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Maternal pre-pregnancy body mass index, gestational weight gain influence birth weight

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ABSTRACT

Background: Evidence suggests that pre-pregnancy body mass index and gestational weight gain have impact on pregnancy and birth weight, yet whether maternal gestational weight gain has a differential effect on the rates of adverse birth weight among women with different pre-pregnancy body mass index categories are unknown.
Methods: We selected 1617 children matched with their mothers as study subjects. The subjects were divided into three categories: weight gain below the American Institute of Medicine guidelines, weight gain within the American Institute of Medicine guidelines and weight gain above the American Institute of Medicine guidelines.
Results: The prevalence of pre-pregnancy underweight and overweight/obese women was 16.3% and 12.3%. And nearly 15.2% of the women had gestational weight gain below American Institute of Medicine guideline, 52.1% of the women had gestational weight gain above American Institute of Medicine guideline. Maternal overweight and obese was associated with increased risk for macrosomia and large-for-gestational age. Women had gestational weight gain below American Institute of Medicine guideline were more likely to have low birth weight and small-for-gestational age than women who had gestational weight gain within American Institute of Medicine guideline. Furthermore, the risks for macrosomia and large-for-gestational age were increased in women with above American Institute of Medicine guideline. And for women with a normal weight before pregnancy, gestational weight gain above the American Institute of Medicine guidelines were associated with higher rates of macrosomia and large-for-gestational age, compared with the women of similar pre-pregnancy weight category but with gestational weight gain within the American Institute of Medicine guidelines.
Conclusions: Women with abnormal pre-pregnancy body mass index and gestational weight gain are at risk for adverse birth weight outcomes. Moreover, gestational weight gain has a differential effect on the rates of adverse birth weight outcomes between women of different pre-pregnancy body mass index categories.

Statement of significance

Problem or issue

Whether maternal gestational weight gain has a differential effect on the rates of adverse birth weight among women with different pre-pregnancy BMI categories are unknown.

What is already know

Pre-pregnancy weight and gestational weight gain outside of the normal range are associated with increased risks for adverse birth weight.

What this paper adds

For women with a normal weight before pregnancy, gestational weight gain above the American Institute of Medicine guidelines were associated with higher rates of macrosomia and large-for-gestational age, compared with the women of similar pre-pregnancy weight category but with gestational weight gain within the American Institute of Medicine guidelines.

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1. Introduction

Overweight and obesity is a worldwide epidemic problem and the prevalence of obese women in childbearing age have shown the trend of rising.[1] From 1980 to 2013, the world prevalence of overweight or obese women increased from 29.8% to 38.0%.[2] Obesity among American women increased from 24.8% in 1999 to 28.3% in 2008,[3] and almost 48% of the childbearing age women are overweight or obese now.[4] Almost 33% of pregnant women were overweight or obese in the United Kingdom,[5] and 10%–24% of pregnant women were overweight or obese in China.[6,7] On the other hand, the phenomena of underweight is also common with almost 11%–13% of women in China were underweight.[6,7]

Many studies have found that intrauterine environment changes during pregnancy can cause a wide range of damage to the offspring.[8,9,11–15] Too little gestational weight gain increased risks of low birth weight and preterm birth,[8,9] and the latter disorder was ranked the seventh in the leading causes of global years of life lost.[10] In contrast, excessive gestational weight gain is associated with gestational diabetes, cesarean birth and postpartum weight retention.[11–13] Furthermore, excessive gestational weight gain has been linked to childhood obesity in the offspring,[14] which is associated with increased risk of chronic diseases in later life.[15] And accumulating evidence have shown that pre-pregnancy women with overweight or obesity were at increased risk for adverse maternal and neonatal outcomes.[16] It included gestational diabetes mellitus (GDM), preterm birth, large-for-gestational age (LGA), macrosomia and neonatal death.[17–22] In contrast, maternal underweight was associated with small-for-gestational age (SGA) and low birth weight.[23,24] Nevertheless, the effect of maternal pre-pregnancy body mass index, gestational weight gain on birth weight are unknown, and it is unclear whether there is a differential effect of gestational weight gain (GWG) on the rate of adverse birth weight among women of different pre-pregnancy BMI categories.

Therefore, the objectives of this study were: (1) to investigate the prevalence of pregnancy underweight, normal weight, overweight and obesity defined by body mass index (BMI), and the prevalence of GWG below the American Institute of Medicine (IOM) guideline, GWG within IOM guideline and GWG above IOM guideline in China; (2) to study the associations between maternal pre-pregnancy BMI, gestational weight gain and adverse birth weight respectively; and (3) to evaluate the effect of GWG on the rates of adverse birth weight between women of different pre-pregnancy BMI categories.

2. Methods

2.1. Participants

Our team selected Xiaoxian, the most northern of Anhui province, as study sites. With informed consent, we recruited 1733 children matched their mothers who received regular physical examinations in the 13 XiaoXian Maternal and Child HealthCare Hospitals from August 2014 to February 2015. After excluding mothers who had pregnancy complications and infants who had birth defects, 1617 normal birth outcomes and their mothers were included in our final study. Confidential interviews were conducted by trained research assistants to collect information. The information obtained was: (1) maternal characteristics, including age, height, weight before pregnancy, weight at birth, education level, paternal education level, pregnancy history, lifestyle before and during pregnancy (alcohol consumption and smoking), anxiety trait, stress during pregnancy and bleeding, vomiting in the first trimester. (2) offspring characteristics, including delivery mode, gender, birth weight, and birth height.

2.2. Measurements

Maternal self-reported pre-pregnancy weight and height were used to calculate the pre-pregnancy BMI [calculated as weight (kg)/height $(m)^2$], which was further categorized into four groups: underweight ($<18.5\,kg/m^2$), normal weight ($18.5–24.0\,kg/m^2$), overweight ($24.0–28.0\,kg/m^2$), and obese ($28.0\,kg/m^2$ or higher).[35] Gestational weight gain was calculated by subtracting each woman's pre-pregnancy weight from her weight at delivery. The 2009 IOM GWG recommendation is for underweight, normal weight, overweight, and obese women to gain 12.5–18 kg, 11.5–16 kg, 7–11.5 kg, and 5–9 kg, respectively.[1] Women were categorized into three groups based on GWG relative to the 2009 IOM recommendations: (1) weight gain below the IOM guidelines; (2) weight gain within the IOM guidelines; and (3) weight gain above the IOM guidelines.

We also considered the potential effect of maternal anxiety trait as well as prenatal stress on birth weight. Maternal anxiety trait was assessed using the State-trait Anxiety Inventory.[25] The State-trait Anxiety Inventory is a 40-item self-rating questionnaire, we chose 21–40 items to assess maternal trait anxiety. The total score was calculated by summing all of the items, and a score above the cut-off score of 49 is used as an indication of trait anxiety. Maternal stress during pregnancy was assessed using the Life Events Scale for Pregnant Women.[36] It is a 53-item self-rating questionnaire and the participants were asked to indicate whether the events had occurred during pregnancy using a dichotomous (yes–no) response scale. The values in each event were summed and used to assess the participant's perception of stress, and a score above the cut-off score of 375 is an indication.

We examined and categorized birth weight as following: low birth weight (<2500 g), SGA (defined as birth weight below the 10th percentile of mean weight corrected or fetal sex and gestational age), LGA (defined as birth weight above the 90th percentile of mean weight corrected for fetal sex and gestational age), macrosomia (>4000 g).[26]

2.3. Ethical considerations

All the investigators have had research ethics training. Participation and their parents were voluntary, and informed consent was sought from all the respondents. And the data were collected and analyzed anonymously. Our study procedures were approved by the ethics committee of Anhui Medical University, Hefei, China.

2.4. Statistical analysis

Continuous variables were presented as the mean (SD), and categorical variables were calculated as the number and rate (%). Histograms and P–P plots were applied to evaluate the normality of the distribution of the continuous variables. To test the research hypothesis, multivariable logistic regression analysis was used to control for potential confounders when assessing the associations between pre-pregnancy BMI, gestational weight gain and adverse birth weight, and evaluating the effect of GWG on the rates of adverse birth weight among women of different pre-pregnancy BMI category. Adjusted odds ratios (*aOR*) and 95% confidence intervals (*CI*) were calculated to describe the relative risk. All analyses were performed using SPSS, version 11.0 (SPSS Inc.). $P \leq 0.05$ (two-sided) was considered statistically significant.

3. Results

The means, standard deviations and other information of all descriptive variables are listed in Table 1 and Fig. 1. Nearly 16.3% of

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