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Pre-pregnancy weight change and incidence of gestational diabetes mellitus: A finding from a prospective cohort study

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ABSTRACT

Aims: In a population-based cohort study we examined the associations between early adult pre-pregnancy weight change and the risk of gestational diabetes mellitus (GDM).
Methods: The study included 3111 women from the 1973–78 cohort of the Australian Longitudinal Study on Women's Health. These women have been surveyed regularly since 1996. Women without diabetes and GDM were followed-up between 2003 and 2012. Generalized estimating equations were used to assess the effect of baseline (1996, mean age 20 years) and pre-pregnancy body mass index (BMI) and the pre-pregnancy weight changes on the incidence of GDM. The full models were adjusted for sociodemographic and lifestyle factors.
Results: From 2003 to 2012, 229 GDM cases (4.4%) were reported in 5242 pregnancies. Relative to normal BMI women, obese women at baseline (RR: 1.8, 95% CI: 1.1, 2.8) and prior to pregnancy (RR: 2.7, 95% CI: 2.0, 3.6) were at greater risk of GDM. Weight gains prior to each study pregnancy were strongly associated with increased GDM risk with an adjusted RR ranging from 2.0 to 2.9. Within under/normal range of BMI, women with a moderate/high (>2.5%/year) weight gain had 2.7 (95% CI: 1.3, 5.5) times the risk of GDM compared with women with stable weight.
Conclusions: Early adult weight gain, even within normal BMI range, is an important risk factor for the development of GDM. Weight gain prevention from early adulthood to prior to pregnancy appears to be the main strategy to prevent the incidence of GDM.

1. Introduction

Gestational diabetes mellitus (GDM), a state of impaired glucose tolerance recognised for the first time in pregnancy, is one of the most frequent pregnancy complications associated with higher maternal and perinatal adverse outcomes [1]. The prevalence is increasing mainly as a result of the rising proportion of women with pre-pregnancy obesity, sedentary lifestyles and advanced maternal age at birth [2,3]. Women with GDM are more likely to develop type 2 diabetes in later life compared to women without GDM [4].

The cross sectional association between body mass index (BMI) and GDM is well established [5]. Although evidence of a causal relationship is scarce, in a meta-analysis of

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observational studies, the risk of development of GDM ranged from a two- to fivefold increase for women who were overweight and severely obese prior to pregnancy, respectively [6]. A number of studies [7–10] have also showed that weight gain over the life course has substantial effect on the development of diabetes and other cardiovascular risks in non-pregnant women and men. However, there are only a few studies [11,12] of the relationship between early adult pre-pregnancy weight change and the risk of GDM.

In the life course, young adults (20–29 years of age) are at higher risk of increased weight gain [13]. Changes in the early adult pre-pregnancy weight over the reproductive years of the life course may have more important effect than the immediate pre-pregnancy weight. The women who develop GDM have been shown to have had nearly a twofold rate of weight gain prior to pregnancy than non GDM women [11]. Even in a normal range of BMI, a pre-pregnancy weight gain has been associated with an elevated risk of GDM [12,14]. Weight gain/retention between consecutive pregnancies has also been found to be linked with the increased risk of GDM [14,15]. However, the existing scarce studies were limited to nursing professional mothers whose childhood body shape and weight (at 18 years) were reported retrospectively and subsequent adult weights were collected over a short interval [12]. The other studies collected weight trajectories in a single retrospective interview [11] or measured only inter-pregnancy weight change [14,15] rather than over the reproductive course of life. These studies were further limited to clinical populations and lacked adjustment for potential confounders such as diet, and physical activity, a fact acknowledged by the authors [11].

We therefore primarily aimed to examine whether the changes in early adult pre-pregnancy weight from baseline (1996, 18–23 years of age) to 25–30 years of age (2003) and to each study pregnancy (with children born between 2003 and 2012) are associated with the development of GDM using data from a broadly representative population-based cohort study of Australian women. As a secondary objective, we investigated the effect of early adult pre-pregnancy weight change on the subsequent risk of GDM in women within different BMI categories.

2. Subjects, materials and methods

2.1. Data source and participants

The Australian Longitudinal Study on Women's Health (ALSWH) is an ongoing large longitudinal population-based study examining the health of over 58,000 Australian women. In 1996, three cohorts of women born in 1973–78 ('young', aged 18–23 at baseline), 1946–51 ('mid-age', aged 45–50 at baseline), and 1921–26 ('older', aged 70–75 at baseline) were randomly selected from the national Medicare health insurance database, which includes all Australian citizens and permanent residents. Random samples were drawn within each age group with oversampling of women in the rural and remote areas to ensure ongoing sufficient power for statistical comparisons of the circumstances and health of city and country women. ALSWH collects self-reported data using mailed or online surveys for each cohort about every three years on a rolling basis. Further details of ALSWH are available elsewhere [16]. Informed consent was obtained from all participants at each survey, with ethical clearance obtained from the Human Research Ethics Committees of the University of Newcastle and the University of Queensland.

This study used data from the young (born in 1973–78) cohort. All women who completed the baseline survey (Survey 1 [S1]) in 1996 (n = 14,427) were eligible for this study. Further, as inclusion criteria, these women needed to have responded to Survey 2 (S2) and Survey 3 (S3) as well as having given birth at least once between S3 and Survey 6 (S6). However, a substantial number of women did not respond to S2 or S3 (n = 4606) and another 4596 women did not report the birth of a child between S3 and S6. Women who were pregnant at S1 (n = 65), S2 (n = 192) and S3 (n = 456) were also excluded as pre-pregnancy weight was not available in earlier surveys. Further details are displayed in Fig. 1.

2.2. BMI and weight change

In this study, early adult baseline and pre-pregnancy BMI as well as weight changes (between subsequent surveys: S1–S2; S2–S3; and S1 to each study pregnancy) were the primary exposures of interest. Self-reported height and weight at S1 were used to calculate baseline BMI and those reported in a survey prior to each study pregnancy were used to calculate the pre-pregnancy BMI, and were categorised as underweight (<18.5), normal (18.50–24.99), overweight (25.00–29.99) and obese ($\geqslant$30) [17].

Weight change between S1 and S2 was denoted as S2–S1 weight and for weight change between S2 and S3 it was denoted as S3–S2 weight. Weight change from S1 to each study pregnancy was calculated as the difference between weight prior to each study pregnancy and S1 weight.

Further, the annual weight change was calculated by subtracting self-reported weight at successive surveys and dividing by weight at the earlier survey and the number of years between the surveys (S1 and S2 were 4 years apart, S2 and S3 were 3 years apart, whereas S1 and study pregnancies were on average 7 [for those born between S3 and Survey 4 (S4); S1–S3], 10 [for those born between S4 and Survey 5 (S5); S1–S4], and 13 [for those born between S5 and S6; S1–S5] years apart). The annual weight change was categorised as high (>5%), moderate (>2.5–5%), small (>1.5–2.5%) loss; stable (loss or gain of up to 1.5%); small (>1.5–2.5%), moderate (>2.5–5%), or high (>5%) gain [18]. However, very few women had high or moderate weight loss and these were collapsed to a single category representing 'loss' (>1.50%).

2.3. Ascertainment of GDM

The diagnosis of GDM was self-reported. In S4, GDM was obtained from the following question "In the last 3 years, have you been diagnosed or treated for gestational diabetes (yes/no)?", whereas in S5 and S6 GDM was obtained for each live birth from the following single question; "were you diagnosed or treated for gestational diabetes?" In this study, women who had history of GDM up to S3 were excluded. Incidence of GDM was defined as new cases between 2003 (S3) and 2012 (S6).