

Original Article

Inadequate gestational weight gain and adverse pregnancy outcomes among normal weight women in China

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Received October 17, 2014; Accepted January 7, 2015; Epub February 15, 2015; Published February 28, 2015

Abstract: Objective: The objective of the paper is to find the association between inadequate gestational weight gain and pregnancy outcomes in normal weight women in China. Method: A retrospective study was conducted among 13,776 normal weight pregnant women who received antenatal care and delivered singleton infants at the participating hospital during August, 2009 to July, 2013. Adverse pregnancy outcomes like low birth weight (LBW), preterm birth, birth asphyxia, neonatal intensive care unit (NICU) admission and length of hospital stay were compared and analyzed between two groups with inadequate and adequate gestational weight gain. Results: According to the IOM recommendations, inadequate gestational weight gain was found to be 14.7% in this study. Women with inadequate gestational weight gain (GWG) were found to be at a higher risk for LBW (aOR = 2.13, 95% CI: 1.75, 2.86) and preterm birth (aOR = 1.44, 95% CI: 1.21, 1.67) than those in the adequate gestational weight gain group, after adjusting for monthly family income, maternal education, occupation, and whether they received any advice regarding benefits of gestational weight gain and residential area. However, inadequate GWG was not associated with longer hospital stay (aOR = 1.13, 95% CI: 0.91-1.43) in adjusted model. In addition, the rate of birth asphyxia and NICU admission were similar in both groups ($P > 0.05$). Conclusions: Normal weight pregnant women with GWG below the recommended AOM 2009 guidelines were found to be at an increased risk of low birth weight and preterm birth.

Keywords: Gestational weight gain, pregnancy outcomes, low birth weight, preterm birth

Introduction

Gestational weight gain (GWG) is an unique and complex biological phenomenon to support the normal growth and development of the fetus. The mechanisms underlying GWG have not been well explained yet. However, research indicates that suboptimal GWG, whether excessive or inadequate, is associated with a series of maternal and neonatal complications and even life-threatening diseases [1-7]. Therefore, GWG has been thoroughly studied as a predictor of adverse pregnancy outcomes and used as a basic indicator evaluating maternal and neonatal health during the prenatal period [8, 9].

Irrespective of the overall increasing trend of excessive GWG worldwide, inadequate GWG remains a major public concern in both devel-

oped and developing countries [10, 11]. According to CDC Pregnancy Risk Assessment Monitoring System (PRAMS), about 20% normal weight women suffered GWG below the IOM recommendations in 2003 in United States [12]. Ota et. al, with a prospective health-facility-based study, indicates 26% Vietnam women gain less than 10 kg during pregnancy [13]. Analysis on the secular trend of GWG among women in southeast China yields similar results, showing that near half of women have insufficient GWG during 1994-2005 [14]. Therefore, it is in urgent need to elucidate the impact of insufficient GWG on pregnancy outcomes for evidence-based management strategy.

However, understanding these associations of GWG with possible pregnant outcomes is complex, as a broad range of factors [15, 16], and having impact on GWG are also correlated with

the outcomes of pregnancy. Moreover, most of the previous studies examining the association of inadequate GWG with unfavorable pregnancy outcomes were mainly conducted in developed countries [17-19]. It may [11, 13] inappropriate to women in less-developed countries because of the heterogeneity of anthropometry. In addition, due to absence of official recommendations on GWG in China, the guidelines for GWG are mainly based on IOM recommendations. It is unclear whether these guidelines are applicable to developing countries as they are not intended for use in areas other than developed countries.

In the present hospital-based retrospective cohort study, we aimed to examine the impact of inadequate GWG on adverse pregnancy outcomes in normal weight nulliparous women with emphasis on neonatal complications.

Methods

Study subjects

This retrospective observational study was conducted in a tertiary care hospital in China. Women who received antenatal care and delivered singleton infants during August 2009 to July, 2013 in this hospital were included in this study. The inclusion criteria for this study were: aged 18-40 years, normal pre-pregnancy weight, GWG \leq 16 kg, singleton pregnancy and primipara women. According to the standard of Working Group on Obesity in China, normal weight was defined as BMI within 18.5-23.9 kg/m², calculated using the weight (kg) and height (m) recorded at the first antenatal visit within the first 12 weeks of pregnancy. Women having excessive GWG (above 16 kg) or having history of diabetes mellitus, severe congenital anomalies and hypertension were excluded from this study. In addition, women with missing data on maternal pre-pregnancy BMI, GWG, birth weight at delivery or pregnancy outcomes of interest were further excluded from this cohort.

Participants were classified as inadequate GWG group (GWG < 11.5 kg) and normal GWG group (GWG within 11.5-16 kg), according to the 2009 IOM GWG recommendations [12]. The study was approved by the institutional review board of Jishuitan Hospital.

Data collection

Pre-pregnancy weight and height were obtained from prenatal records as reported by mothers at their first prenatal visit, final pregnancy weight was collected from the prenatal records. Information regarding mother's age at conception, residential area (urban or rural), smoking status (never smoked and ever smoked), social status defined by years of education (less than 10-years, 10-12 years and more than 12-years), occupation (office work or others) and yearly incomes, history of chronic diseases (yes or no), were gathered from medical records. In addition, information on whether they received any advices about benefits of gestational weight gain from any medical institute before or during pregnancy was also obtained. Weight gain of mothers during pregnancy was calculated as the difference between pre-gestational weight and weight at the time of delivery.

The following neonatal outcomes were considered for the study: birth weight, gestational age (GA), mode of delivery (Cesarean or non Cesarean), 5-minute Apgar score, need for admission to neonatal intensive care unit (NICU) and duration of hospital stay.

Low birth weight was defined as an infant having birth weight less than 2500 g after a regular gestational period of 37-41 weeks. Gestational age was directly estimated from last menstrual period and/or early ultrasound report at an initial visit. Delivery occurring before 37 completed weeks of gestation was considered as pre-term birth. The criteria for NICU admission in our institution were the occurrence of any of the conditions like respiratory or circulatory instability, suspected sepsis, or for closed observation as assessed by neonatologists. Length of hospital stay was dichotomized into \leq 5 days and $>$ 5 days.

Statistical analysis

All statistical analyses were performed using the SPSS 13.0 package (SPSS, Chicago, IL). Variables were described by frequencies and mean \pm standard deviation (SD). Continuous variables were compared by the Student t-test while categorical variables were compared by χ^2 test. Multivariable logistic regression analyses were performed for adjustment for potential confounders to determine the association of GWG with adverse pregnancy outcomes of

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Table 1. Socio-demographic characteristics of participants having adequate and inadequate gestational weight gain

Maternal characteristics	Normal GWG (N = 11 751)	Inadequate GWG (N = 2 025)	P
Maternal age, (yrs), mean \pm SD*	26.9 \pm 2.9	27.5 \pm 2.7	0.15
Gestational age, (wk)s, mean \pm SD*	39.3 \pm 1.1	39.1 \pm 1.5	0.83
Smoking during pregnancy, (%)	2.3	1.9	0.20
Monthly Family income, Yuan, (%)			< 0.01
< 2,000	20.9	27.9	
2,000-3,999	46.3	48.4	
\geq 4,000	32.8	23.7	
Maternal Education, (yrs)			< 0.01
< 10	23.7	29.3	
10-12	36.8	40.1	
\geq 12	39.5	30.6	
Job type, %			< 0.01
Office work	47.8	36.1	
Others	52.2	63.9	
Weight gain advice, (%)	63.9	42.7	< 0.01
Residential area, (%)			< 0.01
Urban	74.5	59.3	
Rural	25.5	40.7	

*Student t-test was performed for continuous variables.

Table 2. Comparison of pregnancy outcomes among mothers having adequate and inadequate gestational weight gain

Adverse pregnancy outcomes	Normal GWG (N = 11 751)	Inadequate GWG (N = 2 025)	P*
LBW	4.7	7.9	< 0.01
Preterm birth	3.2	5.4	< 0.01
cesarean delivery	60.5	58.3	0.06
NICU	2.1	1.7	0.21
Hospital stay > 5 days	5.2	9.3	< 0.01

*Chi-square test.

interest. Covariates having a *p*-value below 0.15 were included in the final model. *P* < 0.05 was considered to be statistically significant.

Result

The socio-demographic characteristics of the participants are presented in **Table 1**. Out of total 13,776 eligible participants, 14.7% (*n* = 2,025) women were classified as having inadequate GWG, while 74.3% (*n* = 11,751) women were classified as having normal GWG. Grand mean maternal age, gestational weeks and BMI were 27.3 years, 39.1 \pm 1.3 weeks and 22.8 kg/m², respectively. Overall, both groups had similar maternal age at conception, gesta-

tional age, proportion of smokers and receivers of advices regarding benefits of gestational weight gain from medical institutes (*P* > 0.05). However, women having inadequate GWG had a lower education level, lower monthly family income, less likely to be office goers and mostly lived in rural areas with reference to those in normal GWG group (*P* < 0.01).

As shown in **Table 2** women having inadequate weight gain had an increased risk of delivering a low birth weight baby and giving birth to a preterm baby, their babies were more likely had a longer hospital stay with reference to that in normal GWG group (*P* < 0.01). However, no significant difference was observed in 5-minute Apgar score (less than 7), NICU admission and cesarean delivery between two groups of mothers (*P* > 0.05).

Results of multivariate logistic regression analyses showing association between GWG and adverse pregnancy outcomes of interest are presented in

Table 3. In unadjusted model, inadequate GWG were found to be positively associated with the occurrence of LBW (OR = 2.17, 95% CI: 1.71, 2.79), preterm birth (OR = 1.85, 95% CI: 1.43, 2.41) and length of hospital stay (OR = 1.27, 95% CI: 1.13, 1.44). Although a marked decrease of odds ratios was observed for LBW (aOR = 2.73, 95% CI: 2.26, 3.37), preterm birth (aOR = 1.44, 95% CI: 1.11, 1.90), all these associations were found to be statistically significant. However, compared to women having adequate gestational weight gain, those having inadequate GWG did not have any significant association with length of hospital stay (aOR = 1.13, 95% CI: 0.91-1.43) in the adjusted model.

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Table 3. Risk of Adverse Neonatal Outcomes by inadequate Gestational Weight Gain

Adverse pregnancy outcomes	cOR (95% CI)	aOR (95% CI)*
LBW	2.77 (2.31, 3.39)	2.13 (1.75, 2.86)
Preterm birth	1.85 (1.43, 2.41)	1.44 (1.21, 1.67)
Hospital stay > 5 days	1.27 (1.13, 1.44)	1.13 (0.91-1.43)

*Adjusting monthly family income, maternal education, occupation, weight gain advices and residential area.

Discussion

Although findings from previous studies have consistently confirmed the role of gestational weight gain in determining pregnancy outcomes, there has been limited research focusing on insufficient gestational weight gain and its sequelae. In this retrospective cohort of Chinese nulliparous women, inadequate GWG was found to be positively associated with the risk of LBW and preterm birth, which corroborated with other studies indicating that inadequate maternal weight gain was an independent predictor of negative pregnancy outcomes [11, 18]. To the best of our knowledge, this was the first study examining the impact of inadequate GWG on pregnancy outcomes among normal weight women in China.

The total amount of weight gain during pregnancy was determined by a broad range of factors. Aside from the influence of physiological functioning and genetic predisposition, some social, environmental and behavioral factors, as growing studies indicated [3, 5, 9, 15], also had decisive impact on the weight gain. Consistent to previous reports, in the current cohort, women having inadequate GWG were likely to be with less education, in unfavorable social economic status and with non-office job in comparison to their counterparts. In addition, advice on gaining an appropriate amount of weight during pregnancy was considered to be an effective way to help women achieve optimal weight. However, women receiving advice on weight gain did not show a substantial improvement of GWG in several intervention trials [20, 21]. Similarly, women gaining weight below the recommendations seemed to have an equal chance to receive medical advice to their counterparts, suggesting the great gap between what physicians said they were doing and what women said they were receiving.

In the current cohort, all study participants were from a tertiary hospital in Beijing, the most economically and culturally developed region in China, where women could acquire better health services than those in other areas. As expected, based on the recommendations of the new guidelines of the Institute of Medicine in 2009, only 14.7% of nulliparous women were classified as having inadequate weight during pregnancy, which was much lower than the results from previous studies in China and other less-developed countries [13, 14]. Our data seemed to be consistent to a few reports from western populations, in which between 7 and 24% of women the weight gain was below the IOM recommendations [22]. However, due to the heterogeneity of study design and study setting, the direct comparison might be unreasonable.

Available literatures have consistently demonstrated that inadequate GWG was strongly associated with lower LBW. Ota, et al. reported that the probability of delivering an infant too small for gestational age was 1.90-fold among normal weight Vietnam women having low GWG [13]. In a systematic review, Han et al reported that low GWG increased 1.85-fold risk of LBW, 1.84-fold in developing and 3.02-fold in developed countries, respectively [23]. In the present study, the crude OR and adjusted OR was 2.77 and 2.13, which was a little bit higher than that in previous reports. Although the magnitude of association varied substantially across studies, due to use of the different cutoff values for classification of inadequate GWG and different eligibility criteria for selecting participant, these consistent findings highlighted the importance of health physicians to be aware of this adverse outcome and carefully monitor the women who were at risk. This was especially true for China, where more than one million LBW infants were born each year.

Preterm birth was a critical indicator of maturity, implying increased risks of infant death and morbidity. Although the causal relationship between low GWG and preterm birth remained elucidation, mainly due to the lack of strong biological plausibility, a few observational studies have shown that GWG have decisive influence on the occurrence of its occurrence. In a case-

control study, Sonela et al reported that women who did not reach the recommended gestational weight gain were 1.8-fold risk of having a preterm birth compared to the women which reach this weight [24]. Similar result was presented by Han et al, who reported that women with low total gestational weight gain had increases in preterm birth < 37 weeks (RR = 1.64) [23]. Moreover, the effect, as these studies indicated, was modified by pre-pregnancy weight, with stronger association in underweight women and obese women and moderate association in normal weight women. In the present study, we restricted participants in women with normal weight and observed 1.44-fold increased risk of preterm birth in women having adequate GWG after controlling for confounding factors, which was in line with previous reports.

However, there were some limitations in this study. First, pre-gestational weight was self-reported by the participants and this might be subjected to recall bias. However, previous studies have indicated that the less accurate reporting of weight occurred mainly among overweight women [19]. A study by Lim et al. suggested a high correlation between self-reported pre-gestational weight and observed weight among women in developing country [25]. Second, although we controlled potential confounders by multivariable regression analyses and restriction, the chances of residual confounding could not be ruled out as other studies have suggested possible association of, GWG with several factors including physiological, psychological, behavioral, family, social, cultural, and environmental factors [12]. Finally, dichotomization of GWG as inadequate and normal, further limited the study results. Further research is required to determine what should be the optimal range of gestational weight gain that could minimize the risk of undesirable birth outcomes in the setting of Chinese women.

To sum, normal weight women having GWG below the guidelines as suggested by the 2009 AIOM were at an increased risk of several adverse pregnancy outcomes. Health care providers should be aware of these adverse pregnancy outcomes and they should encourage women to have optimal weight gain during pregnancy to improve the birth outcomes.

Disclosure of conflict of interest

None.

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