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Impact of inter-pregnancy BMI change on perinatal outcomes: a retrospective cohort study

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ABSTRACT

Objective: To examine the patterns and predictors of inter-pregnancy body mass index (BMI) change and its impact on perinatal outcomes in the second pregnancy.
Design: Retrospective cohort study.
Setting: Tertiary teaching hospital in Adelaide, Australia.
Population: Women with their first and second consecutive, singleton deliveries occurring between 2000 and 2012 ($N = 5371$).
Methods: Inter-pregnancy weight change calculated based on difference between BMI at respective antenatal booking visits. Association between inter-pregnancy weight change and perinatal outcomes investigated using multivariate generalised linear models, with stratification according to initial maternal BMI category in first pregnancy.
Main outcome measures: Gestational diabetes (GDM); pregnancy induced hypertensive disorders; small-for-gestational age (SGA); preterm birth; large-for-gestational age (LGA) and macrosomia (>4500 g).
Results: On average, women with a normal BMI gained 1 kg/m^2 between first and second pregnancies, while women who were overweight or obese gained 1.37 kg/m^2. Among women with a normal BMI in their first pregnancy, a BMI increase of ≥4 kg/m^2 was associated with increased risk of developing GDM (aRR 1.97; 95% CI 1.22–3.19), a macrosomic (aRR 4.06; 95% CI 2.25–7.34) or LGA infant (aRR 1.31 0.96–1.78) in the second pregnancy, while a reduction in BMI (≤−2 kg/m^2) was associated with an increased risk of SGA (aRR 1.94; 1.19–3.16). Among women who were overweight or obese in their first pregnancy, a BMI increase of ≥2–4 and ≥4 kg/m^2 was associated with increased risks of developing GDM in the second pregnancy (aRR 1.39; 95% CI 1.01–1.91 and aRR 1.64 95% CI 1.16–2.31; $p_{trend} < 0.001$), while no associations were observed for a BMI increase and risk of a macrosomic, SGA, or LGA infant. In contrast, reduction in BMI (≤−2 kg/m^2) was associated with a reduced risk of GDM (aRR 0.58 95% CI 0.37–0.90) and SGA (aRR 0.47; 95% CI 0.25–0.87).
Conclusion: Increases in BMI between pregnancies is associated with an increased risk for perinatal complications, even in normal-weight women, while a reduction in BMI is associated with improved perinatal outcomes among women who are overweight/obese. Inter-pregnancy weight control is an important target to reduce the risk of an adverse perinatal outcome in a subsequent pregnancy.

Introduction

Obesity is a growing problem worldwide with significant morbidity and public health consequences. In 2008, 56% of Australian women over 20 years old were overweight or obese [1] and 26.2% and 23.8% of pregnant South Australian women were overweight or obese at their 10 week booking visit, respectively [2].

It is well established that entering pregnancy with a high BMI is associated with numerous complications, including hypertensive disorders of pregnancy, thromboembolic disorders, infection, caesarean section and stillbirth [2–10]. Furthermore, infants born to overweight and obese women are more likely to be macrosomic, diagnosed with a congenital anomaly or require neonatal intensive care [2–10].

Villamor and Cnattingius demonstrated in 2006 that increasing weight gain between first and second pregnancies increased the

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likelihood of developing gestational diabetes (aOR 2.09 (1.68–2.61) per >3 BMI unit increase) and preeclampsia (aOR 1.78 (1.52–2.08) per >3 BMI unit increase), in Swedish women of any initial BMI category. A sub analysis of women with a normal booking BMI $<25\ kg/m^2$ demonstrated that the risk of adverse perinatal outcomes increased with significant weight gain, even if the weight gain did not cause the woman to become overweight [11], i.e. women who may have gained more than 3 BMI units but still remained within the normal weight category ($\leq 25\ kg/m^2$).

Subsequently, multiple studies have investigated the effect of inter-pregnancy weight change on the risk of maternal and neonatal complications in Europe and the United States [12–19]. Previous findings have been inconsistent, but generally showed that inter-pregnancy weight gain in women of normal BMI in their first pregnancy was associated with adverse perinatal outcomes in the second pregnancy. To date, there are limited studies specifically examining the impact of BMI loss between pregnancies, which could be expected to have a protective effect on subsequent perinatal outcomes among women who are overweight or obese in their first pregnancy. Children born to women following anti-obesity surgery enjoy a significant reduction in severe obesity, insulin resistance and cardiometabolic markers, when compared to those born prior to maternal surgery, which is sustained into adolescence. This suggests that a benefit is most likely conferred, and suggests that these benefits may extend far beyond the neonatal period [20].

Therefore, the purpose of this study is to investigate patterns and predictors of weight change between pregnancies in a contemporary Australian cohort, and the impact of such changes on subsequent perinatal outcomes in the second pregnancy.

Methods

We conducted a retrospective cohort study utilising routinely collected data on all births occurring in the Women's and Children's Health Network (WCHN) in South Australia, Australia. The project was approved by the Human Research Ethics Committees of the Women's and Children's Health Network and the University of Adelaide in South Australia (ID REC2219/10/14).

All women who had their first two consecutive singleton births between January 2000 and December 2012 at the Women's and Children's Hospital (WCH) in Adelaide, South Australia were included ($N = 8368$). Women were excluded if their BMI was not recorded during either pregnancy ($N = 2596$), and if their BMI was $<18.5\ kg/m^2$ during their first pregnancy ($N = 218$). Outliers were assessed and 183 women were excluded with a height difference of >5 cm between pregnancies, leaving a final cohort of 5371 women. Weight was not routinely recorded at time of delivery, and subsequently, the effect of gestational weight gain was not investigated.

Outcomes were based on data routinely collected and recorded in the WCH Perinatal Statistics Collection. Data is collected on the pregnancy and outcome of every live birth and late fetal death occurring at the WCH. Data are collected according to the guidelines of the Pregnancy Outcome Unit of the South Australian Department of Health for the Supplementary Birth Records (SBRs) and in consultation with the senior clinicians at the hospital. Data collection began in the late 1980s and complete, validated data are available from 1990 onwards. Data are collected by a specially trained research midwife from the women's medical records following delivery through use of a structured coding sheet. It is important to note that included in the medical record is the South Australian Pregnancy Record (SAPR), which is a hand-held antenatal record carried by each woman throughout her pregnancy and contains notes by all health providers consulted during the pregnancy. From the medical records, information is collected on maternal illnesses (e.g. diabetes, gestational diabetes, epilepsy, asthma and psychiatric illness), lifestyle factors (e.g. smoking), obstetric history, course of delivery, pregnancy complications and newborn characteristics (e.g. birth weight). Inter-pregnancy interval was calculated from delivery to conception. All SBRs are checked manually for completeness and data discrepancies and then go through a series of automated validation procedures during data entry. The information in the perinatal statistics collection has been previously validated and has been shown to be very reliable when compared with hospital medical records [21], and has been utilised in previous studies examining perinatal outcomes [22–24].

Weight change was measured in terms of BMI units between the booking visit of the first and second pregnancy, women who had their first antenatal visit after 15 weeks gestation did not have a booking weight recorded.

Baseline characteristics and determinants of inter-pregnancy weight gain were assessed. Outcomes included were gestational diabetes (diagnosis as marked on data collection sheet, OGTTs not); pregnancy induced hypertensive disorders (diagnosis as marked on data collection sheet: preeclampsia, gestational hypertension, chronic hypertension, superimposed preeclampsia) small-for-gestational age (SGA – <10th centile customised for maternal height, weight, fetal sex, gestation and ethnicity); large-for-gestational age (LGA – >10th centile customised for maternal height, weight, gestation and ethnicity), macrosomia >4500 g, and preterm birth.

Women were grouped according to the world health organisation (WHO) BMI classifications; normal weight $18.5–25\ kg/m^2$, overweight $25–30\ kg/m^2$ obese $>30\ kg/m^2$. We hypothesised that weight change might behave physiologically differently when occurring in a woman who was already overweight, with a possible different magnitude of effect on GDM, hypertensive disorders of pregnancy and birthweight, as she moves either closer to or further away from the healthy weight range. Thus, overweight and obese women were analysed separately to women of normal BMI (Fig. 1).

Statistical analysis

Baseline characteristics and determinants of inter-pregnancy BMI change were assessed using a Kruskal–Wallis test. The impact of BMI change between pregnancies on subsequent perinatal outcomes in the second pregnancy were compared using a generalised linear model (Poisson distribution) with robust variance estimates, with resulting relative risks (RR) and 95% confidence intervals (CIs). Inter-pregnancy BMI change was

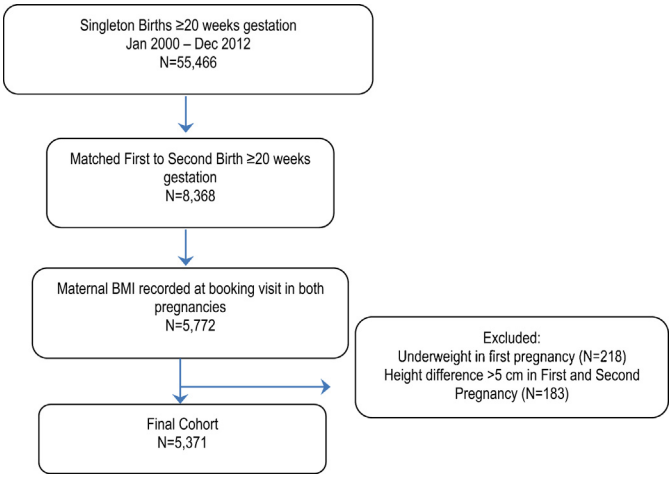

Fig. 1. Participant flow diagram.