78	1.41 (0.79–2.53)
Certificate or diploma	10 436	100/23 414	42.71	2.11 (1.36–3.28)
University degree	9 411	79/21 079	37.48	1.89 (1.20–2.97)
Area-level disadvantage by IRSD quintile (Q)‡				
Q1 (high disadvantage)†	8 558	35/19 503	17.95	1.00
Q2	14 128	72/32 055	22.46	1.28 (0.85–1.94)
Q3	12 163	73/27 704	26.35	1.47 (0.97–2.23)
Q4	5 858	35/13 163	26.59	1.45 (0.89–2.37)
Q5 (low disadvantage)	8 615	95/19 242	49.37	2.88 (1.89–4.39)
No private health insurance†	18 590	19/42 528	4.47	1.00
Private health insurance	30 774	293/69 229	42.32	9.25 (5.70–15.00)

IRSD = Index of Relative Socioeconomic Disadvantage.
* Adjusted for age and sex. † Reference category. ‡ Area-level disadvantage was based on the Socio-Economic Indexes for Areas IRSD,[19] derived from postcode of residence and categorised into quintiles using cut-off scores from the 2006 Australian census. ◆

death, or 30 June 2010, whichever occurred first.

Data on participant characteristics were based on self-reported data from the questionnaire. Variables were categorised as shown in Box 1 and Box 2. Socioeconomic variables included annual pre-tax household income, education and area-level disadvantage. Area-level disadvantage was based on the Socio-Economic Indexes for Areas Index of Relative Socio-Economic Disadvantage (IRSD),[19] derived from postcode of residence and categorised into quintiles using cut-off scores from the 2006 Australian census. Other variables included PHI (including holders of a Department of Veterans' Affairs [DVA] card), BMI, sex, age group, area of residence (based on the Accessibility/Remoteness Index of Australia Plus,[20] derived from postcode), marital status, country of birth, self-rated health, diabetes (ever diagnosed by a doctor), number of other doctor-diagnosed chronic conditions, smoking, tertile of physical activity (based on number of weekly sessions of walking and moderate and vigorous activity, weighted for intensity) and alcohol intake.

Negative binomial regression was used to estimate bariatric surgery rates according to baseline characteristics and to model inequality estimates. We used separate multivariable regression models for the two main SES variables of interest — household income and area-level disadvantage. We calculated rate ratios (RRs) for each socioeconomic level using the lowest level as the reference group, adjusting for all other non-SES variables (Model 1). In Model 2, we added PHI. We then quantified the extent to which PHI explained any socioeconomic variation in bariatric surgery rates by testing for equality of the SES coefficients across Models 1 and 2. Stata version 12.1 (StataCorp) was used for all analyses.

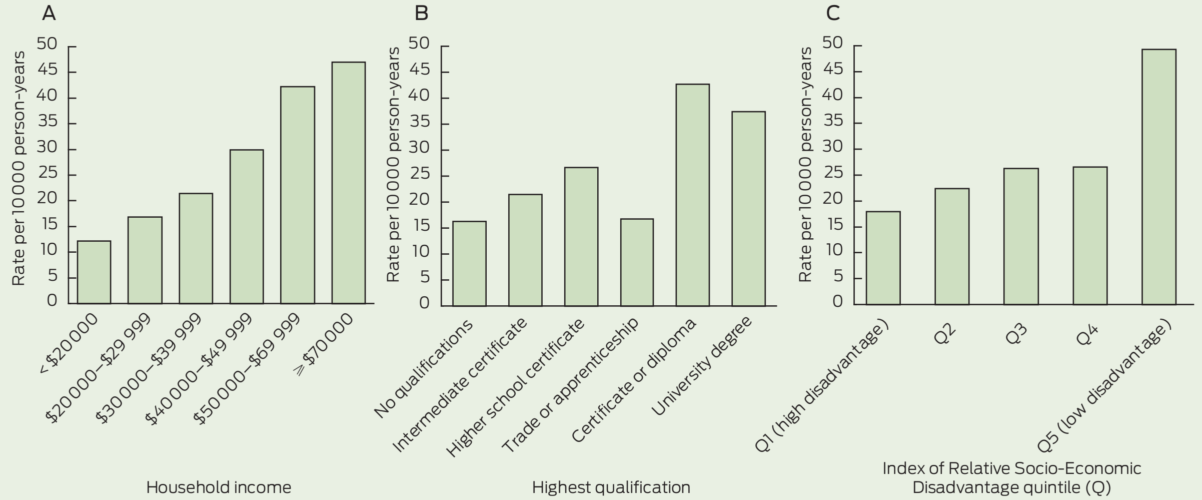
Ethics approval for this project was obtained from the NSW Population and Health Services Research Ethics Committee and the Australian National University Human Research Ethics Committee.

Results

Survey and linked hospital and death data were available for 266 724 of the 266 848 current participants in the 45 and Up Study. After excluding those who had BMI data missing (20 262 participants; 7.60%) and those who had had bariatric surgery before recruitment (17 participants), there were 55 038 participants (22.33%) with BMI ⩾ 30 kg/m² who were eligible for this study. As no one over the age of 74 in this sample had bariatric surgery in the follow-up period, we confined our analysis to those aged less than 75 years (49 364 participants).

A total of 312 participants had surgery over 111 757 person-years (py) of follow-up (mean, 2.26; SD, 0.86), giving a rate of 27.92 (95% CI, 24.91–31.19) per 10 000 py. Of these, only one was treated as a public patient and four as DVA patients, with the remainder treated as private patients. The mean BMI (at baseline) of those having surgery was 39.15 kg/m². The principal diagnosis was recorded as

3 Rates of bariatric surgery in relation to household income, education level and area-level disadvantage* in 49 364 participants with body mass index ⩾ 30 kg/m²



* Area-level disadvantage was based on the Socio-Economic Indexes for Areas Index of Relative Socio-Economic Disadvantage (IRSD),[19] derived from postcode of residence and categorised into quintiles using cut-off scores from the 2006 Australian census. ◆

obesity (ICD-10 code E66) in 261 patients (84%) and as diabetes (E10 or E11) in 45 patients (14%). Only six of the 312 procedures were bypass procedures, the remaining 98% being gastric banding or gastroplasty.

Descriptive data showing bariatric surgery rates in relation to participant baseline characteristics are shown in Box 1 and Box 2. Rates of surgery increased with increasing BMI, ranging from 3.72 per 10 000 py (BMI 30–32.49 kg/m^2) to 227.77 per 10 000 py (BMI 45–50 kg/m^2). Rates varied significantly in relation to all participant characteristics except country of birth and marital status ($P > 0.05$). Higher rates were associated with being female, younger, a resident in a major city, in poorer health, a non-smoker, a non-drinker and being in the lowest tertile of physical activity.

With regard to SES, unadjusted rates (Box 2 and Box 3) and age–sex-adjusted RRs (Box 2) show that bariatric surgery rates were higher among those who were relatively advantaged. There was a clear socio-economic gradient with household income; for IRSD, the most notable difference was between the top quintile (low disadvantage) and the other quintiles; for education, rates were highest among those with post-school (non-trade) qualifications and lowest in those with no qualifications; and rates were much higher among those with PHI than among those without.

The degree of socioeconomic inequality in bariatric surgery rates, after adjusting for all variables except PHI (Model 1), was substantial (Box 4). The adjusted RRs for household income show a clear gradient, with those in the highest bracket (⩾ $70 000) five times more likely to have surgery than those in the lowest bracket (< $20 000) (RR, 5.27; 3.18–8.73). After adjusting for PHI (Model 2), the RRs decreased by 35%–62% ($P < 0.001$ for all income levels), confirming that PHI explained a substantial proportion of income-related inequality. Nevertheless, significant inequality remained, with those in the highest income bracket still being almost twice as likely to have bariatric surgery as those in the lowest bracket (RR, 1.98; 1.15–3.41). When income and education were jointly modelled, this made virtually no difference to the income inequality estimates, while education inequality estimates were not significant in either Model 1 or 2 (results not shown).

Rates of surgery by IRSD quintile show that those living in areas of least disadvantage were four times more likely to have surgery than those living in the most disadvantaged areas (RR, 4.01; 2.41–6.67), after taking into account potential confounding factors (Model 1). After adjusting for PHI, the RR for each quintile of disadvantage decreased by 12%–40% ($P < 0.001$ for all quintiles). However, significant inequality remained, with those in the least disadvantaged areas still being over twice as likely to have bariatric surgery than those in the most disadvantaged areas (RR, 2.41; 1.48–3.93).

Discussion

There is significant inequality in the uptake of bariatric surgery among obese people in Australia, with the likelihood of surgery increasing with increasing SES. Even when measured using an area-level measure of disadvantage, and adjusting for remoteness and other factors, the magnitude of inequality is substantial. Of particular note is the fivefold higher rate of surgery in those with household incomes of $70 000 or more, compared with that of those with household incomes less than $20 000. PHI accounted for some but not all of the observed SES inequalities. While people with higher education qualifications were twice as likely to have surgery as those with no qualifications, much of this was because of the association between education and income.

Our inequality findings differ from a previous report that showed that bariatric surgery rates in the middle SES quintile of area disadvantage were more than double those of any other SES quintile;[14] however, this report was based on the whole population, not the obese population, and hence did not take into account the "need" for surgery. Our findings that bariatric surgery is more common among women, middle-aged rather than older people, and among those living in major cities are consistent with previous reports.[14] In addition, the variation in rates we found in relation to health characteristics was in keeping with the indications for surgery[7] — the likelihood of surgery increased with increasing BMI, and was greater among those with poor health, diabetes and other chronic conditions. We also found that current smokers were less likely to have surgery than non-smokers.

Strengths of this study include its grounding in a very large population-based cohort, allowing a relatively rare event to be examined; investigation of a large range of factors not recorded in routine data; and use of linked administrative records, allowing virtually complete and objective ascertainment of surgery. A limitation is that BMI was based on self-reported weight and height. However, a validation study involving participants in the 45 and Up Study found that the mean difference between self-reported and measured BMI was not large (on average, 0.74 kg/m^2), with sensitivity for classifying obesity of 79%, and importantly, specificity of 99%.[21] Although the relatively low response rate and the potential for a "healthy cohort effect" mean that the estimates of surgery rates in our sample may be different to those of the general population, relative comparisons of surgery rates among groups within the cohort remain valid.[22,23] Some caution must be applied, however, in generalising the size of the inequality estimates to younger ages, and beyond NSW, which has the highest proportion of private hospital weight loss procedures of all Australian jurisdictions.[14]

There are many potential barriers to bariatric surgery, apart from cost, that may underlie variations in uptake of surgery. These include patients' preferences and clinical decisions regarding the suitability of patients for surgery, and possibly views by some that bariatric surgery is largely cosmetic. However, the observed SES-related inequality in rates of surgery is also likely to reflect system-wide issues, including the mix of public and private care, out-of-pocket costs, limited resources and cost-sharing between state and federal governments. Moreover, the current situation is that there is very limited availability of bariatric surgery in public hospitals, while Medicare subsidises bariatric surgery and post-surgical care for private patients, effectively restricting access to people with PHI and those who can afford to pay what are usually large associated out-of-pocket costs.

In 2009 the House of Representatives Standing Committee on Health and Ageing Inquiry into Obesity recommended that equity in access be ensured by publicly funding bariatric surgery.[24] Our findings suggest that bariatric surgery, an MBS-listed procedure, is currently largely available only to those who can afford PHI and the associated out-of-pocket costs, with poor access to these cost-effective procedures in the section of the population that is most in need. Continuing inequity in access is likely to exacerbate existing inequalities in obesity and related health problems. However, if bariatric surgery came to be less discretionary over time, particularly for the treatment of type 2 diabetes,[25] such inequalities could decline. While resource issues may limit the total number of patients that can have bariatric surgery, there is scope to consider how the distribution of limited supply can be improved, and the potential savings that could be made from increasing supply and improving health outcomes.

4 Adjusted rate ratios for bariatric surgery in relation to household income and to area-level disadvantage in 49 364 participants with body mass index ⩾ 30 kg/m^2, without and with adjustment for private health insurance*

	Rate ratio (95% CI)	
	Model 1 (no adjustment for private health insurance)	Model 2 (adjusted for private health insurance)
Household income		
<\$20 000†	1.00	1.00
\$20 000–\$29 999	1.72 (0.92–3.25)	1.12 (0.58–2.19)
\$30 000–\$39 999	2.42 (1.28–4.60)	1.25 (0.65–2.44)
\$40 000–\$49 999	3.06 (1.69–5.55)	1.61 (0.85–3.05)
\$50 000–\$69 999	4.49 (2.59–7.79)	1.98 (1.12–3.51)
⩾ \$70 000	5.27 (3.18–8.73)	1.98 (1.15–3.41)
Private health insurance		
No†	—	1.00
Yes	—	9.53 (5.08–17.89)
Area-level disadvantage, by IRSD quintile (Q)‡		
Q1 (high disadvantage)†	1.00	1.00
Q2	1.47 (0.93–2.32)	1.29 (0.82–2.03)
Q3	1.56 (0.98–2.50)	1.22 (0.77–1.93)
Q4	1.60 (0.89–2.86)	1.10 (0.62–1.95)
Q5 (low disadvantage)	4.01 (2.41–6.67)	2.41(1.48–3.93)
Private health insurance		
No†	—	1.00
Yes	—	13.24 (7.78–22.52)

IRSD = Index of Relative Socio-Economic Disadvantage. * Household income and area-level disadvantage are modelled separately. All models adjusted for body mass index, sex, age, region of residence, country of birth, marital status, self-rated health, diabetes, other chronic conditions, smoking, alcohol consumption and physical activity. Test for heterogeneity between rate ratios in Model 1 and Model 2, $P < 0.001$ at every level of household income and IRSD. † Reference category. ‡ Area-level disadvantage was based on the Socio-Economic Indexes for Areas IRSD,[19] derived from postcode of residence and categorised into quintiles using cut-off scores from the 2006 Australian census. ◆

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