Effects of prepregnancy body mass index and weight gain during pregnancy on perinatal outcome in glucose-tolerant women

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Abstract

Aim. – The aim of this study was to determine the effects of maternal prepregnancy body mass index (BMI) and weight gain during pregnancy on perinatal outcome in non-diabetic women.

Methods. – The clinical records of consecutive women who had undergone a glucose challenge test (GCT) and then delivered in our university hospital between January 2004 and December 2009 were retrospectively reviewed. Prepregnancy BMI and pregnancy weight gain were classified according to the US Institute of Medicine guidelines (1990).

Results. – Of the eligible 2225 patients, obese and overweight women had a greater percentage of macrosomic babies (17.7% and 8.9%, respectively) compared with normal weight women (4.5%). However, when considered according to weight gain during pregnancy, the results were statistically significant only for excess weight gain in the obese (OR: 8.3, 95% CI: 2.4–28.4) and overweight (OR: 2.9, 95% CI: 1.2–6.8) groups. Also, the surgical delivery rate was significantly higher in the obese vs normal weight women (56% vs 36%, respectively) although, in this case, there was no difference according to normal and excess weight gain during pregnancy (OR: 1.4, 95% CI: 0.7–2.6).

Conclusion. – Overweight and obese women have an increased risk rate of macrosomia that can be limited by well-controlled weight gain during pregnancy. There was also a significantly higher rate of surgical delivery in the obese compared with the normal weight group that was, however, independent of excessive weight gain during pregnancy.

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Keywords: Prepregnancy weight; Gestational weight gain; Macrosomia; Caesarean section

Résumé

Impact de l’indice de masse corporelle prégestationnel et de la prise de poids pendant la grossesse sur les événements périnatals de femmes avec tolérance au glucose normale.

Objectifs. – L’objectif de notre étude était d’évaluer les effets de l’indice de masse corporelle (IMC) prégestationnel et de la prise de poids pendant la grossesse sur les événements périnatals des femmes enceintes avec tolérance normale au glucose.


Résultats. – L’analyse des données a révélé une fréquence élevée de macrosomie chez les nouveau-nés de mères obèses ou en surpoids comparés aux nouveau-nés de mères de poids normal (respectivement 17,7 % et 8,9 % vs 4,5 %). En outre, l’analyse de l’échantillon selon le degré d’augmentation pondérale au cours de grossesse et l’IMC prégestationnel a indiqué qu’il n’exista d’augmentation significative de la fréquence de la macrosomie que lorsque la prise de poids pendant la grossesse était excessive chez les femmes obèses (OR 8,3, IC à 95 % : 2,4–28,4) et chez les femmes en surpoids (OR 2,9, IC à 95 % : 1,2–6,8). Nous avons, par ailleurs, trouvé un nombre de césariennes plus élevé chez les femmes obèses que chez les femmes normopondérales (56 % vs 36 %), indépendamment de la prise de poids pendant la grossesse (OR 1,4, IC à 95 % : 0,7–2,6).

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Thus, the combined effects in non-diabetic women of both January 2004 and December 2009. The study received approval of all consecutive Caucasian patients who had undergone a glu-
sured for admission for delivery regarding weight gain dur-

Although all women with glucose intolerance in pregnancy (GDM or one abnormal value) were excluded from our study, a slight but significant difference was observed in all groups for mean glycaemia which, on multivariate logistic regression, correlated with macrosomia, thus representing an independent risk factor ($P=0.01$; OR: 1.035, 95% CI: 1.008–1.062); this, however, was not the case for surgical delivery ($P=0.43$; OR: 1.0, 95% CI: 0.99–1.01).

### 1. Introduction

The number of overweight women of childbearing age has rapidly increased all over the world [1–3], while gestational weight gain is also greater than ever before [4]. These condi-
tions have become a problem for antenatal care units because of the well-recognized increased risk of maternal and neonatal complications. Specifically, high prepregnancy body mass index (BMI) and excess weight gain during pregnancy have each been associated with an increased risk of neonatal macrosomia [5], which is itself associated with a high risk of childhood obesity [6,7] and surgical delivery.

Numerous studies have already been published on this sub-
ject; however, while some have analyzed the effects of maternal weight and weight increase while ignoring diabetes [8], others [9–11] have excluded cases of pregestational diabetes, but not gestational diabetes mellitus (GDM) or, like Jensen et al. [12], have performed an observation of an historical cohort of 481 obese women with a normal oral glucose tolerance test (OGTT) in the third trimester (BMI ≥ 30 kg/m²). Furthermore, many studies restricted their analyses to either prepregnancy weight [5,13] or weight gain during pregnancy [14], while others considered only surgical delivery [15] as the primary outcome. Thus, the combined effects in non-diabetic women of both prepregnancy BMI and weight increases during pregnancy on the risk of macrosomia and modality of delivery have still not been completely evaluated.

The purpose of the present retrospective study was to deter-
mine the effects of pregnancy weight gain on perinatal outcome in different BMI groups of non-diabetic women delivering single babies at term.

### 2. Patients and methods

Data were retrospectively reviewed from the medical records of all consecutive Caucasian patients who had undergone a glu-
cose challenge test (GCT) at our university hospital between January 2004 and December 2009. The study received approval from the Institutional Review Board. For each patient, maternal self-reported prepregnancy weight and height (directly mea-
sured on admission for the GCT) were collected and used to calculate prepregnancy BMI (kg/m²). These data were later updated on admission for delivery regarding weight gain dur-
ing pregnancy, and then for mode of delivery, birth weight, Apgar score and neonatal intensive care unit (NICU) admission. Macrosomia was defined as a baby weight greater than 4000 g.

Of the 2580 screened patients, 40 had twin pregnancies, 100 had a preterm delivery (less than 37 weeks of gestation), 190 had a diagnosed glucose intolerance in pregnancy (103 cases of GDM and 87 with one abnormal value) and 25 had no information regarding delivery, and were all excluded from our study. The remaining 2225 women were categorized as underweight (BMI < 19.8 kg/m²), normal weight (BMI 19.8–26 kg/m²), over-
weight (≥ 26–29.9 kg/m²) and obese (≥ 30 kg/m²). Then, in each group, women were differentiated as having had either normal or excess weight gain (throughout the whole of the pregnancy), according to the US Institute of Medicine (IOM) guidelines [16].

### 3. Statistical analysis

The Statistical Package for the Social Sciences computer software (IBM SPSS Statistics version 17.0) was used for the statistical analysis. Variables were expressed as means ± SD or n (%). Differences among the groups were analyzed by analysis of variance (Anova) or chi² tests. Multiple logistic regression was used to assess the odds ratio (OR) of independent variables, and 95% confidence intervals (CI) were also calculated. Gestation age at delivery and glycaemia were considered confounding fac-
tors, and adjusted ORs were calculated. $P<0.05$ was considered significant for all the data analyzed.

### 4. Results

According to prepregnancy BMI, the 2225 eligible patients were classified as underweight ($n = 284$; 12.7%), normal weight ($n = 1430$; 64.3%), overweight ($n = 336$; 15.1%) and obese ($n = 175$; 7.9%). None of these patients smoked more than three cigarettes per day or drank alcohol at any time during their pregnancy.

Table 1 shows the characteristics of the study population. The underweight women were younger and had a parity status that was significantly different from all the other groups, while gestational age at the time of GCT did not differ among the groups. Gestational age at delivery and the caesarean section rate were significantly increased in the obese group compared with all the others. Mean weight gain was also statistically different among the groups, most likely because of the different prescribed diets for each group. Nevertheless, in the present study, 59.4% (104/175 women) in the obese group gained too much weight. Although all women with glucose intolerance in pregnancy (GDM or one abnormal value) were excluded from our study, a slight but significant difference was observed in all groups for mean glycaemia which, on multivariate logistic regression, correlated with macrosomia, thus representing an independent risk factor ($P=0.01$; OR: 1.035, 95% CI: 1.008–1.062); this, however, was not the case for surgical delivery ($P=0.43$; OR: 1.0, 95% CI: 0.99–1.01).
Comparison of maternal and neonatal characteristics according to body mass index categories.

5. Weight gain during pregnancy (kg) 20.9
Gestational age at delivery (weeks) 39.0
but with excessively low BMI, too [17]. In our group of under-weight women before pregnancy, the risk of low birth weight were no differences in Apgar scores at 1 and 5 min or in NICU the two groups in caesarean section rate.

The neonatal outcomes that were statistically different in obese women compared with the others were macrosomia, Apgar scores at 1 and 5 min, and NICU admission. In the overweight group, macrosomia was significantly different, but there were no differences in Apgar scores and NICU admission. Specifically, the rates of macrosomia were 4.5% in the normal weight, 8.9% in the overweight and 17.7% in the obese women. These data gave an OR of 3.4 (95% CI: 1.5–7.6) in the obese women, whereas macrosomia was significantly related to excess vs normal weight gain (26.2% vs 5.5%, respectively; P = 0.0001; OR: 8.3, 95% CI: 2.4–28.7) in this group. Furthermore, no statistical differences were reported for surgical delivery, which showed only a slight difference (OR: 1.4, 95% CI: 0.7–2.6).

A similar difference in macrosomia was also reported for overweight women with excess weight gains in pregnancy, but with a lower but significant OR (2.9) and no differences between the two groups in caesarean section rate.

5. Discussion

Maternal obesity has long been correlated with an increased incidence of hypertensive disorders and GDM, macrosomia, surgical delivery, neonatal hypoglycaemia and NICU admission. In our present study population, the data confirms that the prepregnancy BMI was closely related to the perinatal outcome. In fact, in the obese (prepregnancy BMI ≥ 30 kg/m²), we observed greater frequencies of macrosomia, caesarean delivery, low Apgar scores at 1 and 5 min, and NICU admission.

Some studies have hypothesized that adverse perinatal outcomes can occur not only with high prepregnancy BMI scores, but with excessively low BMI, too [17]. In our group of under-weight women before pregnancy, the risk of low birth weight and NICU admission was not significantly different from that of the normal weight group, although the risk of preterm delivery (less than 37 weeks) was not considered in the present study. This observation may have been due to the high mean weight gain during pregnancy (20.9 ± 10.5 kg), thus compensating for their being underweight before falling pregnant.

However, excessive weight gain during pregnancy also represented a risk factor for macrosomia across all of our study groups. Indeed, there was a significant difference in the percentage of macrosomic babies – 8.3% vs 4.2%, respectively (P = 0.0001) – on comparing women with excess vs normal weight gain during pregnancy (OR: 2.0, 95% CI: 1.4–2.9). On considering this variable across all four classes of prepregnancy BMI, excess weight gain during pregnancy did not change the risk of macrosomia in the first two BMI groups, and the risk was similar between those with normal and excess weight gain; in the overweight and obese women, however, there was a highly significant difference (P = 0.0001) between these two groups (OR: 2.9, 95% CI: 1.2–6.8 and OR: 8.3, 95% CI: 2.4–28.7, respectively).

These findings suggest that women who become pregnant when they are already overweight or obese should follow a strict dietary regimen to avoid excess weight gain during pregnancy to reduce their likelihood of delivering a large gestational age baby. Our results also confirm in part the conclusions of Kabali and Werler [9], but with a few important differences. Our present study involved a larger sample size (2225 vs 815 women), thereby giving more power to our statistical differences; also, not only were diabetic patients excluded from our study, but also all those with glucose intolerance in pregnancy, to exclude any influence of glycaemia in our present study population. Also, our overweight patients were divided into two groups—specifically, the overweight (BMI 26–29.9 kg/m²) and the obese (BMI ≥ 30 kg/m²)—and our findings demonstrated significant differences in each of these groups. In fact, even Hederson et al. [18], who also reported that overweight women who gain more weight than the IOM recommendations are at an increased risk of delivering macrosomic babies, failed to distinguish between overweight and obese women. Our present study considered macrosomia as an infant weight greater than 4000 g while Hederson et al. defined it as greater than 4500 g.

Table 1
Comparison of maternal and neonatal characteristics according to body mass index categories.

<table>
<thead>
<tr>
<th></th>
<th>Underweight (n = 284)</th>
<th>Normal weight (n = 1430)</th>
<th>Overweight (n = 336)</th>
<th>Obese (n = 175)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>28.6 ± 4.4*</td>
<td>29.5 ± 4.7</td>
<td>30.3 ± 5.1</td>
<td>29.9 ± 5.0</td>
</tr>
<tr>
<td>Parity (≥ 1)</td>
<td>80 (28%)*</td>
<td>616 (43%)</td>
<td>169 (50%)</td>
<td>94 (53%)</td>
</tr>
<tr>
<td>Gestational age at GCT (weeks)</td>
<td>25.7 ± 2.1</td>
<td>25 ± 2.1</td>
<td>25.5 ± 2.4</td>
<td>25.9 ± 2.8</td>
</tr>
<tr>
<td>Gestational age at delivery (weeks)</td>
<td>39.0 ± 1.6</td>
<td>38.9 ± 1.5</td>
<td>38.8 ± 1.6</td>
<td>38.6 ± 1.8*</td>
</tr>
<tr>
<td>Weight gain during pregnancy (kg)</td>
<td>20.9 ± 10.5*</td>
<td>15.9 ± 10.2</td>
<td>8.5 ± 10.7*</td>
<td>6.5 ± 9.6*</td>
</tr>
<tr>
<td>Glycaemia (mg/dL)</td>
<td>73.4 ± 8.5</td>
<td>74.7 ± 9.5</td>
<td>78.7 ± 10.6*</td>
<td>79.2 ± 10.8*</td>
</tr>
<tr>
<td>Surgical delivery (n [%])</td>
<td>95 (33.5)</td>
<td>515 (36)</td>
<td>133 (39.6)</td>
<td>98 (56)*</td>
</tr>
<tr>
<td>Apgar at 1 min</td>
<td>8.0 ± 1.6</td>
<td>8.3 ± 1.5</td>
<td>8.0 ± 1.7</td>
<td>7.6 ± 2.2*</td>
</tr>
<tr>
<td>Apgar at 5 min</td>
<td>9.5 ± 0.6</td>
<td>9.5 ± 0.8</td>
<td>9.5 ± 0.7</td>
<td>9.4 ± 1.0</td>
</tr>
<tr>
<td>NICU admission (n [%])</td>
<td>8 (2.8)</td>
<td>31 (2.1)</td>
<td>10 (2.9)</td>
<td>12 (6.8)*</td>
</tr>
<tr>
<td>Macrosomia (n [%])</td>
<td>9 (3.2)</td>
<td>65 (4.5)</td>
<td>30 (8.9)*</td>
<td>31 (17.7)*</td>
</tr>
<tr>
<td>Hypertensive disorders (n [%])</td>
<td>10 (3.5)</td>
<td>37 (2.5)</td>
<td>24 (7.1)*</td>
<td>15 (8.5)*</td>
</tr>
</tbody>
</table>

GCT: glucose challenge test; NICU: neonatal intensive care unit. *P < 0.05 vs normal weight.
Prevalence and odds ratio (OR) of macrosomia and caesarean section according to prepregnancy body mass index/weight gain by pregnancy categories.

<table>
<thead>
<tr>
<th>Macrosomia (%)</th>
<th>OR (95% CI)</th>
<th>Caesarean section (%)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obese/excess weight gain (n = 104)</td>
<td>26.2</td>
<td>8.3 (2.4–28.7)</td>
<td>59.6</td>
</tr>
<tr>
<td>Obese/normal weight gain (n = 71)</td>
<td>5.5</td>
<td>5.0</td>
<td>50.7</td>
</tr>
<tr>
<td>Overweight/excess weight gain (n = 169)</td>
<td>13.0</td>
<td>2.9 (1.2–6.8)</td>
<td>39.6</td>
</tr>
<tr>
<td>Overweight/normal weight gain (n = 167)</td>
<td>4.8</td>
<td>3.9</td>
<td>39.5</td>
</tr>
<tr>
<td>Normal/excess weight gain (n = 609)</td>
<td>4.6</td>
<td>1.0</td>
<td>37.4</td>
</tr>
<tr>
<td>Normal/normal weight gain (n = 821)</td>
<td>4.5</td>
<td>3.5</td>
<td>35.0</td>
</tr>
<tr>
<td>Underweight/excess weight gain (n = 134)</td>
<td>4.5</td>
<td>2.2 (0.5–9.3)</td>
<td>34.3</td>
</tr>
<tr>
<td>Underweight/normal weight gain (n = 150)</td>
<td>2.0</td>
<td></td>
<td>32.7</td>
</tr>
</tbody>
</table>

Another consideration related to excess baby weight is that it is highly likely that prepregnancy BMI and weight gain during pregnancy not only influence fetal growth, but also possibly result in long-term programming of childhood weight. Catalano et al. [19] reported that higher maternal prepregnancy BMI was the strongest determinant of childhood adiposity and was independent of macrosomia. For this reason, they suggested that “health care providers should continue to encourage women to stay within the recommended weight before to become pregnant”.

Prepregnancy BMI has also been confirmed as a risk factor for surgical delivery, with a high rate of caesarean section (36%) in obese women, as has already been reported by many authors [20–22]. In our present study, we complete this observation by reporting that, unlike macrosomia, the surgical delivery rate was not influenced by weight gain during pregnancy, an observation shared by Magriples et al. [20], who hypothesized that “in obese women it could be due to an increase in volume of the soft tissues in the pelvis that narrows the pelvic outlet and give also a negative effect on abdominal tone and then on fetal position”. It may also be that this observation is related to the high mean percentage of caesarean section in our centre (37%), which is in line with other Italian departments of obstetrics and gynaecology, but higher compared with other European countries.

6. Conclusion

Overweight and obese women can reduce their risk of macrosomia by limiting their weight gain during pregnancy, whereas the higher surgical delivery rate in obese women is independent of excess weight gain during pregnancy. For this reason, health-care providers need to be informed of the IOM recommendations for gestational weight gain, and should provide individual assistance on dietary intake and physical activity to keep pregnancy weight gain within the ranges recommended. Furthermore, the IOM committee has emphasized the importance of conceiving at a normal BMI by providing women of childbearing age with a service of preconception weight counselling. This appears to be an effective way to reduce not only macrosomia, but also surgical delivery rates and childhood overweight/obesity.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


