CEOG Clinical and Experimental Obstetrics & Gynecology

Does gestational weight gain of more than 12 kg in women increase the risk of a cesarean section delivery, gestational diabetes and pregnancy induced hypertension? A retrospective case series

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Summary

Purpose: The purpose of this study was to investigate whether the gestational weight gain of more than 12 kg represented a risk factor for an increased rate of cesarean section (CS) delivery, gestational diabetes, and pregnancy-induced hypertension (PIH). *Materials and Methods:* This was a retrospective case series study performed in a Greek National Health Service hospital and included women having given birth to singleton pregnancies between 2004-2009. Cases with multiple pregnancies, stillbirths, and congenital fetal abnormalities were excluded. *Results:* 600 eligible women were included in the study. Gestational weight increase correlated positively and was higher in women with a CS delivery, gestational diabetes, and PIH. The prepregnancy body mass index was identified as a predictor of gestational diabetes. The weight gain of less than 12 kg during pregnancy provided a protective effect against CS delivery by reducing the likelihood of this by 85%. *Conclusion:* The present authors have shown that the increased body weight gain during pregnancy of more than 12 kg is associated with increased rates of CS delivery, gestational diabetes, and hypertensive disorders in pregnancy.

Key words: Body mass index; Cesarean section; Gestational diabetes; Preeclampsia.

Introduction

There are several reports in literature that prepregnancy body mass index (BMI) is a risk factor associated with maternal and neonatal morbidity. In a recent cohort study that involved 75,432 women from Australia, it was found that maternal obesity was associated with hypertension in pregnancy, gestational diabetes, and increased rates of cesarean section (CS) delivery [1]. Another large population register-based cohort study of 99,403 live births in the United Kingdom found that overweight and obese women had a higher risk of CS delivery and giving birth to macrosomic infants [2]. Other researchers investigating the effect of obesity on the neonatal outcomes concluded that maternal obesity was significantly associated with neonatal macrosomia and meconium aspiration syndrome [3].

As the correlation between maternal BMI and perinatal outcome has been studied extensively in the literature, there are not many published studies investigating the effect of excessive weight gain during pregnancy on the perinatal outcome of women. In 2009 the Institute of Medicine (IOM) and the National Research Council (NRC) in the United States released a guideline commenting on the recommended weight gain during pregnancy in relation to maternal prepregnancy BMI [4]. In this guideline, major research gaps were identified that involved the significant lack of evidence on the effect of weight gain during pregnancy on both the maternal and neonatal outcomes. The IOM and NRC in September 2013 released an updated report quoting that 'many women still do not receive adequate pre- or post-conception advice about weight and pregnancy-weight gain' [5]. Moreover, the report stated that the health professionals were not familiar with the new recommendations about pregnancy weight gain and therefore did not provide adequate guidance to their clientele. A most recent study from the United Kingdom demonstrated that midwives, who are considered the frontline professionals in the provision of weight-related advice to pregnant women, are still biased when providing advice to obese women by their own personal beliefs about body image and their counselling is not always evidence-based [6].

While the IOM and NRC have recommended that women with a normal BMI should gain no more than 35 lbs (or 15.8 kg) during pregnancy and overweight women should gain no more than 25 lbs (or 11.3 kg), nevertheless,

Revised manuscript accepted for publication November 9, 2015

Clin. Exp. Obstet. Gynecol. - ISSN: 0390-6663
XLIV, n. 4, 2017
doi: 10.12891/ceog3461.2017

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researchers are still trying to identify more strict weight gain limits. At present there is a lack of evidence about the cut-off point for the optimal weight gain during pregnancy in order to reduce antenatal complications.

The primary objective of this study was to investigate the effect of weight gain during pregnancy on the perinatal outcome in women. The secondary objective was to determine any cut-off values for gestational weight increase that could be predictive of the mode of delivery, gestational diabetes, and hypertension in pregnancy.

Materials and Methods

This was a retrospective case series of women who gave birth at the maternity unit of a Greek National Health Service (NHS) hospital in the area of Ptolemaida of Northern Greece between the years 2004-2009. Data were collected with manual retrieval of the hospital notes for each woman identified during the study period. The authors recorded information on the womens' age, parity, and mode of delivery. They only used in their calculations, the occurrence only of gestational diabetes and pregnancy-induced hypertension (PIH), as these were the most frequently occurring antenatal complications in this cohort. They did not include other end-points in this study as dependent variables, as their incidence rates were less than 1% and the sample was small and therefore the study was underpowered to detect any significant associations, if present. The neonatal variables recorded were birth weight and gestational age at birth.

The weight gain during pregnancy and the prepregnancy BMI were recorded. The prepregnancy maternal BMI was calculated using the self-reported prepregnancy weight and measured height at the patient's first antenatal visit at five to eight weeks of gestation as recorded in the maternal notes. Prepregnancy BMI was further categorized according to the World Health Organization's definition into four groups according to BMI: 1) underweight (< 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥ 30.0 kg/m^2) [7]. All women during their admission to give birth on the birthing suite were weighed and their weight was recorded in the maternity notes. Pregnancy weight gain was determined using the mother's weight just prior to delivery subtracted from the prepregnancy weight.

The authors did not record the reason for CS delivery as a variable in their analyses. The reason is that the indication was missing in the majority of the hospital notes of the women. Therefore, the indication for CS was not accounted for as a potential confounding factor.

Quantitative variables are presented with mean and standard deviation. Qualitative variables are presented with absolute and relative frequencies. Fisher's exact test was used for the comparison of proportions. Student's *t*-test and ANOVA was computed for the comparison of mean values. Multiple logistic regression analyses were conducted in order to find if weight gain during pregnancy was independently associated with the mode of delivery and the occurrence of antenatal complications. Odds ratios with 95% confidence intervals were calculated from the results of the logistic regression analyses. Receiver operating characteristic (ROC) curves were used in order to estimate the optimal cut-off's of weight gain during pregnancy for the outcomes of the study. Statistical analysis for quantitative data was performed with the use of SPSS statistical software version 19.0 and level of significance was set at $p = 0.05$ (two-tailed).

Ethical approval for collection and management of data in this study was obtained by the hospital's Ethics Committee.

Table 1. — *The clinical features for the cohort of n=600 women.*

	N	%
Age (years), mean ± SD	28.1±5.0	
Nulliparity	255	42.6
Gestational weight gain (kg), mean ± SD	11.5±2.7	
Weight gain (≤ 12 kg)		
No	115	19.2
Yes	485	80.8
Prepregnancy BMI (kg/m^2), mean ± SD	22.6±2.2	
Prepregnancy BMI (kg/m^2)		
Underweight	3	0.5
Normal	525	87.5
Overweight	72	12.0
Gestational age (weeks)		
37-41	566	94.3
> 41	23	3.8
< 37	11	1.8
Mode of delivery		
Vaginal birth	404	67.3
CS	196	32.7
Birth weight (g), mean ± SD	3266.0±444.7	
Birth weight (g)		
2,500−4,000 g	554	92.3
< 2,500 g	17	2.8
< 1,500 g	0	0.0
> 4,000 g	29	4.8
Gestational diabetes		
No	561	93.5
Yes	39	6.5
Pregnancy induced hypertension		
No	585	97.5
Yes	15	2.5

*SD: standard deviation.

Results

680 women were initially identified as having given birth at the NHS hospital of Ptolemaida in Northern Greece during the five-year study period. Nevertheless, 80 were excluded because of multiple pregnancies (n=30) and missing data (n=50). This resulted in the inclusion of 600 pregnant women who delivered singleton, live-born infants with no major congenital anomalies.

Table 1 shows the clinical features of the women in this cohort. Mean age was 28.1 years with 98.2% of women delivering at term and the CS delivery rate was 32.7%. Approximately 9% presented with an antenatal complication such as gestational diabetes (6.5%) and PIH (2.5%). Preeclampsia involved only two out of the 15 women with hypertension in pregnancy. Mean gestational weight gain was 11.5 kg with 19.2% of women gaining more than 12

Table 2. — *Percentage of women with a body weight gain of ≥ 12 kg during pregnancy according to their clinical features.*

	Body weight gain of ≥12 kg during pregnancy				
	Yes		No		*p*-value
	N	%	N	%	
Mode of delivery					
Vaginal birth	38	9.4	366	90.6	< 0.001*
CS	77	39.3	119	60.7	
Gestational age (weeks)					
37− 41	109	19.3	457	80.7	0.160*
> 41	2	8.7	21	91.3	
< 37	4	36.4	7	63.6	
Gestational diabetes					
No	104	18.5	457	81.5	0.138*
Yes	11	28.2	28	71.8	
Hypertensive disorders					
No	107	18.6	478	81.4	0.002*
Yes	8	53.8	7	46.2	
Birth weight (g), mean±SD	3244.4±495.5		3271.1±432.1		0.564**
Birth weight (g)					
2,500−4,000 g	100	18.1	454	81.9	0.050†
< 2,500 g	6	35.3	11	64.7	
> 4,000 g	9	31.0	20	69.0	

*Fisher's exact test; **student's *t*-test; †ANOVA.

Table 3. — *Mean gestational weight gain according to the participants' clinical features.*

	Weight gain during pregnancy (kg)		
	Mean	SD	*p*-value*
Prepregnancy BMI			
Underweight	11.00	2.40	< 0.001
Normal	14.60	2.90	
Mode of delivery			
Vaginal birth	10.86	2.44	< 0.001
CS	12.72	2.89	
Gestational age (weeks)			
37−41	11.46	2.75	0.613
> 41	11.39	1.95	
< 37	12.27	3.23	
Gestational diabetes			
No	11.24	2.58	< 0.001
Yes	14.74	2.85	
Hypertensive disorders			
No	11.37	2.67	< 0.001
Yes	15.77	2.20	
Birth weight (g)			
2,500−4,000 g	11.38	2.67	0.004
< 2,500 g	11.82	3.41	
> 4,000 g	13.07	3.01	

*Student's *t*-test.

kg throughout pregnancy. Prepregnancy BMI was normal in 87.5% of women and 12% were overweight at booking.

Table 2 shows the percentage of women who gained ≥12 kg of body weight in pregnancy in relation to their clinical features. The percentage was significantly higher in those women who had a CS delivery, hypertension in pregnancy, and in those with a birth weight of > 4000 grams.

Table 3 shows the mean gestational weight gain according to the womens' clinical features in pregnancy. Weight increase correlated positively and was higher in those with CS delivery, gestational diabetes, hypertensive disorders, and birth weight of > 4,000 grams.

Multiple regression analysis showed that the increased gestational weight gain was a significant predictor for the likelihood of a CS delivery (OR = 1.34, 95% CI: 1.24−1.46; $p < 0.001$). Conversely, if a woman had gained ≤12 kg during pregnancy, this offered a protective effect against CS (OR = 0.15, 95% CI: 0.09−0.24; $p < 0.001$) reducing the likelihood of CS by 85%. Additionally, ROC analysis showed that the optimal cut-off for the prediction of CS from weight gain during pregnancy was 12 kg (65.3% sensitivity and 57.4% specificity). Multiple regression analysis also identified that the increased prepregnancy BMI was a significantly strong predictor for gestational diabetes (OR for overweight women at booking = 85.86, 95% CI: 26.25−280.82; $p < 0.001$). The only association between gestational diabetes and weight gain was shown through ROC analysis where the optimal cut-off for the discrimination of women with gestational diabetes from weight gain during pregnancy was 13 kg (74.4% sensitivity and 78.8% specificity).

Multiple analysis also showed that if a woman had gained ≤12 kg during pregnancy, this offered a protective effect against the pooled conditions of CS delivery, gestational diabetes, and hypertension in pregnancy (OR = 0.29, 95% CI: 0.12−0.69; $p = 0.005$), reducing the likelihood of these pooled occurrences by 71%. Additionally, ROC analysis showed that the optimal cut-off for the prediction of the aforementioned pooled conditions from weight gain during pregnancy was 14 kg (73.3% sensitivity and 86.7% specificity).

Discussion

This study involved a cohort of 600 women who gave birth in a Greek NHS hospital over a five-year period. The great majority of the participants (87.5%) had a normal prepregnancy BMI and 12% were reported as overweight. Similar percentages were noted in a recent multicenter study performed in the United States in 2013 where 69% of the participants had a normal BMI and 15% were overweight [8]. In the present study, 19.2% of the participants had a weight gain of more than 12 kg during their pregnancy. This percentage is significantly much less than what is reported in other studies where more than half of pregnant women exceed the recommended weight gain during

pregnancy [9, 10].

The present study has shown that women who gained more than 12 kg of body weight during pregnancy were at a higher risk of CS delivery. Moreover, if a woman had gained ≤12 kg during pregnancy, this offered a protective effect against CS delivery while reducing the likelihood of this by 85%. The present findings are in agreement with a recent cohort study published in 2013 that involved nulliparous women from several different countries who participated in the multicenter SCOPE trial [11]. Researchers found that after using the 2009 IOM guidelines for the definition of ideal weight gain during pregnancy, nulliparous women with an increased weight gain had an increased risk for CS delivery (OR = 1.46; 95% CI : 1.03−2.07) [11]. Furthermore, the ideal weight gain during pregnancy for the prediction of CS in the present study was 12 kg, which is much lower than the 15.8 kg recommendation from the Institute of Medicine in 2009 [4].

The present study identified that the increased prepregnancy BMI had a significant effect on the pregnancy outcome with overweight pregnant women being at an increased risk of developing gestational diabetes. This is in line with an earlier study of 287,213 pregnancies in the United Kingdom in 2001 where a BMI of > 25 kg/m^2 was correlated with a significantly increased risk of gestational diabetes (OR = 1.68; 99% CI: 1.53−1.84) [12]. Even though regression analysis in the present study did not identify weight gain during pregnancy as an independent risk factor for gestational diabetes, nevertheless ROC analysis showed that there was a cut-off point of 13 kg in women that could be used for the prediction of developing gestational diabetes. It is interesting that another recent study of 37,973 pregnant women in China also concluded that gestational weight gain was not an independent risk factor itself for gestational diabetes. Only when weight gain during pregnancy was combined with prepregnancy obesity there was a two-fold higher risk of gestational diabetes [13]. The researchers in their study unfortunately did not provide any cut-off points for gestational weight gain for the prediction of gestational diabetes [13].

The present authors did not demonstrate that prepregnancy BMI or weight gain during pregnancy was an independent risk factor for developing PIH. This study only indicated that the percentage of women who gained ≥12 kg of body weight in pregnancy was significantly higher in those women who had hypertension in pregnancy. The only instance where weight gain of less than 12 kg in women offered a protective effect against PIH was when this antenatal condition was pooled with the other conditions of gestational diabetes and CS delivery, thus probably indicating that the cohort was underpowered for this arm of the study. In this case, a weight gain of ≤12 kg during pregnancy reduced the likelihood of the pooled conditions of hypertension in pregnancy, CS delivery, and gestational diabetes by 71%. The optimal cut-off for the prediction of women with the aforementioned pooled conditions from weight gain during pregnancy was 14 kg.

There are several reports in literature about the association between weight increase during pregnancy and prepregnancy BMI with hypertensive disorders in pregnancy [14]. A report from Canada in 2009 found that the excess weight gain in both normal weight and overweight women at booking was associated with increased rates of gestational hypertension (OR = 1.27; 95% CI: 1.08−1.49) [9]. An earlier systematic review of 13 studies by O'Brien *et al.* in 2003 that included more than 1.4 million women managed to quantify the risk of preeclampsia in regards to maternal BMI [15]. They found that the risk typically doubled with each five to seven kg/m^2 increase in prepregnancy BMI and remained strong even after adjustment for confounding factors, such as diabetes mellitus, multiple gestations or other confounders. A most recent case-control study concluded that there was a 1.5-fold higher likelihood of developing PIH in women with an initial BMI of ≥ 30 kg/m^2 as compared to BMI of < 30 kg/m^2 [16]. Similar results were presented by an earlier study of 287,213 pregnancies in London where a BMI of > 25 kg/m^2 was correlated with an increased risk of preeclampsia (OR = 1.44; 99% CI: 1.28−1.62) [12].

There are certain limitations to consider about this study. First, the retrospective nature indicated that all data were extracted from the hospital-held maternal notes. Therefore it was not possible to have a weekly body weight measurement in order to associate any rapid body weight increases with antenatal pathology occurrence. Second, the prepregnancy weight was self-reported during the first antenatal visit of the women at five to eight weeks of gestation and therefore may be subject to a recall bias. Third, the indication for CS delivery was not available for the majority of women to be included as a variable in the present analyses. The strength of this study was the simple study design of assessing the associations of gestational weight gain and maternal prepregnancy BMI, with the mode of delivery, gestational diabetes, and PIH. Extrapolation of results in this way allows for a clear understanding and a better implementation of the findings in antenatal clinical practise.

Conclusion

The present authors have shown that the increased body weight gain during pregnancy of more than 12 kg was associated with increased rates of CS delivery, gestational diabetes, and hypertensive disorders in pregnancy. What is new with the present study is that the cut-off points are lower than those provided by the IOM recommended guidelines issued in 2009 about the ideal weight gain during pregnancy [4]. This is an issue that requires further clarification in future studies.

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