Obesity, Pregnancy and Lifestyle Clinic: Evaluation and Outcomes

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Abstract

Background: Increasing numbers of women are entering pregnancy with an elevated body mass index (BMI). Elevated maternal BMI is associated with a number of adverse obstetric and neonatal outcomes, however attention to diet and lifestyle during the antenatal period has been shown to reduce the rate of many of these complications. The Obesity, Pregnancy and Lifestyle (OPAL) clinic was started at the Northern Hospital in July 2018 to provide specialised antenatal care to women with Class III obesity (BMI ≥ 40 kg/m²).

Methods: We performed a retrospective cohort study of women with a BMI ≥ 40 kg/m² delivering a singleton pregnancy at the Northern Hospital, Melbourne, Victoria, between January 2019 and April 2020, comparing obstetric and neonatal outcomes of women who attended the OPAL clinic (n=60) to those who received standard antenatal care (n=121). Statistical analysis performed using χ², Fisher’s Exact Test, Student’s T-test and Mann-Whitney (rank sum) test with a significance level of 0.05.

Results: Compared to similar women in standard antenatal care, women who attended the OPAL clinic are more likely to be younger (mean age 29 vs 32, p = 0.001), to be primiparous (OR 2.65 (1.33-5.28), p = 0.005) and to be born in Australia or New Zealand (OR 0.47 (0.22-1.03), p = 0.057).

OPAL women also attended a significantly higher number of antenatal appointments (9 vs 8, p=0.017) and had a lower median gestational age of delivery (38.3 vs 38.5, p=0.024).

Conclusions: These results suggest that the OPAL clinic has achieved increased engagement of women with class III obesity in antenatal care. However, significant demographic differences indicate there is a subset of women still not receiving specialist care despite best intentions, indicating clinic processes are in need of review. Future research should focus on the patient experience of women attending the OPAL clinic.

Background

The developed world is facing an obesity epidemic. Consequently, increasing number of women are entering pregnancy with an elevated body mass index (BMI). In Australia, it is estimated that one in five pregnant women are obese, with the proportion of women with severe, class III obesity (BMI ≥ 40 kg/m²) increasing over time (1, 2).

This is particularly true for The Northern Hospital, a non-tertiary Victorian hospital servicing the Northern Growth Corridor of Melbourne, an area of high population growth and significant cultural and socio-economic diversity. Pregnant women attending The Northern Hospital have an increased rate of obesity compared to the general Australian population; of the women who gave birth at The Northern Hospital between 2011 and 2016, 31.6% were overweight (BMI 25-29kg/m²) and 28.3% were obese (BMI ≥ 30), of which 4.8% fell into obese class III (3).

Maternal obesity during pregnancy is well recognised to be associated with many adverse outcomes for both mother and child (4-7). Antenatally, obese women are at an increased risk of gestational diabetes mellitus (GDM), pre-eclampsia (PET), miscarriage, antenatal depression and maternal death (4-8). Intrapartum, these women face elevated rates of birth interventions, in particular caesarean section (CS) and postpartum haemorrhage (PPH), as well as increased anesthetic risks (4-7, 9). Postpartum, obesity is associated increased rates of delayed wound healing, infection, thromboembolic disease and postpartum depression (4-8). Women who are obese before pregnancy are also more likely to have excessive gestational weight gain (GWG) during their pregnancy and are also more likely to maintain this increased weight gain postnatally (7). Elevated maternal BMI also increases the risk of complications for the neonate, including macrosomia, pre-term birth and reduced Apgar score (4-7). Furthermore, pregnant women who are overweight or obese may experience stigma due to their weight which may impact on their experience of healthcare throughout their pregnancy (10).

There is emerging evidence that antenatal lifestyle interventions have the potential to reduce the rate of many of the adverse outcomes associated with obesity in pregnancy (11-16). In particular, dietary and lifestyle interventions have been shown to decrease the incidence of excessive gestational weight gain and gestational diabetes mellitus (12, 13, 15-18).

The Obesity, Pregnancy and Lifestyle (OPAL) clinic was started at the Northern Hospital in July 2018 to address the needs of pregnant women with a BMI of 40 kg/m² or higher (obese class III), as well as women who have had bariatric surgery regardless of BMI (Figure 1). The clinic provides obstetrician-led care with dietitian, midwife and anaesthetic input, as well as structured clinical pathways for assessment of foetal growth, maternal comorbidities and specialist referral when required. It aims to improve the obstetric and neonatal outcomes of these women through targeted attention to diet, gestational weight gain and other lifestyle factors while receiving their antenatal care. The clinic also aims to reduce the stigma felt by obese patients through the provision of care in a non-judgemental environment by health care practitioners who are aware of and sensitive to their needs and experienced in the care of obese patients. In doing so, it hopes to maximise women's engagement with care and behaviour change motivation, as well as enhancing their overall antenatal experience.

This study aims to (i) characterise the current operation of the OPAL clinic, with a particular focus on women's engagement in pregnancy care, and (ii) evaluate its impact on obstetric and neonatal outcomes. Our hypothesis is that women in the OPAL clinic will have increased engagement in care, demonstrated through an increased rate of antenatal attendance, and a reduced rate of adverse outcomes compared to similarly obese women who received standard antenatal care.
Methods

We performed a retrospective cohort study of women with a maternal Body Mass Index (BMI) ≥ 40 kg/m² delivering a singleton pregnancy at The Northern Hospital, Victoria, between 1 January 2019 and 31 April 2020. Data were collected from the hospital’s Birthing Outcome System. Eligible women were divided into two groups based on the stream of antenatal care received: Obesity, Pregnancy and Lifestyle (OPAL) clinic or standard antenatal care. Women with multiple pregnancies, previous bariatric surgery and those who did not receive consistent care from either stream were excluded (figure 2).

Women in the OPAL clinic receive antenatal care from a dedicated obstetrician, midwife and dietician. In order to be accepted for care in the OPAL clinic, women must have a BMI of ≥ 40 kg/m² and be less than 18 weeks gestation. Care is provided based on the Clinical Practice Guidelines for Obesity During Pregnancy, Birth and Postpartum as published in the Department of Health Safer Care Victoria Maternity eHandbook (19). Women are referred to a dietician during the initial assessment and are advised follow up with them at least once each trimester, with increased visits as required. Nutritional advice is provided as per the Australian Guide to Healthy Eating in Pregnancy and is tailored to the individual. General physical activity advice is also provided. The clinic also aims to reduce the experience of weight stigma through a non-judgemental and sensitive approach to care.

Maternal demographic characteristics assessed included: age, weight, BMI, gravidity, parity, indigenous status, country of birth, preferred language and smoking status at any stage of pregnancy. Maternal weight and BMI were recorded at the first antenatal visit. Postcode information was categorised by Victorian Socioeconomic Indexes for Areas (SEIFA) using the Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) (20).

Obstetric outcomes included: number of antenatal visits, gestational weight gain (GWG), gestational diabetes mellitus (GDM), pregnancy-induced hypertension (PIH), pre-eclampsia (PET), induction of labour (IOL), delivery mode (normal vaginal birth, elective caesarean section, emergency caesarean section, instrumental birth (forceps or ventouse), vaginal birth after caesarean (VBAC), vaginal breech), shoulder dystocia, postpartum haemorrhage (PPH) (≥ 500 mL for vaginal births, ≥ 1000 mL for caesarean section) and third or fourth degree perineal tears. GWG was calculated as the change in weight from the first antenatal visit to the date of admission to hospital for delivery if available, otherwise the final recorded antenatal visit.

Neonatal outcomes included: gestational age of delivery, birth status, birthweight, Apgar scores <7 at one and 5 minutes, resuscitation, admission to a special care nursery (SCN) or neonatal intensive care unit (NICU), hypoglycaemia, respiratory distress and feeding type during hospital stay. Stillbirths were included in the analysis of neonatal outcomes.

Statistical analysis was performed using IBM SPSS 25. The level of significance was set at 0.05. Maternal demographic characteristics and maternal and neonatal outcomes were compared using χ², Fisher’s Exact Test (variables with counts <5), Student’s T test (for age variable given normal distribution) and Mann-Whitney (rank sum) test. Multivariable logistic regression was undertaken for mode of delivery controlling for primiparity. Odds ratio (OR) and 95% confidence intervals (CI) were calculated.

This research was approved as a Quality Improvement & Innovation Project by the Northern Health Office of Research (ALR 06.2020). As this study was a retrospective audit that was conducted using data routinely collected as part of clinical care, the need for submission to a Health Human Research Ethics Committee for ethical approval and individual patient consent was waived. All methods were carried out in accordance with relevant guidelines and regulations.

Results

In 2019, 4.2% of women who gave birth at the Northern Hospital were recorded as having a body mass index (BMI) of 40kg/m² or higher at time of booking. Of the 181 women with a BMI ≥ 40 kg/m² that were included in the study, 60 (33%) attended the Obesity, Pregnancy and Lifestyle (OPAL) clinic and 121 (67%) received standard antenatal care at Northern Health.

Maternal Demographics

The demographics of the women attending the OPAL clinic vs standard antenatal care are listed in Table 1.
Table 1  
Maternal Demographics

| Maternal Characteristic          | Total (n=181) | Standard Antenatal Care (n=121) | OPAL (n=60) | P-Value | OR (95% CI) |
|----------------------------------|---------------|---------------------------------|-------------|---------|-------------|
| Mean age, years +/- SD           | 31 +/- 5      | 32 +/- 5                        | 29 +/- 5    | 0.001   |             |
| Age above mean                   | 80 (44.2%)    | 61 (50.4%)                      | 19 (31.7%)  | 0.017   | .456 (.238- .873) |
| Median weight, kg (IQR)          | 117 (110-126) | 117 (110-126)                   | 119 (110-126)| 0.462   |             |
| Median BMI, kg/m² (IQR)          | 43 (41-46)    | 43 (41-45)                      | 43 (41-47)  | 0.122   |             |
| BMI above median                 | 75 (41.4%)    | 49 (40.5%)                      | 26 (43.3%)  | 0.715   | 1.124 (.601-.2102) |
| Median gravida, (IQR)            | 3 (2-4)       | 3 (2-5)                         | 2 (1-3)     | 0.001   |             |
| Median parity, (IQR)             | 1 (0-2)       | 2 (1-2)                         | 1 (0-2)     | 0.001   |             |
| Primiparous                      | 46 (25.4%)    | 23 (19.0%)                      | 23 (38.3%)  | 0.005   | 2.649 (1.328-5.284) |
| Median booking gestational age, weeks (IQR) | 15 (11.4-19.6) | 16.4 (12.4-23.0) | 12.2 (11.3-15.8) | <0.001 |
| Indigenous                       | 3 (1.7%)      | 3 (2.5%)                        | 0 (0%)      | 0.552   |             |
| Born outside AUS/NZ              | 46 (25.4%)    | 36 (29.8%)                      | 10 (16.7%)  | 0.057   | .472 (.216-.1.033) |
| English not preferred language   | 22 (12.2%)    | 17 (14.0%)                      | 5 (8.3%)    | 0.268   | .556 (.195-.5.88) |
| Smoked during pregnancy          | 27 (14.9%)    | 19 (15.7%)                      | 8 (13.3%)   | 0.674   | .826 (.339-.2.013) |
| SEIFA IRSAD quintile             | 0.759         |                                 |             |         |             |
| 1 (lowest)                      | 54 (29.8%)    | 36 (29.8%)                      | 18 (30.0%)  |         |             |
| 2                               | 74 (40.9%)    | 50 (41.3%)                      | 24 (40.0%)  |         |             |
| 3                               | 38 (21.0%)    | 23 (19.0%)                      | 15 (25.0%)  |         |             |
| 4                               | 10 (5.5%)     | 8 (6.6%)                        | 2 (3.3%)    |         |             |
| 5 (highest)                     | 5 (2.8%)      | 4 (3.3%)                        | 1 (1.7%)    |         |             |

Results are presented at n (%) unless otherwise indicated

Significant (p < 0.05) characteristics are indicated in bold text

BMI, body mass index; AUS, Australia; NZ, New Zealand; SEIFA IRSAD, Victorian Socioeconomic Indexes for Areas using the Index of Relative Socioeconomic Advantage and Disadvantage

The median baseline BMI for both groups was 43 kg/m², with no significant difference between them (p = 0.122) (figure 3). There was no significant difference in smoking status or IRSAD score between women in the OPAL clinic and standard antenatal care.

There were however a number of differences in baseline characteristics between the two groups.

Women in the OPAL clinic were significantly more likely to be younger (mean age 29 vs 32, p = 0.001) (figure 4) and to be primiparous (OR 2.65 (1.33-5.28), p = 0.005) (figure 5) compared to women in standard antenatal care.

There was a trend for women in the OPAL clinic towards being less likely to be born outside of Australia or New Zealand (OR 0.47 (0.22-1.03), p = 0.057).

No women identifying as Aboriginal or Torres Strait Islander attended the OPAL clinic, contrasting with three women who received standard antenatal care. Of these three, two were enrolled in the Koori Clinic, a maternity service for Aboriginal and Torres Strait Islander Women, and one was enrolled in the Collaborative Care Clinic due to being unavailable at the time of the OPAL clinic.

**Obstetric Outcomes**

The obstetric outcomes of women attending the OPAL clinic vs standard antenatal care are listed in Table 2.
| Maternal Characteristic | Total  
|-------------------------|-------|
|                         | (n=181)| Standard Antenatal Care  
|                         | (n=121)| OPAL  
|                         | (n=60)| P-Value | OR (95% CI) |
| Median number of antenatal visits (IQR) | 8 (7-10) | 8 (6-10) | 9 (8-10) | 0.017 |
| Number of antenatal visits above median | 83 (46.1%) | 52 (43.4%) | 31 (51.7%) | 0.209 | 1.298 (0.715-2.603) |
| Median GWG, kg (IQR) | 7 (3-10) | 6 (2.3-9.5) | 7.5 (4.5-11.5) | 0.078 |
| GWG above median | 76 (43.2%) | 45 (38.8%) | 31 (51.7%) | 0.102 | 1.687 (0.899-3.164) |
| Excessive GWG | 55 (31.3%) | 40 (34.5%) | 15 (25.0%) | 0.355 |
| <5kg | 69 (39.2%) | 45 (38.8%) | 24 (40.0%) | |
| 5-9.1kg | 52 (29.5%) | 31 (26.7%) | 21 (35.0%) | |
| >9.1kg | 63 (35.6%) | 40 (34.2%) | 23 (38.3%) | 0.586 | 1.197 (0.625-2.282) |
| GDM | 11 (6.1%) | 8 (6.7%) | 3 (5.0%) | 0.754 |
| PIH | 8 (4.4%) | 5 (4.2%) | 3 (5.0%) | 1.000 |
| PET | 86 (47.5%) | 52 (43.0%) | 34 (56.7%) | 0.082 | 1.735 (0.929-3.241) |
| IOL | 0.398 |
| Vaginal | 76 (42.2%) | 50 (41.7%) | 26 (43.3%) | |
| Elective CS | 51 (28.3%) | 37 (30.8%) | 14 (23.3%) | |
| Emergency CS | 41 (22.8%) | 24 (20.0%) | 17 (28.3%) | |
| Instrumental | 10 (5.6%) | 8 (6.7%) | 2 (3.3%) | |
| VBAC | 1 (0.6%) | 1 (0.8%) | 0 (0.0%) | |
| Vaginal breech | 1 (0.6%) | 0 (0.0%) | 1 (1.7%) | |
| Shoulder dystocia | 3 (1.7%) | 3 (2.5%) | 0 (0.0%) | 0.552 |
| PPH | 40 (22.2%) | 25 (20.8%) | 15 (25.0%) | 0.526 | 1.267 (0.609-2.633) |
| Perineal tear (3rd, 4th degree) | 1 (0.5%) | 0 (0.0%) | 1 (1.7%) | 0.331 |

Results are presented at n (%) unless otherwise indicated

Significant (p < 0.05) outcomes are indicated in bold text

GWG, gestational weight gain; GDM, gestational diabetes mellitus; PIH, pregnancy-induced hypertension; PET, pre-eclampsia; IOL, induction of labour; CS, caesarean section; VBAC, vaginal birth after caesarean; PPH, post-partum haemorrhage

The median number of antenatal visits was higher for women attending the OPAL clinic (9) compared to those attending standard antenatal care (8) (p=0.017) (figure 6).

Median gestational weight gain for OPAL women was 7.5kg, compared to 6kg for women in standard antenatal care, however this difference was not statistically significant (p=0.078) (figure 7). Forty percent (n=24) of OPAL women gained weight within the recommended gestational weight gain guidelines for pregnant women with a BMI \( \geq 40 \text{kg/m}^2 \) (5-9.1kg) (figure 8). Twenty-five percent (n=15) women gained less than the recommended weight and thirty-five percent (n=21) gained weight in excess of the recommendation. This is compared to women in standard antenatal care, of whom thirty nine percent (n=45) gained weight within the recommendations, thirty four percent (n=40) gained less, and twenty seven percent (n=31) gained more.

The incidence of gestational diabetes mellitus (GDM) was similar across the two groups, with thirty-eight percent (n=23) of OPAL women and thirty-four percent (n=40) of women in standard antenatal care diagnosed with GDM during their pregnancy (OR 1.2 (0.625-2.282) p=0.586).

Fifty-seven percent (n=34) of OPAL women underwent induction of labour (IOL), compared to forty-three percent (n=52) of women in standard antenatal care. This difference was not statistically significant (p=0.082).

The most common mode of delivery for both women in the OPAL clinic and standard antenatal care was via caesarean section, with fifty-two percent (n=31) of OPAL women and fifty-one percent (n=61) of women in standard antenatal care delivering via either elective or emergency caesarean section.
Of these, twenty-three percent (n=14) were elective and twenty-eight percent (n=17) emergency for OPAL women, compared to thirty-one percent (n=37) elective and twenty percent (n=24) emergency for women who received standard antenatal care.

There was a trend towards a reduction in the rate of instrumental deliveries for OPAL women, with three percent (n=2) of OPAL women having instrumental deliveries compared to seven percent (n=8) in standard antenatal care. The differences in mode of delivery between the two groups was not statistically significant (p=0.398), even when corrected for primiparity (Table 3).

Table 3
Multivariate Analysis of Mode of Delivery, compared to Vaginal Delivery

|                          | P-value | OR (95% CI)         |
|--------------------------|---------|---------------------|
| Elective CS              | 0.761   | 1.133 (0.508-2.524) |
| Emergency CS             | 0.911   | 0.954 (0.416-2.187) |
| Instrumental delivery    | 0.134   | 3.678 (0.669-20.215)|

Results presented as adjusted odds ratio (95% CI). Adjusted for primiparity. Statistical significance (P < 0.05 indicated in bold text. Vaginal birth after caesarean and vaginal breech excluded due to low numbers.

CS, caesarean section.

There were zero cases of shoulder dystocia for OPAL women, compared to three cases (2.5%) in standard antenatal care (p=0.552).

There were no significant differences in other obstetric outcomes between the two groups, including incidence of pregnancy-induced hypertension, pre-eclampsia, post-partum hemorrhage and 3rd or 4th degree perineal tears (Table 2).

**Neonatal Outcomes**

The neonatal outcomes of women attending the OPAL clinic vs standard antenatal care are listed in Table 4.
Table 4
Neonatal Outcomes

| Outcome                                      | Total (n=181) | Standard Antenatal Care (n=121) | OPAL (n=60) | p-Value | OR (95% CI) |
|----------------------------------------------|---------------|---------------------------------|-------------|---------|-------------|
| Median gestational age of delivery, weeks   |               |                                 |             |         |             |
| (IQR)                                        | 38.4 (37.6-39.2) | 38.5 (37.6-39.3)               | 38.3 (37.6-38.5) | 0.024   |             |
| Gestational age of delivery above median     |               |                                 |             |         |             |
|                                               | 81 (44.8%)    | 63 (52.1%)                      | 18 (30.0%)  | 0.005   | 0.395 (.024-.761) |
| Prematurity, weeks                           |               |                                 |             | 0.021   |             |
| Term (37.0-41.3)                             | 163 (90.6%)   | 108 (90.0%)                     | 55 (91.7%)  |         |             |
| Late pre-term (32.0-36.6)                    | 14 (7.8%)     | 12 (10.0%)                      | 2 (3.3%)    |         |             |
| Early pre-term (<32.0)                       | 2 (1.1%)      | 0 (0.0%)                        | 2 (3.3%)    |         |             |
| Post-dates (>41.3)                           | 1 (0.6%)      | 0 (0.0%)                        | 1 (1.7%)    |         |             |
| Preterm                                      | 16 (8.9%)     | 12 (10.0%)                      | 4 (6.8%)    | 0.585   | 0.655 (.202-2.124) |
| Miscarriage /stillbirth                      | 2 (1.1%)      | 1 (0.8%)                        | 1 (1.7%)    | 0.611   | 2.034 (125-33.090) |
| Median birthweight, grams (g) (IQR)         | 3450 (3125-3790) | 3460 (3155-3785)       | 3405 (3050-3810) | 0.558   |             |
| Apgar score <7 at 1 min                      |               |                                 |             |         |             |
|                                               | 20 (11.1%)    | 14 (11.7%)                      | 6 (10.0%)   | 0.737   |             |
|                                               | 5 (2.8%)      | 3 (2.5%)                        | 2 (3.3%)    | 1.000   |             |
| Neonatal resuscitation                       | 101 (55.8%)   | 69 (57.0%)                      | 32 (53.3%)  | 0.638   |             |
| Admission to NICU/SCN                        | 34 (18.9%)    | 22 (18.3%)                      | 12 (20.0%)  | 0.788   |             |
| Neonatal hypoglycaemia                       | 12 (6.7%)     | 6 (5.0%)                        | 6 (10.0%)   | 0.205   |             |
| Neonatal respiratory distress                | 8 (4.4%)      | 5 (4.2%)                        | 3 (5.0%)    | 1.000   |             |
| Feeding during hospital admission            |               |                                 |             | 0.400   |             |
| Exclusive breastmilk                         | 90 (50.3%)    | 64 (53.3%)                      | 26 (44.1%)  |         |             |
| Exclusive formula                            | 25 (14.0%)    | 17 (14.2%)                      | 8 (13.6%)   |         |             |
| Breastmilk & formula                         | 58 (32.4%)    | 34 (28.3%)                      | 24 (40.7%)  |         |             |
| Attempted breastmilk then suppressed         | 6 (3.4%)      | 5 (4.2%)                        | 1 (1.7%)    |         |             |

Results are presented at n (%) unless otherwise indicated

Significant (p < 0.05) outcomes are indicated in bold text

NICU, neonatal intensive care unit; SCN, special care nursery

The median gestational age of delivery was lower for OPAL women (38.3 weeks) compared to standard antenatal care (38.5 weeks) (p=0.024) (figure 10).

There was an overall trend towards significance of reduced rate of prematurity when comparing OPAL women to standard antenatal care (p=0.021) (figure 11). Overall, seven percent (n=4) of OPAL woman and ten percent (n=12) of women who received standard antenatal care experienced pre-term birth (p=0.585). The incidence of late pre-term birth was higher for women in standard antenatal care, with ten percent (n=12) women delivering between 32.0 to 36.6 weeks compared to three percent (n=2) in the OPAL clinic.

There was one incidence of stillbirth for standard antenatal care and one miscarriage for the OPAL clinic.

Median birthweight was 3405g for OPAL women and 3460g for women in standard antenatal care, with no significant difference between the two groups (p=0.558).

There were no significant differences in other neonatal outcomes between the two groups, including Apgar score <7 at 1 minute and 5 minutes, neonatal resuscitation, neonatal respiratory distress and feeding during hospital admission (Table 4).
Discussion

Our study is the first Victorian-based analysis of a specialised antenatal clinic for women with Class III obesity in a non-tertiary hospital. Our study demonstrates the demographic differences between women with a body mass index (BMI) of 40 kg/m² who attended the Obesity, Pregnancy and Lifestyle (OPAL) clinic to those who received standard antenatal care at Northern Health. It also describes the level of antenatal attention received by the two groups, as well as the rates of obstetric and neonatal outcomes.

In line with previous studies of the population of pregnant women attending Northern Health, our study demonstrates that women with an elevated BMI experience a high degree of obstetric and neonatal complications, as well as an increased rate of birth interventions (3). This is also consistent with the broader literature describing the risks associated with maternal obesity in pregnancy.

Our study reveals that there are significant demographic differences between the population of women enrolled in the OPAL clinic compared to those receiving standard antenatal care. OPAL women are more likely to be younger, to be primiparous and to be born in Australia or New Zealand. The reason for these demographic differences is not currently clear, however we can speculate that this may be because women who are younger, primiparous and Australian or NZ-born are more likely to be health conscious and therefore more willing to engage in specialist care through the OPAL clinic. Conversely, procedures during booking in may be leading to these women being selectively targeted for care through the OPAL clinic. What this does clearly demonstrate is that cultural background has an impact on the way women engage with health care during their pregnancy, and that this needs to be taken into account in the design and recruitment processes of pregnancy care services.

Notably, the OPAL clinic also recruited no women of an Aboriginal or Torres Strait Islander background. However, this is most likely because there is a culturally safe service that already exists in the Koori Maternity Clinic to service the needs of Aboriginal and Torres Strait Islander women, as opposed to these women not being engaged in antenatal care.

Our study demonstrates an increase in antenatal attention provided by the OPAL clinic. On average, women in the OPAL clinic attended significantly more antenatal appointments than women in standard antenatal care. This may indicate that the OPAL clinic was able to achieve a greater engagement in antenatal care. A key factor in this may enhanced continuity of care through consistency in the health care provider. Women in the OPAL clinic were seen by the same dedicated clinic obstetrician and midwife, compared to those in standard care who did not necessarily have this same consistency. Continuity of midwife care has been shown to be an important factor in increasing maternal satisfaction with antenatal care in low risk pregnancies (21), however there is limited research into the application of this practice into high risk pregnancies such as those complicated by maternal obesity. An obesity-sensitive approach by the health care providers in the OPAL clinic may have also contributed to increased engagement in care. The OPAL clinic offers an opportunity for women with high risk pregnancies and a risk of stigma who may not have access to private care to have an enhanced antenatal care experience.

Our study demonstrates the women in the OPAL clinic had a lower gestational age of delivery compared to women in standard antenatal care (38.3 weeks vs 38.5 weeks). However, there was no difference in the rate of pre-term deliveries between the two groups. Due to the complications associated with obesity during pregnancy, including increased rates of gestational diabetes mellitus, macrosomia, pre-eclampsia and stillbirth, timing of delivery is often planned, either via induction of labour or elective caesarean section (19). Safer Care Victoria guidelines recommend that delivery for women with a BMI ≥ 50 kg/m² occur at 38-39 weeks. The earlier gestational age of delivery may reflect an increased level of surveillance during antenatal care through the OPAL clinic and thus planned timing of delivery.

We were not able to demonstrate a reduction in excessive gestational weight gain for women in the OPAL clinic compared to standard antenatal care. This may be because women in standard antenatal care were more likely to present for antenatal care for the first time later in their pregnancy (median gestational age of booking 12.2 weeks vs 16.4 weeks) due to the selection criteria of the OPAL clinic requiring booking in to occur prior to 18 weeks gestation. This may have led to initial weight measured being higher as it occurred later in the pregnancy, therefore leading to a lower gestational weight gain calculation. Furthermore, maternal weight at term was not recorded for many women, forcing us to rely on the final maternal weight recorded at an antenatal visit. This inconsistency in recording may have impacted on the accuracy of our calculation.

At this stage, our study is not able to demonstrate an improvement in obstetric and neonatal outcomes through the OPAL clinic. Currently numbers are too small to demonstrate changes in outcomes between the two groups, especially for rarer obstetric and neonatal outcomes. However, there is a trend towards a reduction in late preterm births, fewer instrumental deliveries and a reduced rate of shoulder dystocia. Further follow up is required to investigate these outcomes.

The lack of improvement in obstetric and neonatal outcomes is not entirely surprising as results from other studies have been mixed, showing inconsistent or minimal improvements in outcomes with antenatal dietary and lifestyle interventions. A Cochrane systematic review revealed limited impact of diet and/or exercise intervention on many obstetric and all neonatal outcomes (13). There are a number of barriers for dietary and lifestyle interventions during pregnancy, including physiological changes such as nausea and cravings, a short period of intervention (especially before diagnosis of GDM) and concerns over foetal growth with high intensity interventions (22).

Limitations
As this study was conducted retrospectively, there was a reliance on patient records which were not always complete. In particular, not all women had a recorded maternal weight at term, meaning that there was inconsistency in the precise gestation of the final maternal weight and therefore the calculation of gestational weight gain.

Given the non-randomised design of the study as we were investigating a clinic that was currently functioning outside the scope of a clinic trial, there were significant demographic differences between women in the OPAL clinic and those in standard antenatal care. This impacts on our ability to compare outcomes between the two groups. However, this demographic difference highlights the way in which the clinic is currently functioning, revealing that a particular subset of obese women are being targeted by the clinic through their own desires or the recruitment process.

The OPAL clinic was started in July 2018. This limits the number of participants we were able to include in this study. This limitation in sample size impacts on our ability to assess any changes in rarer obstetric and neonatal outcomes.

Finally, although women in the OPAL clinic were provided with specific dietary and lifestyle advice, this study did not measure the level of behaviour change inspired by this advice compared to antenatal care. This means we are unable to tell whether any change in outcomes was due to ineffective measures or failure to implement said measures.

**Implications for future practice, policy and future research**

This study is among the first to investigate the impact of an obesity-specific antenatal clinic in a Victorian hospital. The information may assist in the ongoing development and expansion of the OPAL clinic and influence pregnancy care for obese woman more broadly.

Considering the demographic differences between women enrolled in the OPAL clinic and those receiving standard antenatal care, further investigation into the reason why this is the case is important in order to ensure we are providing culturally safe care to all women and offering specialised care in an equitable and unbiased way. Specifically, focusing on the engagement of women from diverse cultural backgrounds is a priority, especially given the diverse population serviced by Northern Health.

OPAL women had extra antenatal attention, on average having one extra clinic appointment during their antenatal period. This may be due to better engagement in antenatal care. This is especially important for women who have an elevated BMI as they may experience stigma and discussion and measurement of weight can be a sensitive issue. Future research should focus on the experience of women who have attended the OPAL clinic and how it compares to standard antenatal care and their other experiences in the healthcare system.

Given these promising findings, the OPAL clinic should be expanded to increase its capacity to provide specialised and sensitive antenatal care to women with class III obesity.

**Conclusions**

Obesity in pregnancy is an important health care issue for maternity health care providers. The Obesity, Pregnancy and Lifestyle (OPAL) Clinic aims to provide women with an elevated body mass index (body mass index) with a specialised antenatal care pathway that supports and engages mothers, encourages healthy lifestyle behaviours and ultimately improves pregnancy outcomes for this high-risk cohort.

This is the first study to analyse a specialised antenatal clinic for women with Class III obesity in Victoria, Australia. Despite not yet demonstrating a measurable improvement in obstetric and neonatal outcomes, this evaluation of the OPAL clinic has revealed a number of important findings.

Firstly, the OPAL clinic is attracting a subset of obese pregnant women who are, on average, younger, primiparous and of an Australian or New Zealand background. This indicates that a woman's baseline characteristics, in particular her cultural background, impact on the way in which she interacts with antenatal health care services. Consequently, maternity health care providers need to ensure they are delivering care in a manner that is both equitable and culturally safe. This is especially pertinent for Northern Health, which services a population with significant cultural diversity. How best to deliver culturally safe maternity services and thus improve engagement in care for women of diverse cultural backgrounds is worthy of future research.

Secondly, women in the OPAL clinic had on average one more antenatal appointment than those in standard care, indicating that they received extra antenatal attention. This suggests that women in the OPAL clinic have greater engagement in their antenatal care. This is important because women with an elevated BMI are both at an increased risk of complications and are more likely to feel stigmatised in a health care setting. Future research should focus on the experience of women in the OPAL clinic to reinforce and further explore these findings.

**Abbreviations**
| Acronym | Description |
|---------|-------------|
| BMI     | Body Mass Index |
| CS      | Caesarean section |
| GDM     | Gestational diabetes mellitus |
| GWG     | Gestational weight gain |
| IOL     | Induction of labour |
| IRSAD   | Index of Relative Socioeconomic Advantage and Disadvantage |
| NICU    | Neonatal intensive care unit |
| OPAL clinic | Obesity, Pregnancy and Lifestyle clinic |
| PET     | Pre-eclampsia |
| PIH     | Pregnancy-induced hypertension |
| PPH     | Postpartum haemorrhage |
| SCN     | Special care nursery |
| SEIFA   | Socioeconomic Indexes for Areas |
| VBAC    | Vaginal birth after caesarean |

**Declarations**

**Ethics approval and consent to participate:**

This project was assessed by the Northern Health Office of Research (NHOR), which contains the governing institutional ethics review committee for negligible and low-risk ethics approvals conducted solely at Northern Health. NHOR determined that this work does not raise any ethical concerns and does not fall within the category of a ‘research’ project within the National Statement on Ethical Conduct in Human Research (NHMRC, 2007). This project does not require submission to a Health Human Research Ethics Committee for ethical approval. In addition, this Quality Improvement & Innovation project can be described as an activity to monitor, improve and evaluate the quality of health services provided by Northern Health (approval number ALR 06.2020). As such, informed consent was not required for this study.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare they have no competing interests.

**Funding**

Not applicable.

**Authors’ contributions**

VR was responsible for project conceptualisation and supervision. AM provided access to and aided in the collection of data. RS performed data collection, data analysis and report writing. All authors read and approved the final manuscript.

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Figures
Figure 1

Booking in processes for the Obesity, Pregnancy and Lifestyle (OPAL) Clinic

Figure 2

Method of selection of study participants. Exclusion criteria included women with a BMI < 40kg/m2, multiple pregnancy, previous bariatric surgery or inconsistent/undocumented antenatal care model.
Figure 3

Body Mass Index (BMI) at booking in of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care

Figure 4

Age of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care
Figure 5
Parity of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care

Figure 6
Number of antenatal visits of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care
Figure 7

Gestational weight gain (GWG) of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care

Figure 8

Gestational weight gain of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care. Weight gain target for women with BMI $\geq 40$kg/m$^2$ during pregnancy is 5-9.1kg.
Figure 9
Mode of delivery of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care.

Figure 10
Gestational age at delivery of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care. Stillbirth/miscarriages excluded.
Figure 11

Gestational age at delivery by category of women enrolled into Obesity Pregnancy and Lifestyle (OPAL) Clinic vs Standard Antenatal Care.