Effect of maternal body mass index and weight gain in women with gestational diabetes on the incidence of large-for-gestational-age infants

1. Introduction

It is currently estimated that 50–60% of pregnant women are overweight or obese at the beginning of pregnancy [1,2]. Overweight and gestational diabetes (GD) often coexist, with approximately 65–75% of women with GD being overweight or obese [1,3]. Despite the fact that both maternal obesity and GD are associated with maternal and fetal adverse events, there is ongoing debate over the impact of maternal hyperglycaemia and maternal adiposity on the risk of large-for-gestational-age (LGA) infants. Maternal prepregnancy body mass index (BMI) has been pointed out as an independent predictor of newborn birth weight, and obesity seems to be a stronger predictive factor for macrosomia than hyperglycaemia [2–4]. Another factor that has to be taken into account is excessive weight gain during pregnancy, which has been associated with both GD and LGA [1,5].

The primary aim of the present study was to analyze the influence of maternal prepregnancy BMI and excessive weight gain on the occurrence of LGA infants in women with GD according to the new International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria. The secondary objectives were to analyze the:

- absolute and excessive weight gains in pregnancy according to various prepregnancy maternal BMI categories;
- influence of maternal prepregnancy BMI and maternal excessive weight gain in the week of GD diagnosis, the need for insulin therapy and metabolic control in the third trimester.

2. Material and methods

This was a multicentre cross-sectional study of women diagnosed with GD at medical centres that were part of the Portuguese Group for the Study of Diabetes and Pregnancy in 2011. These centres were representative of the country as a whole, and each hospital sent their data, obtained from the patients’ medical records, to the coordinator of the study group. The merged data were blinded for both patient and hospital identification to preserve full privacy. Included were women diagnosed with GD according to the new IADPSG criteria, while excluded were multiple pregnancies and cases that lacked information on maternal BMI [6].

Also studied were the following variables: maternal characteristics (age, multiparity, previous GD, previous macrosomia, prepregnancy BMI); factors related to the present pregnancy [week of GD diagnosis, need for insulin therapy, initial weekly and maximum daily insulin dosages, absolute weight gain during pregnancy (in kg) and HbA1c during the third trimester]; and factors related to the newborn [gender, gestational age (GA) and birth weight].

Based on their prepregnancy BMI, the women were divided into three groups: ‘normal weight’ (BMI < 25.0 kg/m²); ‘overweight’ (BMI: 25.0–29.9 kg/m²); and ‘obese’ (BMI ≥ 30.0 kg/m²). Weight gain during pregnancy was classified according to US Institute of Medicine (IOM) recommendations as either ‘excessive’ or ‘not excessive’ for each BMI category [7]. Also, metabolic control during the third trimester was classified as either ‘adequate’ or ‘inadequate’, depending on whether HbA1c was < 5.8% or ≥ 5.8%, respectively. The newborns were also classified as LGA if their weight for GA was > P90 (90th percentile), according to Fenton growth charts [8].

The three groups based on maternal BMI and, within each BMI group, the two subgroups based on weight gain in pregnancy were then compared. For the statistical analyses, Microsoft Office Excel Statistical Package for Social Sciences (SPSS), version 21.0, software was used. Quantitative variables were presented as central tendency measures and dispersion measures, and qualitative variables as absolute numbers and percentages. The search for associations between qualitative variables was by the Chi² test and Spearman’s correlation, while differences in the distribution of quantitative variables were determined by Mann–Whitney and Kruskal–Wallis tests. A binary logistic-regression analysis was conducted to assess predictors for LGA infants. A value of $P \leq 0.05$ was considered statistically significant.

This research was conducted according to the prevailing accepted ethical principles.

3. Results

The present study included 1577 women with a mean age of 33.1 ± 5.3 years (range: 17–48 years); 885 (56.2%) were multiparous, 208 (13.3%) had a personal history of previous GD and 94 (6.0%) had delivered a macrosomic infant in a previous
pregnancy. Prepregnancy mean BMI was 27.5 ± 6.0 kg/m² (range: 14.3–51.8 kg/m²). Prior to pregnancy, 627 (39.8%) were ‘normal weight’, 452 (28.7%) were ‘overweight’ and 498 (31.6%) were ‘obese’; 27.9% had excessive weight gain during pregnancy (17.3% of those with normal weight, 34.3% among the overweight and 35.5% among the obese; *P < 0.001).

During pregnancy, 38.7% of patients were being treated with insulin. In the third trimester, their mean HbA1c value was 5.4 ± 0.5% (range: 3.8–6.4%). Metabolic control was considered ‘adequate’ (HbA1c < 5.8%) in 81.7% and ‘inadequate’ (HbA1c ≥ 5.8%) in 18.3%. Also, of the 1470 newborns that could be classified, 144 (9.8%) were LGA.

A higher BMI category was associated with earlier GD diagnosis (*P < 0.001), a greater need for insulin therapy (*P < 0.001), earlier insulin introduction (*P < 0.05) and a larger total daily insulin dosage (*P < 0.001). Yet, despite this, the mean HbA1c in the third trimester was higher in obese women (5.5 ± 0.6%) than in overweight (5.4 ± 0.4%) and normal weight women (5.3 ± 0.4%; *P < 0.001). The percentage of women with adequate glycaemic control in the third trimester was also significantly different (normal weight: 87.7%; overweight: 82.4%; obese: 72.8%; *P < 0.001), and the occurrence of LGA infants differed across these groups, too (normal weight: 5.7%; overweight: 9.4%; and obese: 15.3%; *P < 0.001).

Within each BMI group, excessive weight gain during pregnancy was associated with a higher HbA1c value in the third trimester and higher newborn birth weight in all BMI groups (*P < 0.05). Fig. 1 shows the incidence of LGA newborns in each subgroup. Within each BMI group, those women with excessive weight gains had a greater incidence of LGA infants than women without excessive weight gain (normal weight: *P = 0.049; overweight: *P = 0.001; obese: *P = 0.004).

On multivariate analysis, the presence of previous GD, excessive weight gain during pregnancy, previous macrosomia and inadequate metabolic control in the third trimester were all found to be predictors of LGA infants, with the latter two factors being the strongest predictors. All other independent variables and, specifically, pre-pregnancy maternal BMI proved not to be relevant predictors of LGA infants in this model (Table 1).

4. Discussion

In the present study population of pregnant women with GD, it was found that 60.3% were overweight or obese, which is concordant with what has been previously described [1, 9]. These women were followed at specialized medical centres by physicians, nurses and nutritionists, and were advised regarding diet and physical activity. Although the majority fulfilled the US IOM recommendations for weight gain, a considerable proportion of

Table 1
Predictors of large-for-gestational-age infants (n = 886).

<table>
<thead>
<tr>
<th>Predictors</th>
<th>P</th>
<th>Odds ratio</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age</td>
<td>0.794</td>
<td>1.007</td>
<td>0.956–1.061</td>
</tr>
<tr>
<td>Multiparity (no/yes)</td>
<td>0.818</td>
<td>1.074</td>
<td>0.856–1.966</td>
</tr>
<tr>
<td>Previous gestational diabetes (no/yes)</td>
<td>0.033</td>
<td>1.975</td>
<td>1.055–3.697</td>
</tr>
<tr>
<td>Previous macrosomia (no/yes)</td>
<td>&lt;0.001</td>
<td>4.046</td>
<td>1.948–8.402</td>
</tr>
<tr>
<td>Prepregnancy maternal body mass index (normal weight/overweight/obese)</td>
<td>0.365</td>
<td>1.156</td>
<td>0.845–1.581</td>
</tr>
<tr>
<td>Insulin therapy during pregnancy (no/yes)</td>
<td>0.765</td>
<td>1.080</td>
<td>0.652–1.790</td>
</tr>
<tr>
<td>Excessive weight gain during pregnancy (no/yes)</td>
<td>&lt;0.001</td>
<td>2.538</td>
<td>1.538–4.189</td>
</tr>
<tr>
<td>Inadequate metabolic control during third trimester* (no/yes)</td>
<td>&lt;0.001</td>
<td>3.068</td>
<td>1.835–5.128</td>
</tr>
</tbody>
</table>

* HbA1c ≥ 5.8%.
overweight and obese women did not, as described elsewhere [1,2,9–11].

In our study, a higher prepregnancy BMI was positively associated with an earlier diagnosis of GD, a more frequent and earlier need for insulin, and a higher insulin dose. This may be due to obese women having more evidence of metabolic dysfunction [12]. Excessive weight gain was not associated with a need for insulin therapy, earlier initiation of treatment or higher insulin doses. HbA1c in the third trimester was significantly different among the three BMI groups, being higher for women with higher prepregnancy BMI. However, in all BMI groups, excessive weight gain during pregnancy was associated with significantly poorer metabolic control in the third trimester. This may have been due to different routine management across treatment centres and greater difficulty in treating GD in women with greater weight gain. It seems, therefore, that both maternal BMI and weight gain during pregnancy are important factors in determining metabolic control in women with GD.

In our study, the occurrence of LGA infants was positively associated with a higher BMI on univariate analysis, with obese women having an almost threefold higher incidence of LGA than normal weight women [1,2,9]. Excessive weight gain was also positively associated with LGA in all prepregnancy BMI groups. Obese women with excessive weight gain had the highest incidence of LGA (21.7%), followed by overweight women with excessive weight gain (16.5%). Normal weight women with excessive weight gain had a higher incidence of LGA compared with overweight women with no excessive weight gain, as has been previously described [11,13]. The relationship between maternal prepregnancy BMI, weight gain during pregnancy and the occurrence of LGA newborns in women with GD has been reported elsewhere with similar results [1,4,9,10].

However, in our multivariate analysis, the initial BMI proved not to be a predictor of LGA infants in women with GD. On the contrary, the importance of excessive weight gain as a more important predictor of LGA was confirmed. This is concordant with previous results obtained in women with GD [11,14]. In our present sample, it was also found that a higher HbA1c in the third trimester was a predictor of LGA babies, which is concordant with previous findings [15].

As far as can be ascertained, this is the first multicentre Portuguese study of the effects of maternal prepregnancy BMI and gestational weight gain in women with GD. Also, our study included a large number of patients representative of a significant percentage of the total Portuguese pregnant population with GD in 2011. Moreover, also included were patients with GD diagnosed according to the new IADPSG criteria, thereby providing an opportunity to examine how this new definition applies to the association between fetal macrosomia and birth weight predictors.

Nevertheless, all cross-sectional multicentre studies have limitations. The diagnosis of GD was not made at the same time in every case, and the effects of possible differences among centres regarding insulin therapy and strategies for weight control during pregnancy cannot be ruled out. Also, as this was the first year for applying the new IADPSG criteria, these differences may have been even more pronounced.

5. Conclusion

In summary, in women with GD, maternal prepregnancy BMI and excessive weight gain during pregnancy are important factors influencing the course of GD. It appears that, while maternal prepregnancy BMI is important, excessive weight gain during pregnancy is a more relevant factor for fetal overgrowth. This highlights the need to not only control women’s weight before pregnancy but, more importantly, during its course as well, to reduce the risk of LGA infants.

Authors’ contributions

M.J.S. conceived the study, conducted the statistical analyses and wrote the manuscript. V.F. contributed to the study design, data interpretation and manuscript-writing. M.L.P. participated in data collection, discussion and writing of the manuscript. O.M. discussed and reviewed the manuscript. The members of The Portuguese Pregnancy and Diabetes Study Group of the Portuguese Society of Diabetology participated in data collection.

Disclosure of interest

The authors declare that they have no competing interest.

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