Obesity in women giving birth in Victoria, 2010–2019: a retrospective cohort study

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The known: The prevalence of obesity among women giving birth is rising in Australia and overseas. It is reported to be higher in regional than metropolitan Victoria, but no large scale comparison of geographic differences has been published in Australia.

The new: During 2010–2019, the prevalence of obesity among pregnant Victorian women increased from 19.6% to 21.5%. In 2019, the proportion of births to women with obesity was larger in regional than metropolitan areas (29.1% *v* 19.4%), as was the rise in prevalence across the decade (rate ratio: 1.16 *v* 1.10).

The implications: Geographic differences in the prevalence of obesity in pregnant women should be considered when planning maternity services in regional areas.

Abstract

Objective: To assess the prevalence of obesity in pregnant women in Victoria, 2010–2019.

Study design: Retrospective cohort study; analysis of Victorian Perinatal Data Collection data.

Setting, participants: Women who gave birth in seventeen Victorian Department of Health areas (eight metropolitan, nine regional), 2010–2019.

Main outcome measures: Proportions of births to women with obesity (body mass index ≥ 30 kg/m^2), by Department of Health area and year.

Results: A total of 710 364 births with records that included the mothers' BMI were recorded in Victoria during 2010–2019. The proportion of births to women with obesity rose from 19.6% (95% confidence interval [CI], 19.3–19.9%) in 2010 to 21.5% (95% CI, 21.2–21.8%) in 2019; the proportion of births to women with normal weight declined from 49.0% (95% CI, 48.6–49.4%) to 46.8% (95% CI, 46.4–47.1%). In metropolitan areas, the proportion of births to women with obesity rose from 17.7% (95% CI, 17.7–17.8%) to 19.4% (95% CI, 19.3–19.4%); in regional areas, it increased from 25.0% (95% CI, 25.0–25.1%) to 29.1% (95% CI, 29.0–29.2%). The increase in prevalence of obesity was greater among women living in the lowest socio-economic standing (Index of Relative Socio-Economic Disadvantage) quintile than for those residing in the quintile of least disadvantage (adjusted rate ratio, 2.16; 95% CI, 2.12–2.20).

Conclusion: The proportion of births to Victorian women with obesity rose during 2010–2019, particularly in regional areas. Ensuring that regional health services are adequately resourced to meet the needs of the increasing number of women at risk of obesity during pregnancy is vital.

The worldwide prevalence of obesity in adults, defined as a body mass index (BMI) of 30 kg/m^2 or more, tripled during 1975–2016; about 15% of women were classified as obese in 2016.[1] In Australia, the proportion of pregnant women with obesity rose from 20.7% in 2012 to 22.7% in 2021.[2] Similar changes have been reported in the United Kingdom, where the proportion of women with obesity during pregnancy rose from less than 10% in the 1990s to 21.3% in 2017,[3] and the United States, where it increased from 18.9% in 2007 to 23.2% in 2016.[4] Differences in obesity rates for pregnant women by geographic remoteness and social disadvantage have been reported overseas and in Australia.[4-6] Published rates of 29.3%[7] and 32.6%[8] for pregnant women in regional Victoria were larger than the national rate in 2021 (22.7%).[2]

Obesity, the most frequent negative physical condition in pregnant women,[9] is associated with several adverse maternal and fetal outcomes. A 2019 meta-analysis found a linear association between maternal BMI and risk of gestational diabetes mellitus, hypertensive disorders of pregnancy, and unplanned caesarean delivery.[10] A linear association between BMI and the risk of term stillbirth has also been reported.[11] Obesity is also associated with greater risks for the fetus, including premature birth, macrosomia, birth-related trauma, hypoglycaemia, and neonatal intensive care unit admission.[10] Infants born to mothers with obesity are also more likely to later develop metabolic[12,13] and neurodevelopmental disorders.[14] In response to the increasing prevalence of maternal obesity and its impact on mothers and their infants, the Royal Australian and New Zealand College of Obstetricians and Gynaecologists[15] and Safer Care Victoria,[16] among others, have developed guidelines for the management of obesity during pregnancy.

In this article, we report the longitudinal assessment of the prevalence of maternal obesity in Victoria, both overall and by geographic location. Our aims were to map the changing prevalence of maternal obesity in Victoria over the course of a decade, and to assess differences between metropolitan and regional areas.

Methods

For our retrospective cohort study, we analysed data from the Victorian Perinatal Data Collection (VPDC), a population-based surveillance system that collects comprehensive information about every registered birth in Victoria,[17] for the period 1 January 2010 – 31 December 2019. More than 160 data items are included for each birth record, in compliance with the Perinatal National Minimum Data Set defined by the Australian Institute of Health and Welfare.[18] Documentation of the mother's BMI at their first hospital visit has been a required data item since 2009. Our study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline.[19]

Women were grouped by local government area (LGA) according to their residential postcode; postcodes included in multiple LGAs were assigned to the LGA with the largest proportion of the postcode population. LGAs were grouped into 17 Department of Health areas (eight metropolitan, nine regional) to produce a heat map. Women living in non-Victorian postcodes were included only if they resided near the state border and

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their nearest maternity service was in Victoria, in which case the neighbouring Victorian postcode was used.

In the VPDC data analysed, BMI was rounded to the nearest whole number. BMI was categorised as underweight (≤ 18 kg/m^2), normal weight (19–24 kg/m^2), overweight (25–29 kg/m^2), obesity (≥ 30 kg/m^2), and extreme obesity (≥ 50 kg/m^2). Socio-economic status (at the postcode level) was based on the Socio-Economic Indexes for Areas (SEIFA) Index of Relative Socio-Economic Disadvantage (IRSD).[20]

Statistical analysis

We summarise socio-demographic of the women who gave birth and perinatal characteristics by year as descriptive statistics. We report proportions of births by maternal BMI category and year, with 95% confidence intervals (CIs) estimated in separate Poisson regression models for each BMI group. As we could not link records for women for whom more than one birth was registered during the study period, we treated each birth as an independent, unique event. We estimated the proportional

1 Socio-demographic and perinatal characteristics of women who gave birth in Victoria, 2010–2019

		Year of birth									
Characteristic	**All years**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Births	710 364	62 846	62 688	66 870	67 248	70 866	75 456	77 112	76 150	75 351	75 777
Age group (years)											
Under 30	266 411 (37.5%)	25 138 (40.0%)	25 320 (40.4%)	26 825 (40.1%)	26 590 (39.7%)	27 653 (39.0%)	28 268 (37.5%)	28 128 (36.5%)	27 254 (35.8%)	26 003 (34.5%)	25 241 (33.3%)
30 or older	443 729 (62.5%)	37 654 (60.0%)	37 302 (59.6%)	40 010 (59.9%)	40 354 (60.3%)	43 205 (61.0%)	47 179 (62.5%)	48 981 (63.5%)	48 893 (64.2%)	49 346 (65.5%)	50 535 (66.7%)
Missing data	224	54	66	44	34	8	9	3	3	2	1
Parity											
0	311 266 (43.8%)	26 984 (42.9%)	27 211 (43.4%)	29 198 (43.7%)	29 670 (44.1%)	31 707 (44.7%)	33 122 (43.9%)	34 019 (44.1%)	33 030 (43.4%)	32 886 (43.6%)	33 439 (44.1%)
One or more	399 098 (56.2%)	35 862 (57.1%)	35 477 (56.6%)	37 672 (56.3%)	37 578 (55.9%)	39 159 (55.3%)	42 334 (56.1%)	43 093 (55.9%)	43 120 (56.6%)	42 465 (56.4%)	42 338 (55.9%)
Missing data	15	0	1	1	0	1	1	1	0	2	8
Country of birth											
Australia	455 522 (64.1%)	44 281 (70.5%)	43 779 (69.9%)	45 182 (67.6%)	45 027 (67.0%)	45 736 (64.5%)	47 693 (63.2%)	47 279 (61.3%)	46 146 (60.6%)	45 199 (60.0%)	45 200 (59.6%)
Other	254 842 (35.9%)	18 565 (29.5%)	18 909 (30.2%)	21 688 (32.4%)	22 221 (33.0%)	25 130 (35.5%)	27 763 (36.8%)	29 833 (38.7%)	30 004 (39.4%)	30 152 (40.0%)	30 577 (40.4%)
Diabetes	4868 (0.7%)	252 (0.4%)	301 (0.5%)	391 (0.6%)	358 (0.5%)	462 (0.7%)	595 (0.8%)	584 (0.8%)	628 (0.8%)	641 (0.9%)	656 (0.9%)
Smoking during pregnancy	53 606 (7.6%)	5991 (9.7%)	5936 (9.6%)	5985 (9.1%)	5645 (8.5%)	5567 (8.0%)	5357 (7.2%)	5138 (6.7%)	5020 (6.7%)	4562 (6.1%)	4405 (5.9%)
Missing data	8698	862	901	900	960	911	969	925	808	758	704
Hospital type											
Public	522 764 (73.9%)	43 342 (69.2%)	43 402 (69.5%)	46 690 (70.0%)	47 672 (71.1%)	51 493 (72.9%)	56 654 (75.3%)	58 380 (75.9%)	58 456 (77.1%)	58 078 (77.8%)	58 597 (78.0%)
Private	184 452 (26.1%)	19 237 (30.8%)	19 060 (30.5%)	19 981 (30.0%)	19 335 (28.9%)	19 173 (27.1%)	18 605 (24.7%)	18 554 (24.1%)	17 397 (22.9%)	16 574 (22.2%)	16 500 (22.0%)
Missing data	3184	231	226	199	241	200	197	178	297	699	680
Geographic location											
Metropolitan	555 820 (78.2%)	47 983 (76.4%)	47 620 (76.0%)	51 397 (76.9%)	51 555 (76.7%)	55 380 (78.1%)	59 778 (79.2%)	61 429 (79.7%)	60 526 (79.5%)	59 858 (79.4%)	60 294 (79.6%)
Regional	154 544 (21.8%)	14 863 (23.6%)	15 068 (24.0%)	15 473 (23.1%)	15 693 (23.3%)	15 486 (21.9%)	15 678 (20.8%)	15 683 (20.3%)	15 624 (20.5%)	15 493 (20.6%)	15 483 (20.4%)
Socio-economic status quintile*											
Most disadvantage	99 975 (14.1%)	9538 (15.2%)	9633 (15.4%)	10 095 (15.1%)	9812 (14.6%)	10 018 (14.1%)	10 415 (13.8%)	10 357 (13.4%)	10 306 (13.5%)	10 083 (13.4%)	9718 (12.8%)
Least disadvantage	181 451 (25.5%)	16 792 (26.7%)	15 994 (25.5%)	16 680 (24.9%)	16 507 (24.5%)	17 960 (25.3%)	19 639 (26.0%)	20 304 (26.3%)	19 677 (25.8%)	18 930 (25.1%)	18 968 (25.0%)

* Index of Relative Socio-Economic Disadvantage;[20] quintile 1 = most disadvantaged, quintile 5 = least disadvantaged. ◆

change in the proportion of women with obesity in unadjusted Poisson regression models; we also report differences in proportions as rate ratios (RRs) with 95% CIs, as the distribution of the primary outcome (the proportion of births to women with obesity) is a discrete frequency distribution of event numbers (eg, repeated BMI measurements) during a fixed period. To map rates of maternal obesity by region during 2010–2019, we calculated the proportions of births to women with obesity by region and year. We estimated the change in the proportion of births to women with obesity associated with selected socio-demographic and perinatal characteristics in Poisson regression models adjusted for age, parity, country of birth, residential socio-economic status, smoking, pre-existing diabetes, and geographic location (in bivariate analyses, the association of each of these variables with maternal BMI was statistically significant); we report adjusted RRs (aRRs) with 95% CIs. Within Poisson models, the statistical significance of differences between groups was assessed in Wald χ^2 tests using robust estimation. $P < 0.05$ (two-sided) was deemed statistically significant. Statistical analyses were performed in SPSS 29.

Ethics approval

The Western Health low risk ethics committee approved the study (QA2020.29_63984).

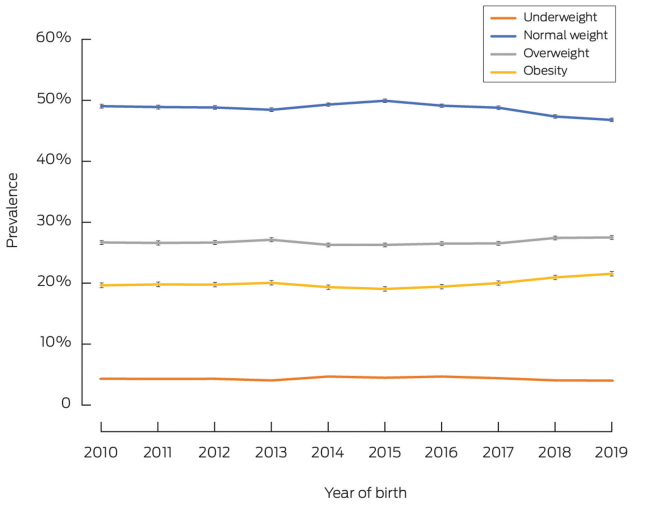
Results

During 2010–2019, 778 988 births in Victoria were recorded; the mother's BMI was not documented in 50 645 cases (2010, 9683 of 74 113 cases [13.1%]; 2019, 1227 of 787 953 cases [1.6%]). After also excluding 17 922 women who were not Victorian residents and 57 invalid cases (BMI > 99 or < 11), we included 710 364 births in our analysis.

The proportion of births to women who were aged 30 years or older increased from 60.0% in 2010 to 66.7% in 2019, as did the proportion of births to women born overseas (from 29.5% to 40.4%) and the proportion of births in public hospitals (from 69.2% to 78.0%). The proportion of births to women with pre-existing diabetes increased from 0.4% in 2010 to 0.9% in 2019; the proportions by parity changed irregularly during the study period. The proportion of births to women who smoked during pregnancy declined from 9.7% in 2010 to 5.9% in 2019 (Box 1). The proportion of births to women with obesity who smoked during pregnancy also declined (from 14.2% to 9.3%), but was consistently larger than for all women during pregnancy; the proportion of births to women with obesity who were aged 30 years or more increased (from 58.3% to 62.5%) (Supporting Information, table 1), but was consistently smaller than the proportion of all births to women who were aged 30 years or older (reported above).

The proportion of births to women with obesity rose from 19.6% (95% CI, 19.3–19.9%) in 2010 to 21.5% (95% CI, 21.2–21.8%) in 2019; the proportion of births to women with normal weight declined from 49.0% (95% CI, 48.6–49.4%) to 46.8% (95% CI, 46.4–47.1%) (Box 2; Supporting Information, table 2). The numbers of births to women with extreme obesity were relatively small; the proportion increased from 0.27% (95% CI, 0.22–0.31%) to 0.37% (95% CI, 0.33–0.41%) over the same period (Supporting Information, table 2).

2 Categorisation by body mass index of women who gave birth in Victoria, 2010–2019, by birth year*



* The data underlying this graph are included in the Supporting Information, table 2. The proportions of women with extreme obesity are not included in this graph because of their small size, but are included in the Supporting Information table. ◆

The proportion of births to women with obesity in metropolitan areas rose from 17.7% (95% CI, 17.7–17.8%) in 2010 to 19.4% (95% CI, 19.3–19.4%) in 2019, and in regional areas from 25.0% (95% CI, 25.0–25.1%) to 29.1% (95% CI, 29.0–29.2%) (Box 3, Box 4). Increases in the proportion of births to women with obesity were noted in 15 of the 17 Department of Health areas; the proportion in each area was smaller or equal to 30% in 2010, but greater than 30% in five regional areas in 2019 (Box 3, Box 5). The difference in prevalence was greatest for three of the regional areas with proportions exceeding 30% in 2019: Central Highlands (RR, 1.24; 95% CI, 1.22–1.25), Inner Gippsland (RR, 1.21; 95% CI, 1.20–1.23), and Mallee (RR, 1.30; 95% CI, 1.28–1.32). In 2019, the proportion of births to women with obesity was smaller than 30% in all eight metropolitan areas, and smaller than 20% in four metropolitan areas; the proportional change between 2010 and 2019 was greatest for the area with the largest proportion in 2019, Brimbank Melton (19.2%; 95% CI, 18.3–20.0%; RR, 1.21; 95% CI, 1.20–1.22) (Box 3).

The proportion of births to women living in areas of greatest socio-economic disadvantage during 2010–2019 was larger in regional than metropolitan Department of Health areas (27% *v* 10%), and was largest in Mallee (63.1% in IRSD quintile 1) (Supporting Information, table 4). The largest change in the proportion of women with obesity was also in Mallee (from 24.5% in 2010 to 31.8% in 2019) (Box 3).

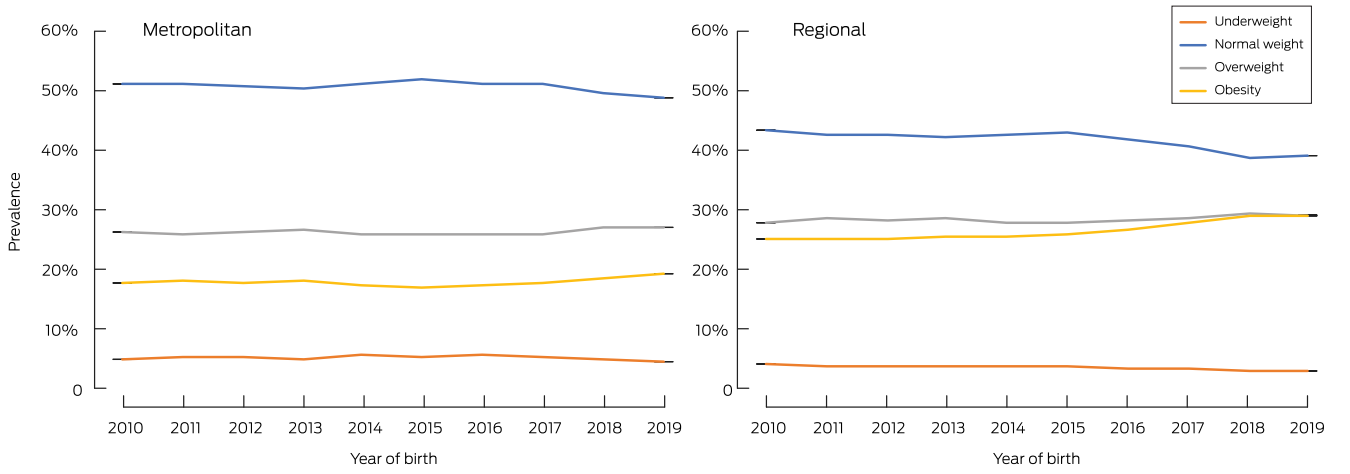
Differences in the proportion of births to women with obesity in 2010 and 2019 were greater in regional than metropolitan areas (aRR, 1.05; 95% CI, 1.03–1.06), for women living in the lowest IRSD quintile (most disadvantaged) than for those residing in the quintile of least disadvantage (aRR, 2.16; 95% CI, 2.12–2.20), and for women who had previously given birth (aRR, 1.30; 95% CI, 1.29–1.31), were born in Australia (*v* overseas: aRR, 1.63; 95% CI, 1.61–1.65), who smoked during pregnancy (aRR, 1.21; 95% CI, 1.19–1.23), or who had pre-existing diabetes mellitus (aRR, 2.22; 95% CI, 2.15–2.29) (aRR, 0.99; 95% CI, 0.98–1.003) (Box 6).

3 Changes in the proportions of live births to women with obesity who gave birth in Victoria, 2010 and 2019, by geographic location and Department of Health area*

Department of Health area	2010 Number	2010 Proportion (95% CI)	2019 Number	2019 Proportion (95% CI)	Proportional change (95% CI)	Rate ratio (95% CI)
All areas	62 846	19.6% (19.6–19.7%)	75 777	21.6% (21.5–21.6%)	9.3% (9.1–9.5%)	1.10 (1.09–1.10)
Metropolitan	46 491	17.7% (17.7–17.8%)	58 857	19.4% (19.3–19.4%)	8.8% (8.5–9.1%)	1.09 (1.09–1.10)
Bayside Peninsula	9106	13.4% (13.4–13.5%)	9417	14.5% (14.4–14.6%)	7.5% (6.7–8.2%)	1.08 (1.07–1.09)
Brimbank Melton	4028	21.3% (21.2–21.5%)	5040	25.8% (25.7–26.0%)	19.2% (18.3–20.0%)	1.21 (1.20–1.22)
Hume Moreland	3224	23.4% (23.3–23.6%)	6091	23.2% (23.0–23.3%)	–1.3% (–2.2 to –0.4%)	0.99 (0.98–0.996)
Inner Eastern Melbourne	5999	9.5% (9.5–9.6%)	5807	10.5% (10.4–10.6%)	9.8% (8.7–11%)	1.10 (1.09–1.11)
North Eastern Melbourne	6529	18.0% (18.0–18.2%)	8120	17.8% (17.8–17.9%)	–1.1% (–1.9 to –0.3%)	0.99 (0.98–0.997)
Outer Eastern Melbourne	4949	20.0% (19.9–20.1%)	5024	20.0% (19.9–20.2%)	0.2% (–0.7 to 1.1%)	1.00 (0.99–1.01)
Southern Melbourne	7469	22.2% (22.1–22.3%)	9551	24.2% (24.1–24.3%)	8.6% (8.0–9.3%)	1.09 (1.08–1.10)
Western Melbourne	5187	19.4% (19.3–19.6%)	9807	19.8% (19.8–19.9%)	2.0% (1.3–2.8%)	1.02 (1.01–1.03)
Regional	16 355	25.0% (25.0–25.1%)	16 920	29.1% (29.0–29.2%)	15.1% (14.7–15.5%)	1.16 (1.16–1.17)
Barwon	3160	21.2% (21.0–21.4%)	3517	23.4% (23.2–23.5%)	9.7% (8.7–10.8%)	1.10 (1.09–1.11)
Central Highlands	2054	24.3% (24.1–24.6%)	2248	30.1% (29.8–30.3%)	21.1% (20.0–22.3%)	1.24 (1.22–1.25)
Goulburn	1723	30.0% (29.6–30.2%)	1826	33.2% (33.0–33.5%)	10.6% (9.5–11.8%)	1.11 (1.10–1.12)
Inner Gippsland	2091	25.7% (25.5–26.0%)	1999	31.2% (30.9–31.4%)	19.4% (18.2–20.5%)	1.21 (1.20–1.23)
Loddon	2408	26.7% (26.5–26.9%)	2580	29.3% (29.1–29.5%)	9.3% (8.3–10.4%)	1.10 (1.10–1.11)
Mallee	1192	24.5% (24.2–24.8%)	1125	31.8% (31.5–32.2%)	26.2% (24.6–27.7%)	1.30 (1.28–1.32)
Outer Gippsland	1192	24.2% (23.9–24.5%)	859	28.4% (28.0–28.8%)	16.1% (14.3–17.9%)	1.18 (1.15–1.20)
Ovens Murray	1346	23.2% (23.0–23.5%)	1329	28.0% (27.7–28.3%)	18.5% (17–20%)	1.20 (1.18–1.22)
Western District	1492	27.6% (27.4–27.9%)	1437	32.8% (32.6–33.1%)	17.4% (16.0–18.7%)	1.19 (1.17–1.20)

* Changes in proportions (2010–2019) and rate ratios estimated in separate Poisson regression models for each Department of Health area. ◆

4 Categorisation by body mass index of women who gave birth in Victoria, 2010–2019, by geographic location and birth year*

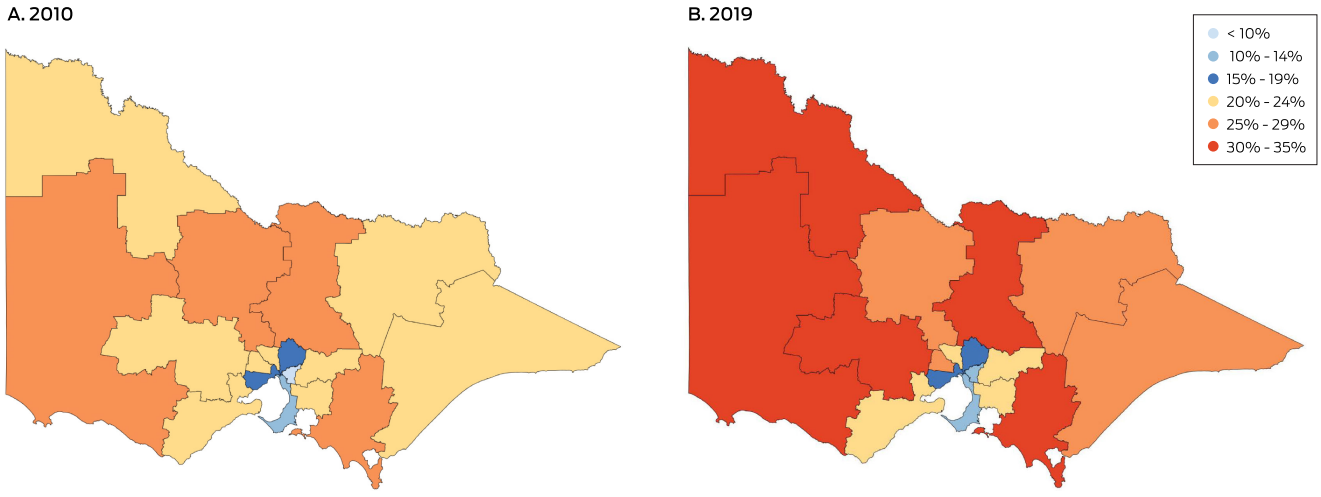


* The data underlying this graph are included in the Supporting Information, table 3. ◆

Discussion

We found that the prevalence of maternal obesity increased in Victoria during 2010–2019, as also reported in other developed countries.[3,4] The difference in prevalence between regional and metropolitan areas in the proportions of births to women with obesity was marked, and it increased across the decade. In 2019, the proportion of women with obesity among those who gave birth in regional areas ranged between 23.4% and 33.2%, similar to earlier figures reported for regional Victoria (2005–2010:

5 Proportions of women who gave birth in Victoria, 2010 and 2019, with obesity, by Department of Health area*



* Corresponding maps for each year of the study period are available on the Institute for Health Transformation (Deakin University) website (https://tinyurl.com/pregnancyobesityvic). ◆

32.6%;[8] 2017: 29.3%[7]). A general association between geographic remoteness and the prevalence of obesity has previously been described in Australia.[21] We did not have information about the specific hospitals in which women gave birth, but the similarity of our findings regarding the prevalence of obesity to those of earlier studies[7,8] suggests that the vast majority of women in regional Victoria receive pregnancy and labour care in their regional communities.

In Victoria, all four tertiary hospitals that provide maternity and newborn services (level 6 services) are located in metropolitan Melbourne; one regional Department of Health area has less well resourced level 5 services, and no regional area includes level 4 maternal/newborn services.[22] Antenatal care for women with obesity can involve care from several medical and allied health disciplines (including obstetricians, physicians, anaesthetists, mental health practitioners, dietitians, physiotherapists) and more frequent visits to outpatient hospital services.[16] Ultrasonography is technically more difficult in women with obesity and a high level of expertise is required for detecting fetal anomalies and assessing fetal growth.[15] Prolonged labour, more frequent failed induction of labour, and greater risks of need for emergency caesarean delivery and post partum haemorrhage all affect the length of hospital stay.[3,7,15,16] Postnatal support with regard to mental health, breastfeeding, wound healing, and post partum weight management is also important.[15,16] Regional health services may have fewer staff and not have the bariatric equipment required for the complex care of pregnant women with high BMI, particularly those with class III obesity (BMI ≥ 40 kg/m^2).

In our study, the proportion of women in regional areas living in postcodes in the most disadvantaged IRSD quintile was more than twice as large as for women in metropolitan areas (27% *v* 10%). An association of social disadvantage with obesity has been reported,[5] and living in regional areas probably compounds the problem. Area-level socio-economic disadvantage was heterogenous in metropolitan areas; unsurprisingly, the Department of Health area with the highest level of social disadvantage was also the area with the highest prevalence of obesity in pregnant women (Brimbank Melton). The large tertiary maternity service in this area has established a multidisciplinary antenatal clinic for women with extreme obesity (BMI ≥ 50 kg/m^2) and class III obesity with other medical conditions (eg, such as diabetes, hypertension) to manage the complexity of pregnancy for these women; demand, however, exceeds capacity.[23] An American study found that the proportion of women with pre-pregnancy obesity in the 68 largest metropolitan cities ranged from 10.4% to 36.6%.[24] In our study, the proportion of births to women in metropolitan areas with obesity (19.4%) in 2019 was at the lower end of this range, but was markedly larger than reported for Brisbane in 2009 (12.7%).[9] In addition to social disadvantage, the cities in the United States study in which the prevalence of obesity was highest had poorer access to parkland, green spaces, and neighbourhood amenities, corresponding to higher levels of physical inactivity.[24] Differences in similar factors, and in access to public transport networks that encourage more physical activity, may account for some of the variation in the prevalence of obesity across metropolitan areas in Victoria.

The increase in Victoria during 2010–2019 in the proportion of births to women aged 30 years or older was similar to findings in overseas studies.[3,4] While the proportion of births to women with obesity in this age group also increased, it was consistently smaller than for the overall value. Mothers under 30 years of age are more likely to give birth in public hospitals than older women,[2] suggesting that socio-economic standing not only influences the prevalence of obesity but also the age at which women have their babies.

We found that the proportion of births to Victorian women who smoked during pregnancy declined from 9.7% in 2010 to 5.9% in 2019. However, 9.3% of women with obesity reported smoking during pregnancy in 2019, and the proportion with obesity increased more rapidly among women who smoked (by 6%). As the risk of stillbirth is generally greater for women with obesity,[11] reducing smoking during pregnancy is especially important.

More than one-third of women with obesity in our study were having their first child. Women with obesity prior to pregnancy are more likely to retain weight after giving birth.[25] Dietary interventions for pregnant women have not been found to improve outcomes for mothers, including reducing weight after giving birth.[26] Guidelines recommend pre-conception consultation as an opportunity for offering referral to dietitians or metabolic weight loss clinics, and for exploring specific psychosocial contributors to obesity.[15,16] Referral for bariatric

6 Change in the proportion of women who gave birth in Victoria, 2010–2019, with obesity: multivariable Poisson regression analyses

Characteristic	Rate ratio (95% CI)	Adjusted rate ratio (95% CI)*
Age group (years)		
Under 30	1	1
30 or older	0.90 (0.89 – 0.91)	0.99 (0.98–1.003)
Parity		
0	1	1
One or more	1.36 (1.34 – 1.37)	1.30 (1.29–1.31)
Country of birth		
Australia	1.68 (1.66 – 1.70)	1.63 (1.61–1.65)
Other	1	1
Socio-economic status quintile†		
1 (most disadvantaged)	1.71 (1.68 – 1.74)	2.16 (2.12–2.20)
2	1.82 (1.78 – 1.85)	2.16 (2.12–2.20)
3	1.51 (1.48 – 1.54)	1.95 (1.91–1.98)
4	1.45 (1.43 – 1.47)	1.84 (1.81–1.87)
5 (least disadvantaged)	1	1
Birth year		
2010	1	1
2011	1.01 (0.98 – 1.03)	1.00 (0.98–1.02)
2012	1.01 (0.98 – 1.03)	1.01 (0.99–1.03)
2013	1.02 (0.998 – 1.05)	1.03 (1.01–1.05)
2014	0.98 (0.96 – 1.01)	1.01 (0.99–1.03)
2015	0.97 (0.95 – 0.99)	1.00 (0.98–1.02)
2016	0.99 (0.97 – 1.01)	1.04 (1.02–1.06)
2017	1.02 (0.996 – 1.04)	1.07 (1.04–1.09)
2018	1.07 (1.04 – 1.09)	1.12 (1.09–1.14)
2019	1.10 (1.07 – 1.12)	1.16 (1.13–1.18)
Geographic location		
Metropolitan	1	1
Regional	1.48 (1.46 – 1.49)	1.05 (1.03–1.06)
Smoking during pregnancy	1.57 (1.55 – 1.60)	1.21 (1.19–1.23)
Pre-existing diabetes	2.31 (2.21 – 2.41)	2.22 (2.15–2.29)

* Adjusted for maternal age, parity, country of birth, socio-economic status, smoking, pre-existing diabetes, and geographic location. † Index of Relative Socio-Economic Disadvantage.[17] ◆

surgery prior to a planned pregnancy can be considered for women with class III obesity.[15] There is no evidence supporting specific pre-pregnancy interventions for preventing obesity, but lifestyle interventions for women planning pregnancy in the near future are being investigated in two large Australian randomised trials.[27] Equitable access to primary care within their communities is needed to optimise and support healthy behaviour for all women in order to reduce the number who embark on their first pregnancies with avoidable additional risks.

Limitations

We report the first study to examine the prevalence of obesity over time in a large group of pregnant women in Australia, and identified Victorian regions where it is high. As with all retrospective studies, our findings are limited by the accuracy and completeness of the records from which the data we analysed were derived. BMI was based on the value recorded at the first antenatal visit, typically at about week 13 of pregnancy in 2010 and week 10 in 2019. It is probable that some height and weight data were self-reported; measurements by clinicians are preferable. It has been reported that height and weight values reported by women at antenatal visits are strongly correlated with clinician measurements, and more often lead to underestimating than overestimating BMI.[28] One statistical limitation of our analysis was that we could not link data for women who gave birth more than once during the study period; we therefore treated each birth as an independent and unique event when estimating prevalence.

Conclusion

We found that the proportion of pregnant Victorian women with obesity increased during 2010–2019, and that the increase was greater in regional than in metropolitan areas. Ensuring that regional health services are adequately resourced to meet the needs of the increasing number of women at risk of obesity during pregnancy is vital, but, without reducing the socio-economic and health inequities that affect people in regional areas, rates of obesity may continue to rise.

Data sharing: The data analysed in this study are available from the Victorian Perinatal Data Collection.

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Supporting Information

Additional Supporting Information is included with the online version of this article.