

# The effect of obesity on pregnancy outcomes among Australian Indigenous and non-Indigenous women

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**E**liminating disparities between the health status of Indigenous and non-Indigenous Australians is a national priority.<sup>1</sup> Obesity (body mass index [BMI]  $\geq 30.0$  kg/m<sup>2</sup>) is a major contributor to chronic diseases.<sup>2,3</sup> As obesity rates at all ages are higher among Indigenous Australians,<sup>4</sup> obesity-related health disparities between Indigenous and non-Indigenous Australians are a public health concern.

In Australia, maternal overweight (BMI, 25.0–29.9 kg/m<sup>2</sup>) and obesity are endemic in obstetric care.<sup>5</sup> Consistent with national estimates,<sup>4</sup> 32% of non-Indigenous women with singleton pregnancies at the Mater Mothers' Hospital in Brisbane between 1998 and 2009 were overweight or obese before pregnancy.<sup>5</sup> The rate among Indigenous women was even higher, at 45%.<sup>5</sup> The association between overweight or obesity and pregnancy outcomes in Australia is well described for non-Indigenous women, but less comprehensively understood for Indigenous women. These studies have consistently shown that maternal overweight or obesity is associated with increased risk of maternal complications (including gestational diabetes and hypertensive disorders) and perinatal morbidity and mortality. Further, caesarean section rates are higher among overweight or obese women.<sup>5</sup> However, ethnicity may modify the effect of overweight or obesity on maternal and infant outcomes, and its impact at the population level.<sup>6–8</sup>

We aimed to estimate the prevalence of maternal overweight or obesity among Indigenous and non-Indigenous women separately, and to examine whether the effect of overweight or obesity on maternal complications and perinatal outcomes is modified by Indigenous status.

## Methods

We used aggregate data from the population-based Queensland Perinatal

## Abstract

**Objective:** To assess whether the effect of pre-pregnancy overweight or obesity on maternal complications and perinatal outcomes is modified by Indigenous status.

**Design, participants and setting:** Population-based study using de-identified aggregate data on pregnancies resulting in singleton births from Indigenous ( $n = 13\,582$ ) and non-Indigenous ( $n = 241\,270$ ) women from the Queensland Perinatal Data Collection, 1 July 2007 to 31 December 2011.

**Main outcome measures:** Prevalence of maternal (gestational diabetes mellitus [GDM], hypertensive disorders of pregnancy [HDP]) and delivery (preterm birth, birthweight, Apgar score) outcomes by Indigenous status and their association with pre-pregnancy body mass index.

**Results:** In 57% of Indigenous pregnancies and 49% of non-Indigenous pregnancies, the mother was overweight, obese or severely obese. Prevalences of GDM, preterm birth and low birthweight were higher in Indigenous than non-Indigenous pregnancies. Overall rates of HDP were similar for Indigenous (5.1%) and non-Indigenous pregnancies (4.9%); however, rates were higher in normal-weight Indigenous pregnancies (4.0%) than in normal-weight non-Indigenous pregnancies (3.0%). We found that overweight or obesity was associated with higher prevalence of GDM, HDP, high birthweight and low Apgar score. However, the associations with HDP, preterm birth and low birthweight were modified by Indigenous status ( $P$  for interaction,  $< 0.001$  for all). Overweight or obesity accounted for significantly fewer cases of HDP in Indigenous versus non-Indigenous pregnancies (population attributable fraction, 30% v 41%).

**Conclusions:** Maternal overweight or obesity is more common among Indigenous pregnancies, and Indigenous status may modify its association with pregnancy outcomes. Further research needs to explore the issue of increased insulin resistance and higher rates of HDP among normal-weight Indigenous women.

Data Collection (QPDC). The QPDC is a legislated statewide collection of information on all hospital and non-hospital births in Queensland of at least 20 weeks' gestation or at least 400 g birthweight. The study included 15 050 singleton births to Queensland resident Indigenous women and 250 798 to non-Indigenous women between 1 July 2007 and 31 December 2011. Data sourced for this study were sufficiently anonymised to protect patient privacy and confidentiality. Due to these aggregate data not being capable of identifying individual patients, a *Public Health Act 2005* (Qld) application for release of these data was not required.

Self-reported pre-pregnancy height and weight are recorded at the first antenatal visit (in most cases, at around 12–16 weeks' gestation) and have been included in the QPDC since 1 July 2007.

In addition to demographic characteristics of the mother, the QPDC

captures information on each birth, including maternal, peripartum and neonatal outcomes. We had the following maternal factors available for analysis: maternal age ( $< 20$ , 20–24, 25–29, 30–34, 35–39, and  $\geq 40$  years); nulliparity (no, yes); remoteness of usual residence (Accessibility/Remoteness Index of Australia [ARIA+]: major city, inner regional, outer regional, remote, and very remote); maternal smoking during pregnancy (no, yes); mode of delivery (vaginal, caesarean section); pre-existing diabetes mellitus (no, yes); pre-existing hypertension (no, yes); hypertensive disorders of pregnancy (HDP; no, yes); and gestational diabetes mellitus (GDM; no, yes). We had the following infant factors available for analysis: gestational age ( $< 28$ , 28–31, 32–36, 37–41, and  $\geq 42$  weeks); birthweight ( $< 2500$  g, 2500–2999 g, 3000–3499 g, 3500–3999 g, 4000–4499 g, and  $\geq 4500$  g); and Apgar scores at 1 and 5 minutes (score: 0–3, 4–6, and 7–10). To

encompass the maternal and infant factors analysed, data are referred to as “Indigenous pregnancies” and “non-Indigenous pregnancies”.

### Statistical analysis

Associations between BMI and maternal and infant outcomes were assessed using multivariable log-link Poisson models to estimate prevalence ratios (PRs) and 95% confidence intervals adjusted for maternal age, nulliparity, ARIA+ category and smoking status. Additional adjustment for year did not change the observed PRs, so it was not included in the final model. We assessed effect modification by Indigenous status by including an interaction term in the models. Significance of the interaction term was determined by a likelihood ratio test. In supplementary analyses, we estimated adjusted population-attributable fractions (PAFs) for each outcome associated with overweight or obesity,<sup>9,10</sup> and performed analyses additionally stratified by age (<25, ≥25 years), nulliparity and smoking status. Analyses were conducted using SAS 9.3 (SAS Institute) and tests for statistical significance were two-sided at  $\alpha=0.05$ .

## Results

Of 265 848 births, 13 582 to Indigenous women and 241 270 to non-Indigenous women had associated maternal BMI recorded in the QPDC. The percentage of missing BMI data in the QPDC was highest in the first 2 years, but decreased from 11% in 2007 to 2% in 2011. Each year, the proportion of missing BMI data was higher for Indigenous than non-Indigenous pregnancies (2007, 23% v 10%; 2011, 4% v 2%).

In 57% of Indigenous pregnancies and 49% of non-Indigenous pregnancies, the mother was overweight, obese or severely obese (Appendix 1, online at [mja.com.au](http://mja.com.au)). The proportion of pregnancies occurring in overweight, obese or severely obese women remained essentially unchanged over time. BMI and Indigenous status were statistically significantly associated with age, parity, ARIA+ category and smoking during pregnancy.

### Maternal outcomes

Prevalence of GDM was higher in Indigenous than non-Indigenous pregnancies (6.9% v 5.5%,  $P<0.001$ ), while HDP occurred in 5.0% of all pregnancies ( $P=0.14$ ). Overall rates of HDP were similar for Indigenous (5.1%) and non-Indigenous (4.9%) pregnancies; however, rates were higher in normal-weight Indigenous pregnancies (4.0%) versus normal-weight non-Indigenous pregnancies (3.0%).

GDM prevalence increased with increasing BMI (Box; Appendix 2, online at [mja.com.au](http://mja.com.au)); the association did not vary by Indigenous status ( $P$  for interaction, 0.45). In contrast, the PR for HDP associated with obesity was significantly higher for non-Indigenous than Indigenous pregnancies ( $P$  for interaction,  $<0.001$ ). Prevalence of HDP was significantly lower in pregnancies among underweight women than in those among women with normal BMI.

### Delivery outcomes

The prevalence of caesarean section was higher among non-Indigenous than Indigenous women (33% v 25%;  $P<0.001$ ). Overweight, obese or severely obese women’s pregnancies were more likely to end in a caesarean section than pregnancies in women with normal BMI, regardless of Indigenous status ( $P$  for interaction, 0.13).

Preterm births (spontaneous or medically induced) were more likely among Indigenous than non-Indigenous pregnancies. Prevalence of preterm birth before 32 weeks was twofold higher for pregnancies among underweight Indigenous women; however, there was no consistent association between increasing BMI and preterm birth in either group. We found significantly lower prevalence of preterm birth before 37 weeks for pregnancies in overweight or obese Indigenous women, but no association for pregnancies in non-Indigenous women ( $P$  for interaction,  $<0.001$ ).

Birthweight was lower than 2500 g in 9% of babies born to Indigenous women, and 4% born to non-Indigenous women. The prevalence of low birthweight was higher in underweight women’s pregnancies;

however, while BMI was inversely associated with low birthweight overall, the magnitude of the association was stronger for Indigenous than non-Indigenous pregnancies ( $P$  for interaction,  $<0.001$ ).

Pregnancies in underweight Indigenous women had a higher prevalence of low Apgar score at 5 minutes, while obesity was associated with a low Apgar score at 1 and 5 minutes in all pregnancies.

### Supplemental analyses

We calculated PAFs for each outcome associated with BMI  $\geq 25.0$  kg/m<sup>2</sup>. The PAF for GDM was higher for Indigenous (52%; 95% CI, 48%–56%) than non-Indigenous (39%; 95% CI, 38%–40%) pregnancies. Likewise, the PAF for high birthweight was higher for Indigenous (41%; 95% CI, 37%–45%) than non-Indigenous (25%; 95% CI, 24%–25%) pregnancies. In contrast, the PAF for HDP was lower for Indigenous (30%; 95% CI, 24%–36%) than non-Indigenous (41%; 95% CI, 40%–42%) pregnancies.

We observed similar results when we additionally stratified by age, nulliparity and smoking status, and when we excluded births from women with either pre-existing diabetes or hypertension (data not shown).

## Discussion

Almost half of all singleton babies born in Queensland between 2007 and 2011 were born to overweight or obese women, with the highest rates observed in Indigenous women. Consistent with the Australian obstetric population as a whole,<sup>11</sup> 5% and 6% of pregnancies in our study involved HDP and GDM, respectively. Compared with pregnancies in normal-weight non-Indigenous women, the prevalence of HDP or GDM was more than fourfold higher in pregnancies in severely obese non-Indigenous women; 40% of cases of HDP and GDM in non-Indigenous pregnancies may be attributed to overweight or obesity.

To the best of our knowledge, the current study is the first to show that the magnitude of the association between BMI and HDP in Australian women is modified by Indigenous status. Prevalence of HDP was only

**Adjusted prevalence ratios\* and 95% confidence intervals for maternal and delivery outcomes, according to Indigenous status and body mass index (BMI) category**

	Indigenous (n = 13582)					Non-Indigenous (n = 241270)					P for interaction
	Underweight	Normal†	Overweight	Obese	Severely obese	Underweight	Normal†	Overweight	Obese	Severely obese	
No.	857	4966	3776	3353	630	10864	112385	66729	43837	7455	
<b>Maternal outcomes</b>											
GDM	1.17 (0.77–1.78)	1.00	1.94 (1.58–2.38)	3.00 (2.47–3.63)	4.44 (3.48–5.67)	1.00 (0.90–1.12)	1.00	1.65 (1.58–1.73)	2.76 (2.64–2.88)	4.47 (4.18–4.78)	0.45
HDP	0.55 (0.34–0.88)	1.00	1.44 (1.18–1.75)	2.00 (1.64–2.43)	2.12 (1.53–2.94)	0.74 (0.65–0.84)	1.00	1.76 (1.68–1.85)	3.12 (2.97–3.27)	4.95 (4.60–5.32)	< 0.001
<b>Delivery outcomes</b>											
Caesarean section	0.91 (0.77–1.08)	1.00	1.18 (1.08–1.29)	1.32 (1.21–1.44)	1.81 (1.58–2.07)	0.89 (0.86–0.93)	1.00	1.17 (1.15–1.19)	1.36 (1.33–1.39)	1.59 (1.54–1.65)	0.13
Preterm birth < 32 weeks	1.98 (1.36–2.88)	1.00	1.05 (0.78–1.40)	0.87 (0.63–1.20)	1.28 (0.75–2.18)	1.45 (1.22–1.71)	1.00	0.97 (0.87–1.07)	1.05 (0.94–1.17)	1.36 (1.11–1.68)	0.40
Preterm birth < 37 weeks	1.51 (1.25–1.81)	1.00	0.83 (0.72–0.95)	0.69 (0.59–0.80)	0.76 (0.57–1.01)	1.39 (1.30–1.49)	1.00	0.97 (0.93–1.01)	1.00 (0.96–1.05)	1.09 (0.99–1.19)	< 0.001
Low birthweight (< 2500g)	1.56 (1.31–1.86)	1.00	0.68 (0.59–0.78)	0.49 (0.42–0.58)	0.49 (0.34–0.69)	1.80 (1.68–1.93)	1.00	0.81 (0.77–0.85)	0.77 (0.73–0.81)	0.84 (0.75–0.94)	< 0.001
High birthweight (≥ 4000g)	0.65 (0.44–0.97)	1.00	1.70 (1.46–1.99)	2.36 (2.03–2.75)	3.26 (2.64–4.03)	0.50 (0.46–0.54)	1.00	1.44 (1.40–1.48)	1.82 (1.77–1.87)	2.27 (2.16–2.39)	< 0.001
1-minute Apgar score < 7	1.22 (0.97–1.52)	1.00	1.09 (0.95–1.25)	1.23 (1.06–1.42)	1.62 (1.28–2.05)	0.92 (0.86–0.99)	1.00	1.13 (1.09–1.17)	1.27 (1.22–1.32)	1.63 (1.52–1.74)	0.20
5-minute Apgar score < 7	1.71 (1.15–2.54)	1.00	1.06 (0.80–1.42)	1.22 (0.92–1.63)	1.85 (1.18–2.88)	0.95 (0.81–1.11)	1.00	1.02 (0.94–1.10)	1.26 (1.16–1.36)	1.70 (1.46–1.98)	0.16

GDM = gestational diabetes mellitus. HDP = hypertensive disorders of pregnancy. Underweight = BMI, < 18.0 kg/m<sup>2</sup>. Normal = BMI, 18.0–24.9 kg/m<sup>2</sup>. Overweight = BMI, 25.0–29.9 kg/m<sup>2</sup>. Obese = BMI, 30.0–39.9 kg/m<sup>2</sup>. Severely obese = BMI, ≥ 40.0 kg/m<sup>2</sup>. \* Adjusted for maternal age, nulliparity (yes/no), Accessibility/Remoteness Index of Australia category and smoking status. † Reference category.

twofold higher in obese Indigenous women’s pregnancies, and overweight or obesity accounted for only 30% of HDP in Indigenous pregnancies. Similar ethnic differences have been observed in the United States and the United Kingdom.<sup>6,7</sup> In contrast, while the association between maternal overweight or obesity and GDM was not modified by Indigenous status, the burden of GDM associated with overweight or obesity was significantly higher for Indigenous pregnancies.

For high birthweight, the magnitude of the association with obesity was stronger for Indigenous pregnancies, and overweight or obesity accounted for a greater proportion of high birthweight babies born to Indigenous than non-Indigenous women. We found no association between overweight or obesity and preterm birth in non-Indigenous pregnancies; however, prevalence of preterm birth before 37 weeks’ gestation was lower in overweight or obese Indigenous women’s pregnancies. Similar disparities have been reported in three US studies, where the risk

of preterm birth was lower among obese black women and higher among obese white women.<sup>12–14</sup> While studies, including ours, have found higher prevalence of preterm birth in underweight women’s pregnancies, the association with overweight or obesity remains controversial. Two meta-analyses reported a modest increased risk of preterm birth associated with obesity,<sup>15,16</sup> although literature shows conflicting results.

The biological basis for associations between overweight or obesity and adverse pregnancy outcomes are unclear. The varying effects by ethnicity, however, may be due to differences in body fat distribution, as Indigenous women have more central body fat for a given BMI than non-Indigenous women.<sup>17,18</sup> Furthermore, lean Indigenous women are more likely to be insulin resistant,<sup>19</sup> and obesity has been shown to have a greater effect on insulin resistance in non-white than in white women.<sup>8,20</sup> It is also possible that there may be genetic differences between Indigenous and non-Indigenous women that explain different rates of pre-eclampsia, and

this is an important area for further study. There may also be different behaviours in the younger, normal-weight group of Indigenous women that we cannot measure (eg, shorter periods of sperm antigen exposure, higher burdens of inflammation and endothelial dysfunction relating to chronic infections).

The strengths of our study include the large population-based cohort and collection of information on a range of potential confounders. While no studies have assessed the completeness and accuracy of the QPDC as a whole, validation studies of a similar database in New South Wales report high levels of accuracy for infant and maternal outcomes.<sup>21</sup> More missing BMI data from Indigenous pregnancies, likely due to later presentation for antenatal care,<sup>22</sup> may be a limitation. Although we found differences between the characteristics of women with and without BMI data, our results were unchanged when we restricted our analyses to years with more complete data. BMI was based on recalled height and weight; however, a previous study in a subset of

mothers giving birth in Queensland has shown high correlation ( $r=0.95$ ) between maternal estimate of pre-pregnancy weight and weight recorded at the first antenatal visit,<sup>23</sup> and any misclassification would attenuate the associations here. It is unclear whether such misclassification would have differed by Indigenous status. Another possible limitation is the use of self-reported Indigenous status. Indigenous mothers who were not enumerated in the QPDC may have influenced the true association with BMI. While we adjusted for potential confounders, we cannot completely exclude residual confounding. Compared with non-Indigenous women, Indigenous women are younger and tend to be thin when they have their first baby; however, they tend to have more children and gain a lot more weight.<sup>11</sup> Young age and parity are also risk factors for HDP and may confound the associations with obesity. The higher rates of caesarean section for non-Indigenous women may be due to private health insurance status; however, we did not have data on private health insurance status in this study. Finally, because it is possible that subgroups of women may be more likely than others to be screened, the observed effect for obesity may actually underestimate the true effect as the non-disease groups would be very likely to include women with undiagnosed disease. Confounding by indication could have occurred, as obese women may be more likely to be screened for maternal health indicators than non-obese women. It is unclear whether screening is more or less likely to occur in Indigenous women.

In summary, maternal overweight or obesity is common in obstetric care and is associated with poor pregnancy outcomes. Elucidating the reasons for the varying effects by Indigenous status will help in understanding the pathways leading to these events.

**Competing interests:** No relevant disclosures.

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