A profile of body mass index in a large rural Victorian obstetric cohort

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Extensive research has identified overweight and obesity as significant risks for poor obstetric and perinatal outcomes.[1-5] It is widely accepted that increased adiposity increases the likelihood of a range of adverse health conditions affecting pregnancy, such as hypertension, thromboembolism, pre-eclampsia and gestational diabetes.[6-8] Overweight and obesity are believed to impact on the birth process with increased rates of inductions, operative deliveries and technical problems with anaesthetics,[1,9] as well as increased rates of wound breakdown in mothers and longer lengths of hospital stay.[10] Obesity and overweight can also impact on fetal and neonatal health, with increased incidence of abnormal birthweight (large or small for gestational age), birth trauma, shoulder dystocia, fetal distress and increased perinatal mortality.[1,10-13]

Australian studies have reported the prevalence of overweight and obesity in urban obstetric populations as 18% in Perth and 34% Brisbane.[1,2,12] Analysis of a state-wide database of South Australian women reported overweight and obesity prevalence rates of 50.0% overall and 54.4% in rural areas.[5] The present study was initiated as a result of concern about even higher levels of pregnancy overweight and obesity in rural Victoria.

Methods

Data source

Goulburn Valley Health (GVH), in north-east Victoria, is a Level 5 provider of maternity services (Department of Health *Capability framework for Victorian maternity and newborn services*[14]), delivering about 1100 births annually. It serves as a referral hospital for up to seven smaller services in the surrounding areas. Obstetric and neonatal data are routinely collected into a Birthing Outcome System (Version 5, MCATS) database, which includes general demographics, height, weight and antenatal

Abstract

Objectives: To report on the prevalence and implications of overweight and obesity in a rural maternity cohort.

Design, setting and participants: A retrospective 6-year cohort of 6138 pregnancies managed in a rural Victorian maternity service from 1 January 2005 to 31 December 2010.

Main outcome measures: Maternal body mass index (BMI), prevalence of overweight and obesity, prevalence of pregnancy complications and their association with BMI class.

Results: A total of 65.6% of all women were overweight or obese. Only 32.7% of the women were of normal/healthy weight; 1.6% were underweight, 33.0% were overweight, 18.6% were obese class I, 8.3% obese class II and 5.7% were obese class III. Increased BMI was associated with increased rates of induction of labour, gestational diabetes mellitus, pregnancy-induced hypertension, operative vaginal deliveries, caesarean sections, invasive fetal monitoring, increased gestational age at delivery, increased birth weight, and increased maternal length of stay (*P* < 0.01 for all). Analysed separately, 60.5% of first-time mothers were overweight or obese.

Conclusions: Almost two-thirds of this rural maternity cohort were overweight or obese; twice the level reported from metropolitan centres and higher than other Australian reports. The associations with complications are similar to those reported previously. This high rate of maternal overweight and obesity may have implications for rural maternity funding, outcomes and perinatal mortality rates.

information, and all data pertaining to the delivery and immediate postnatal period and neonatal outcomes. Body mass index (BMI) is calculated using the height and weight measured during the first antenatal visit (weight [kg] divided by height squared [m^2]).

Sample

The data were reviewed for all 6796 mothers giving birth from 1 January 2005 to 31 December 2010. There were 100 multiple births and 378 unbooked deliveries, which were excluded, leaving 6318 in the sample. Of these, 180 were excluded because the mothers' height and/or weight were not recorded, and as these missing values represented 2.8% of the dataset, no analyses were conducted on differences. The BMI for the remaining mothers ($n = 6138$) was calculated (kg/m^2) and classified according to the classifications recommended by the World Health Organization, with "underweight" defined as BMI < 18.5 kg/m^2, "normal" defined as BMI 18.5–24.9 kg/m^2, "overweight" as BMI 25.0–29.9 kg/m^2, "obese I" as BMI 30.0–34.9 kg/m^2, "obese II" as BMI 35.0–39.9 kg/m^2 and "obese III" as BMI ⩾ 40.0 kg/m^2.[15] Incidence of over-

weight and obesity was established for the whole group, multiparae ($n = 3893$), nulliparae ($n = 2245$), and those weighed before and after 13 weeks' gestation.

Characteristics of the mother, neonate and delivery method for each BMI group were explored for all cases. Maternal age was calculated as the age at the time of delivery. The mother's Aboriginal and Torres Strait Islander status was used to determine Aboriginality, and country of origin was recoded to "Australia" or "other". Requirement for an interpreter was also reported. A woman was classified as a smoker if she had smoked at any time during the pregnancy. Alcohol intake related to any alcohol intake at any time during pregnancy. "Depression" was reported for any recorded history of depression. Pregnancy-related hypertension was reported if the clinical notes recorded pregnancy-induced hypertension and/or pre-eclampsia. The length of stay was calculated from the date of delivery until the date of maternal discharge. The upper quartile length of stay was calculated as a cut-point for the derived variable "longer length of stay".

1 Characteristics of 6138 mothers in a rural Victorian maternity cohort by body mass index (BMI) class

Characteristics	BMI class (kg/m^2)						
	Underweight (< 18.5) n = 101 (1.6%)	Normal (18.5−24.9) n = 2010 (32.7%)	Overweight (25.0−29.9) n = 2027 (33.0%)	Obese I (30.0−34.9) n = 1141 (18.6%)	Obese II (35.0−39.9) n = 509 (8.3%)	Obese III (≥40.0) n = 350 (5.7%)	P
Mean age in years (SD)	25.6 (6.0)	27.9 (5.8)	29.3 (5.7)	29.1 (5.7)	29.4 (5.6)	29.8 (5.5)	< 0.001
Parity							
0	48 (47.5%)	838 (41.7%)	729 (36.0%)	377 (33.0%)	165 (32.4%)	88 (25.1%)	
1	27 (26.7%)	664 (33.0%)	665 (32.8%)	372 (32.6%)	163 (32.0%)	112 (32%)	
2	16 (15.8%)	300 (14.9%)	351 (17.3%)	193 (16.9%)	91 (17.9%)	75 (21.4%)	
3	6 (5.9%)	123 (6.1%)	159 (7.8%)	102 (8.9%)	46 (9.0%)	48 (13.7%)	
≥4	4 (4.0%)	85 (4.2%)	123 (6.1%)	97 (8.5%)	44 (8.6%)	27 (7.7%)	
Aboriginal or Torres Strait Islander (mother)	10 (9.9%)	99 (4.9%)	81 (4.0%)	82 (7.2%)	28 (5.5%)	32 (9.1%)	0.003
Australian born	80 (79.2%)	1667 (82.9%)	1668 (82.3%)	974 (85.4%)	461 (90.6%)	312 (89.1%)	< 0.001
Interpreter required	5 (5.0%)	126 (6.3%)	140 (6.9%)	86 (7.5%)	22 (4.3%)	19 (5.4%)	0.43
Smoker at any time during pregnancy	51 (50.5%)	653 (32.5%)	573 (28.3%)	343 (30.1%)	176 (34.6%)	110 (31.4%)	0.34
Drinks alcohol at any time during pregnancy	7 (6.9%)	249 (12.4%)	336 (16.6%)	144 (12.6%)	73 (14.3%)	49 (14.0%)	0.29
Insurance status, private	7 (6.9%)	306 (15.2%)	415 (20.5%)	180 (15.8%)	83 (16.3%)	47 (13.4%)	0.96
Hypertensive disorders of pregnancy*	1 (1.0%)	23 (1.1%)	27 (1.3%)	30 (2.6%)	12 (2.4%)	23 (6.6%)	< 0.001
Gestational diabetes	3 (3.0%)	57 (2.8%)	85 (4.2%)	75 (6.6%)	50 (9.8%)	48 (13.7%)	< 0.001
Depression (past history or current)	18 (17.8%)	202 (10.0%)	198 (9.8%)	124 (10.9%)	51 (10.0%)	45 (12.9%)	0.49
Median length of stay in days (IQR)	3 (2−3)	3 (2−4)	3 (2−4)	3 (2−4)	3 (2−4)	3 (2−4)	0.008
Induction of labour	11 (10.9%)	369 (18.4%)	501 (24.7%)	324 (28.4%)	148 (29.1%)	113 (32.3%)	< 0.001
Normal vaginal delivery	77 (76.2%)	1437 (71.5%)	1384 (68.3%)	744 (65.2%)	311 (61.1%)	201 (57.4	< 0.001
Instrument assisted vaginal delivery	8 (7.9%)	196 (9.8%)	162 (8.0%)	84 (7.4%)	22 (4.3%)	19 (5.4%)	< 0.001
Emergency caesarean section	8 (7.9%)	172 (8.6%)	232 (11.4%)	161 (14.1%)	75 (14.7%)	48 (13.7%)	< .001
Elective caesarean section	6 (5.9%)	182 (9.1%)	224 (11.1%)	138 (12.1%)	99 (19.5%)	80 (22.9%)	< 0.001
Vaginal birth after caesarean	2 (2.0%)	21 (1.0%)	23 (1.1%)	14 (1.2%)	1 (0.2%)	2 (0.6%)	0.16

IQR = interquartile range.
* Significant but small numbers. ◆

Induction included artificial rupture of membranes and/or pharmacological interventions. Gestational age was the reported estimated gestational age at delivery, as determined during antenatal care from the results of ultrasound, known dates and clinical examination. The proportion of small-for-gestational-age neonates and large-for-gestational-age neonates was calculated for term (≥37 weeks) deliveries only to minimise the effect of preterm birth. Small for gestational age was defined as a birth weight less than the 10th percentile, and large for gestational age was defined as a birth weight greater than the 90th percentile, adjusted for gestation and gender.[16] Perinatal death rates did not include women or neonates who were transferred and died elsewhere. Respiratory distress was recorded if specified in the clinical notes. Gestational diabetes was defined in accordance with the Australasian Diabetes in Pregnancy Society guidelines.[17]

For normally distributed data, analysis of variance (ANOVA) or t tests were used. For skewed data, non-parametric tests such as the Cochran–Armitage test for trend, Mann–Whitney U and Kruskal–Wallis tests were used to test difference. Adjusted odds ratios (AORs) were calculated with 95% CI using logistic regression analyses controlling for maternal age, parity, smoking status and insurance class. The normal BMI class (18.5−24.9 kg/m^2) was used as the reference group for all others. Goodness-of-fit tests were performed and were satisfactory. All statistical analyses were conducted using SPSS (Version 17, IBM).

The Goulburn Valley Health Ethics and Research Committee and the University of Melbourne Human Research Ethics Committee approved this study.

Results

A total of 6138 women were included in the sample. Of these, 101 (1.6%) were underweight, 2010 (32.7%) were of normal weight, 2027 (33.0%) were overweight, 1141 (18.6%) were obese class I, 509 (8.3%) obese class II and 350 (5.7%) were obese class III. The proportions in each category have been consistent over the period of the study (P = 0.48).

Increased BMI was related to increased rates of induction of labour, gestational diabetes mellitus, pregnancy-induced hypertension, operative vaginal deliveries, caesarean sections (both emergency and elective) (Box 1) and internal fetal monitoring (Box 2). Further, it was found that increased BMI was associated with increased gestational age at delivery and increased birth weight for gestation and gender. Underweight BMI was associated with reduced levels of some maternal complications, such as induction of labour and caesarean deliveries, but not operative vaginal deliveries and preterm birth. Underweight women were found to smoke more but drink less alcohol during pregnancy than women of normal weight (Box 1).

The women who were classified obese class I, II or III were more likely to experience pregnancy-induced hypertension in reference to the women of normal weight (AOR, 2.45;

2 Characteristics of 6138 neonates in a rural Victorian maternity cohort by mother's body mass index (BMI) class

Characteristics	BMI class (kg/m²)						
	Underweight (< 18.5) n = 101 (1.6%)	Normal (18.5–24.9) n = 2010 (32.7%)	Overweight (25.0–29.9) n = 2027 (33.0%)	Obese I (30.0–34.9) n = 1141 (18.6%)	Obese II (35.0–39.9) n = 509 (8.3%)	Obese III (≥40.0) n = 350 (5.7%)	P
Internal fetal monitoring (eg, fetal scalp electrode)	30 (29.7%)	623 (31.0%)	604 (29.8%)	370 (32.4%)	176 (34.6%)	131 (37.4%)	0.004
Fetal scalp lactate testing	0	11 (0.5%)	18 (0.9%)	8 (0.7%)	3 (0.6%)	3 (0.9%)	0.52
Male	54 (53.5%)	1009 (50.2%)	1084 (53.5%)	574 (50.3%)	276 (54.2%)	183 (52.3%)	0.43
Mean gestational age at delivery in weeks (SD)	38.6 (2.4%)	39.2 (1.9%)	39.4 (1.9%)	39.4 (1.8%)	39.2 (2.2%)	39.3 (1.7%)	< 0.001
Macrosomia > 4000 g	2 (2.0%)	169 (8.4%)	289 (14.3%)	210 (18.4%)	122 (24.0%)	78 (22.3%)	< 0.001
Macrosomia > 4500 g	0	32 (1.6%)	46 (2.3%)	42 (3.7%)	32 (6.3%)	21 (6%)	< 0.001
SGA*	24 (23.8%)	224 (11.1%)	174 (8.6%)	84 (7.4%)	25 (4.9%)	26 (7.4%)	< 0.001
LGA*	2 (2.0%)	166 (8.3%)	298 (14.7%)	211 (18.5%)	133 (26.1%)	87 (24.9%)	< 0.001
Phototherapy	4 (4.0%)	65 (3.2%)	72 (3.6%)	40 (3.5%)	25 (4.9%)	14 (4%)	0.18
Perinatal death†	1 (1.0%)	14 (0.7%)	12 (0.6%)	8 (0.7%)	4 (0.8%)	3 (0.9%)	0.62
Respiratory distress	4 (4.0%)	78 (3.9%)	88 (4.3%)	52 (4.6%)	26 (5.1%)	18 (5.1%)	0.05
< 37 weeks' gestation	14 (13.9%)	118 (5.9%)	90 (4.4%)	45 (3.9%)	31 (6.1%)	15 (4.3%)	0.028
Transfer to neonatal intensive care	1 (1.0%)	20 (1.0%)	23 (1.1%)	12 (1.1%)	5 (1.0%)	3 (0.9%)	0.88

LGA = large for gestational age. SGA = small for gestational age.
* 37 weeks' gestation at birth. † The numbers are small and possibly incomplete as neonatal deaths after transfer to an intensive care unit may not have been retrospectively entered into the Birthing Outcome System database. ◆

95% CI, 1.42–4.26 for obese class I; AOR, 2.22; 95% CI, 1.09–4.50 for obese class II; AOR, 6.70; 95% CI, 3.69–12.17 for obese class III). Women classified as obese were also more likely to experience gestational diabetes, have neonates with a birthweight of greater than 4500 g and stay in hospital for longer than the 75th percentile (Box 3).

Women with a BMI class of overweight or higher were more likely to have induced labour and require an emergency caesarean delivery, compared with the normal BMI class. Underweight women were more likely to deliver before 37 weeks

(AOR, 2.40; 95% CI, 1.32–4.37), but obese class I women were less likely to deliver before 37 weeks than women of normal weight (AOR, 0.66; 95% CI, 0.47–0.95).

Internal fetal monitoring, such as fetal scalp electrode, was more likely in all obese classes, with the likelihood increasing with the level of obesity (AOR, 1.18; 95% CI, 1.01–1.39 for class I; AOR, 1.31; 95% CI, 1.06–1.62 for class II; and AOR, 1.64; 95% CI, 1.29–2.10 for class III) relative to the normal weight group (Box 3).

For nulliparae only (n = 2245), there was an overall prevalence of over-

weight and obesity of 60.5% (1359), with 32.5% (729) overweight, 16.8% (377) obese class I, 7.3% (165) obese class II and 3.9% (88) class III.

Of the total sample, there were 1007 (16.4%) women with a recorded BMI from < 13 weeks' gestation, and of these, 61.0% (615) were overweight or obese. Similarly, of the 3119 women with a BMI recorded before 20 weeks' gestation, 1918 (61.5%) were overweight or obese.

Discussion

The rates of overweight and obesity in this rural obstetric population are

3 Adjusted odds ratios* (95% CI) for complications in 6138 mothers and their neonates in a rural Victorian maternity cohort by mother's body mass index (BMI) class

Complications	BMI class (kg/m²)†				
	Underweight (< 18.5) n = 101 (1.6%)	Overweight (25.0–29.9) n = 2027 (33.0%)	Obese I (30.0–34.9) n = 1141 (18.6%)	Obese II (35.0–39.9) n = 509 (8.3%)	Obese III (≥40.0) n = 350 (5.7%)
Gestational diabetes	1.34 (0.46–4.39)	1.32 (0.94–1.87)	2.19 (1.53–3.13)	3.34 (2.24–4.98)	4.81 (3.19–7.25)
Pregnancy-related hypertension	0.95 (0.13–7.12)	1.17 (0.67–2.06)	2.45 (1.42–4.26)	2.22 (1.09–4.50)	6.70 (3.69–12.17)
Induction of labour	0.57 (0.30–1.07)	1.46 (1.25–1.70)	1.80 (1.51–2.14)	1.86 (1.49–2.32)	2.21 (1.72–2.85)
Maternal length of stay > 4 days‡	0.59 (0.29–1.19)	1.10 (0.92–1.32)	1.42 (1.16–1.74)	1.60 (1.23–2.07)	1.94 (1.45–2.60)
Emergency caesarean	1.04 (0.49–2.20)	1.40 (1.13–1.73)	1.95 (1.54–2.46)	2.03 (1.50–2.74)	2.04 (1.43–2.91)
Internal fetal monitoring	0.86 (0.55–1.34)	1.03 (0.90–1.18)	1.18 (1.01–1.39)	1.31 (1.06–1.62)	1.64 (1.29–2.10)
Macrosomia > 4500g	na§	1.33 (0.84–2.11)	2.06 (1.29–3.31)	3.90 (2.36–6.46)	3.53 (2.00–6.22)
SGA	2.35 (1.47–3.76)	0.82 (0.67–1.01)	0.68 (0.52–0.87)	0.48 (0.32–0.71)	0.68 (0.45–1.03)
Prematurity (< 37 weeks)	2.40 (1.32–4.37)	0.76 (0.58–1.02)	0.66 (0.47–0.95)	1.02 (0.68–1.54)	0.71 (0.41–1.24)

na = not applicable. SGA = small for gestational age.
* Odds ratios have been adjusted for parity, insurance class, smoking and maternal age. † The normal BMI class (18.5–≤ 24.9 kg/m²) was the reference group for all others.
‡ 75th percentile of all maternal lengths of stay. § Nil in this category. ◆

considerably higher than reported previously in Australia. Over 65% of the women in the population studied were overweight or obese, compared with 34% in Brisbane, in the largest reported Australian cohort,[12] and 54.7% in the rural South Australian cohort.[5] Another Australian multicentre study reported 43% of nulliparae as overweight or obese,[13] which is still considerably lower than the 60.5% overweight and obesity level among nulliparae reported here.

Maternal outcomes in this study are similar to those in previous reports, again highlighting the strong association between excess weight and maternal complications such as diabetes, hypertension and operative delivery. Rural maternity services in many areas are provided by general practitioners, in facilities that may be less well equipped to deal with these complications. This has implications for rural maternity service planning, necessitating appropriate transfer pathways. Further, the doubling of risk of a hospital stay of more than 4 days for obese class III women, consistent with findings in other studies,[1,7,12] may have implications for health service resourcing, particularly in the context of activity-based funding. This could also affect rural organisations negatively and warrants further assessment.

International and Australian data suggest significant implications of overweight and obesity for perinatal outcomes.[12,18] If other rural areas have overweight and obesity rates similar to this northern-Victorian population, this is likely to have widespread implications for rural obstetric perinatal mortality rates. It is interesting to note that in Victoria, gestation-standardised data generally show considerably worse perinatal mortality in rural areas than in metropolitan Melbourne.[19]

The excess of overweight and obesity in this report might reflect different ways of measuring BMI compared with other studies. There is a lack of consistency in determining BMI in perinatal research, with many reports using estimated prepregnancy weight, while others, as is the case for GVH, use weight measured during the first antenatal visit.[1,7,11,12,20-22] A high percentage of first visits during later gestation could account for variation in

some studies, but at GVH, the rates of overweight and obesity for women who presented below 13 weeks' gestation (61%) and below 20 weeks' gestation (61.5%) were similar to those for the whole group (65.6%). Another potential confounder derives from the role of GVH as a regional referral facility — smaller facilities may transfer women exceeding various BMI thresholds. The effect of the potential transfer of women from small rural centres to GVH appears to be small as, based on postcode data, almost all women lived locally, and of those transferred from another hospital (274), only 47 had class III obesity.

In this cohort, there appears to be a reduction in preterm delivery and small-for-gestational-age births with increasing BMI. Both of these may be advantageous, as they are linked to perinatal mortality. Meta-analyses have confirmed an increased risk of premature delivery with increasing BMI.[23,24] The apparent anomaly in the GVH data is likely the result of the transfer, where possible, of women delivering before 32 weeks' gestation to a tertiary centre. Further, although on population graphs there is an apparent reduction in the risk of small-for-gestational-age babies, recent data have confirmed that this effect is lost when using customised growth charts.[12]

The validity of a finding of excess rural pregnancy overweight and obesity is supported by data from a non-obstetric rural population in south-western Victoria,[25] which showed that 56.8% of women between the ages of 25 and 44 were overweight or obese. Thus, the level of maternal obesity in this study appears to truly reflect a concerning difference between this rural cohort and reported urban maternity populations, a finding that, if widespread, has implications for rural maternity services generally and warrants further investigation.

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