Association between Dietary Glycemic Index and Excess Weight in Pregnant Women in the First Trimester of Pregnancy

Associação entre o índice glicêmico dietético e o excesso de peso em gestantes no primeiro trimestre de gestação

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Abstract

Objective  To assess the association between dietary glycemic index (GI) and excess weight in pregnant women in the first trimester of pregnancy.

Methods  A cross-sectional study in a sample of 217 pregnant women was conducted at the maternal-fetal outpatient clinic of the Hospital Geral de Fortaleza, Fortaleza, state of Ceará, Brazil, for routine ultrasound examinations in the period between 11 and 13 weeks + 6 days of gestation. Weight and height were measured and the gestational body mass index (BMI) was calculated. The women were questioned about their usual body weight prior to the gestation, considering the prepregnancy weight. The dietary GI and the glycemic load (GL) of their diets were calculated and split into tertiles. Analysis of variance (ANOVA) or Kruskal-Wallis and chi-squared (χ²) statistical tests were employed. A crude logistic regression model and a model adjusted for confounding variables known to influence biological outcomes were constructed. A p-value < 0.05 was considered significant for all tests employed.

Keywords

► pregnancy  
► glycemic index  
► glycemic load  
► excess weight

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Introduction

Gestational weight gain is the focus of several studies, as a result of the worldwide epidemic of obesity and its importance in gestational outcomes. In the third trimester of gestation, both in the crude model and in the model adjusted for age, total energy intake, and saturated fatty acids. However, this association was not observed in relation to the GL.

Conclusion A high dietary GI was associated with excess weight in women in the first trimester of pregnancy.

Results The sample group presented a high percentage of prepregnancy and gestational overweight (39.7% and 40.1%, respectively). In the tertile with the higher GI value, there was a lower dietary intake of total fibers (p = 0.005) and of soluble fibers (p = 0.008). In the third tertile, the dietary GI was associated with overweight in pregnant women in the first trimester of gestation, both in the crude model and in the model adjusted for age, total energy intake, and saturated fatty acids. However, this association was not observed in relation to the GL.

The hypothesis that there is an association between overall dietary GI, GL, and disease risk have been inconsistent with this hypothesis. Therefore, given the importance of the diet to the nutritional status and health of pregnant women, the objective of the present study was to evaluate the association of dietary GI and GL during pregnancy with excess weight (overweight and obesity) in women at prepregnancy and during the first trimester of gestation.

Methods A cross-sectional study, part of a larger prospective cohort entitled “Prediction of preeclampsia using the triple vascular
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The sample comprised 217 pregnant women that underwent routine ultrasound scans at between 11 and 13 weeks + 6 days of gestation. Weight and height were measured during pregnancy using a Marte digital anthropometric scale (Marte Científica, São Paulo, SP, Brazil), with a capacity of 200 kg and 2 m, with a sensitivity of 50 g and of 0.50 cm, respectively. The women were questioned about their usual body weight prior to the gestation, considering the prepregnancy weight. Their body mass index (BMI) was calculated as their weight in kilograms divided by their height in meters squared (kg/m²). The prepregnancy BMI was classified according to the World Health Organization (WHO) criteria as underweight (< 18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²) and obese (≥ 30 kg/m²). The gestational BMI was calculated using the table of Atalah et al.15 Overweight or obese women were grouped together into a category named excess weight.

Dietary intake data was collected through interviews that were applied two the 24 hours dietary recall (24hDR) during 2 non-consecutive days, including one weekend day. The pregnant women informed their daily food intake from the previous 24 hours in household measures and, subsequently, we converted them into grams.16 Dietary data were input to the DietWin Professional 2.0 software (dietWin, Porto Alegre, RS, Brazil), which calculated the nutritional composition of the diets, along with the total daily energy intake in kilocalories (Kcal). The nutrients consumed were adjusted for personal variability.

Based on the information available for the chemical composition of the diets, the GI was determined using the table of Brand-Miller et al.18,19 For foods whose GIs were not listed in the tables, the value was estimated based on foods with similar characteristics and carbohydrate levels. The daily GI was calculated by multiplying the GI of each food (IGf) by the proportion of glycemic carbohydrate in the food item (HCOgf = HCOf / total fiber of food) regarding the amount of daily glycemic carbohydrate, and summing the resultant values (daily GI = \( \sum (\text{IGf} \times \text{HCOgf}) / \sum \text{HCOgf} \)). The daily GL was determined by adding the glycemic carbohydrate of each food, in grams, multiplied by its individual GI, and dividing it by 100 (daily GL = \( \sum (\text{IGf} \times \text{HCOgf}) / 100 \)).

The daily GI and GL of each of the two recalls were calculated, and an arithmetic mean of daily GI and GL for each individual was obtained. The usual intake of GI and GL was estimated by the multiple source method (MSM) to correct for interpersonal variability.21 The mean values adjusted by the MSM were split into tertiles.

In addition, the presence of under-reporting of dietary intake was analyzed. To this end, the basal metabolic rate (BMR) was estimated using the formulas recommended by the Food and Agriculture Organization (FAO)/WHO,22 and the total energy intake/BMR ratio was calculated. Values < 1.5, which is the reference cutoff point, were considered indicative of under-reporting.23

The values for dietary intake and anthropometric variables were split into the GI tertiles. Analysis of variance (ANOVA) or the Kruskal-Walls and chi-squared (\( \chi^2 \)) statistical tests were employed. A crude logistic regression model and a model adjusted for confounding variables known to influence biological outcomes were constructed. A p-value < 0.05 was considered significant for all statistical tests used. The IBM SPSS for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA) was used for all analyses.

Results

The majority (77.9%) of the participants of the present study were between 19 and 34 years old, and most patients (67.7%) were married or living with a partner. The distribution of the women according to their reported race was predominantly mixed (71.4%) and white (24.4%). The anthropometric data from the pregnant women are presented in Table 1. The mean prepregnancy BMI of the population studied was 24.5 kg/m² (± 4.4). The prepregnancy BMIs showed that a high percentage (39.7%) of the patients had excess weight (overweight and obese). The gestational BMIs (first trimester of gestation) revealed that 40.1% of the women had excess weight. The mean BMI of the population increased to 25.1 kg/m² (± 4.4). Weight gain occurred in most of the women (71.9%), with a mean weight increase of 3.1 kg (± 2.5).

The relationship between sociodemographic profile, GA, BMI, and food consumption with the GI tertiles are shown in Table 2. There was a significant difference in the consumption of total (p = 0.005) and insoluble fibers (p = 0.008), with a lower intake of this nutrient in the highest GI tertile. The GL varied between the three tertiles (p = 0.002) without a specific pattern, but following the variation of carbohydrates, even though the latter did not give a difference between the tertiles.

### Table 1 Anthropometric assessment at prepregnancy and during the first trimester of pregnancy

| Variable | n (%) |
|----------|-------|
| Prepregnancy nutritional diagnosis | |
| Underweight | 9 (4.1) |
| Normal weight | 122 (56.2) |
| Excess weight | 86 (39.7) |
| Nutritional diagnosis during pregnancy | |
| Underweight | 34 (15.7) |
| Normal weight | 96 (44.2) |
| Excess weight | 87 (40.1) |
| Total | 217 (100.0) |

Source: “Rasmussen et al (2009)”14 and “Atalah et al (1997).”15
All of the dietary intake variables and gestational characteristics were tested according to the GI and GL tertiles. Logistic regression models were constructed showing that the high GI values in the third tertile were associated with excess weight (overweight and obesity) of the pregnant women in the first trimester in both the crude model and in the model adjusted for age, total energy intake, saturated fatty acids, and under-reporting. This association was not observed for the GL (►Table 3).

**Discussion**

The results of the present study revealed a high rate of excess weight (overweight and obesity) before pregnancy, showing the need for continuous monitoring of weight and food consumption. Adequate weight gain and nutrient intake are fundamental for the gestational period, preventing complications in pregnancy outcomes. Prepregnancy excess weight is a risk factor for overweight and obesity during pregnancy. Pregnant women gain weight during this period but beginning the pregnancy with excess weight can lead to an increase in body mass that can affect negatively the health of both the mother and the newborn.

Excess weight in the first trimester of pregnancy was found in 40.1% of the women. This group may have included women with excess weight before pregnancy that continued to gain weight. Excessive gestational weight gain has been associated with an increased risk of large infants for the GA, preeclampsia, gestational diabetes, cephalopelvic disproportion, trauma, asphyxia, and perinatal death. Excessive weight gain can lead to an increased risk of postpartum weight retention, influencing a potential obesity that may persist or worsen during the lifetime of the woman.

【Table 2 Distribution of gestational and dietary intake characteristics according to the glycemic index】

| Variables                        | GI         | p-value*   |
|----------------------------------|------------|------------|
|                                  | 54.1–57.4 (n = 72) | 57.5–58.2 (n = 73) | 58.3–60.5 (n = 72) |
| Dietary intake                   |            |            |            |
| Energy, Kcal                     | 1,950.7 (553.0) | 1,963.7 (629.5) | 1,743.6 (682.2) | 0.061 |
| Protein, g/1000 Kcal             | 44.7 (9.9) | 41.9 (12.2) | 46.1 (12.2) | 0.093 |
| Carbohydrate, g/1000 Kcal        | 128.8 (19.4) | 129.1 (20.4) | 123.2 (20.9) | 0.150 |
| Dietary fiber, g                 | 20.0 (10.5) | 19.7 (9.8) | 15.1 (6.3) | 0.005* |
| Soluble fiber, g                 | 6.9 (4.0) | 6.4 (3.3) | 5.4 (2.7) | 0.071 |
| Insoluble fiber, g               | 9.4 (5.9) | 9.7 (6.6) | 7.0 (3.7) | 0.008* |
| Lipids, g/1,000 Kcal             | 33.8 (6.7) | 34.8 (7.3) | 35.4 (8.7) | 0.435 |
| SFA, g/1,000 Kcal                | 10.8 (3.2) | 9.8 (3.0) | 9.8 (3.1) | 0.065 |
| PFA, g/1,000 Kcal                | 6.4 (3.7) | 6.6 (3.4) | 7.2 (3.7) | 0.250* |
| MFA, g/1,000 Kcal                | 8.8 (2.5) | 8.6 (3.0) | 9.3 (3.4) | 0.354 |
| Glycemic load                    | 141.3 (26.1) | 143.7 (38.4) | 124.5 (32.2) | 0.002* |
| Energy under-reporting, %        | 44 (61.1) | 49 (67.1) | 53 (73.6) | 0.279 |
| Socioeconomic profile            |            |            |            |
| Age, years old                   | 27.6 (6.3) | 27.3 (7.2) | 26.8 (6.9) | 0.284 |
| Marital Status, married (%)      | 45 (62.5) | 55 (75.3) | 47 (65.3) | 0.311 |
| Nutritional status               |            |            |            |
| Gestational age, weeks           | 12.6 (0.9) | 12.8 (0.8) | 12.6 (0.9) | 0.307 |
| Prepregnancy BMI,1 kg/m²          | 24.5 (3.7) | 25.2 (4.1) | 25.0 (4.6) | 0.199 |
| Gestational BMI,2 kg/m²           | 24.9 (3.2) | 25.5 (4.2) | 25.8 (4.6) | 0.204 |
| Pre-BMI,1 excess weight (%)       | 26 (36.1) | 30 (41.1) | 39 (54.2) | 0.078 |
| 2 Gestational BMI, excess weight (%) | 36 (50.6) | 37 (50.7) | 48 (66.7) | 0.074 |

Abbreviations: BMI, body mass index; g, grams; GI, glycemic index; MFA, monounsaturated fatty acids; PFA, polyunsaturated fatty acids; SFA, saturated fatty acids.

Source: *Rasmussen et al (2009)14 and **Atalah et al (1997).15

*ANOVA Test: p < 0.05.

Kruskal-Wallis and χ²: p < 0.05.
Table 3 Odds ratio of gestational body mass index according the tertiles of glycemic index and glycemic load adjusted by the multiple source method

|                          | Gestational BMI* (with and without excess weight) |
|--------------------------|-----------------------------------------------|
|                          | Crude model | Model 1** | Model 2*** |
| GI MSM                   |             |           |            |
| 1st tertile (51.4–57.4)  | 1.00        | 1.00      | 1.00       |
| 2nd tertile (57.5–58.2)  | 1.028 (0.536–1.971) | 0.992 (0.504–1.955) | 0.993 (0.494–1.996) |
| 3rd tertile (58.3–60.5)  | 2.000 (1.020–3.922) | 1.988 (0.981–4.029) | 2.204 (1.064–4.567) |
| p-value                  | 0.045       | 0.059     | 0.034      |
| GL MSM                   |             |           |            |
| 1st tertile (52.9–119.7) | 1.00        | 1.00      | 1.00       |
| 2nd tertile (120.9–146.1)| 1.147 (0.592–2.223) | 1.216 (0.566–2.611) | 1.201 (0.552–2.614) |
| 3rd tertile (148.4–307.0)| 0.756 (0.392–1.458) | 1.149 (0.446–2.961) | 1.645 (0.583–4.644) |
| p-value                  | 0.402       | 0.764     | 0.354      |

Abbreviations: BMI, body mass index; CI, confidence interval; GI, glycemic index; GL, glycemic load; MSM, multiple source method; OR, odds ratio. *First trimester; **Adjusted for age (tertile) and total energy intake (tertile); *** Adjusted for age (tertile), total energy intake (tertile), saturated fatty acids (tertiles), and under-reporting (yes or no).

GI in 78.7% of an obese group, highlighting a high percentage of individuals who consumed diets with inadequate GI at breakfast (82.9%), at afternoon snacks (60.0%), and at dinner (64.6%).

The GI quantifies the glycemic variations in response to the dietary carbohydrate consumption. When diets with high GI are consumed, a glycemic increase occurs due to the high level of glucose, leading to hyperinsulinemia. Different sources of carbohydrates have varying absorption rates, and their effects on plasma concentrations of glucose and insulin vary accordingly. In the present study, both the intake of total fiber as well as of the insoluble fiber declined by the tertile. Diets containing a higher level of fiber retard the absorption of glucose by the organism, avoiding a rapid increase in blood glucose and reducing the release of insulin by the pancreas.

Postprandial glycemia is modulated mainly by the speed of release of carbohydrates derived from the diet into the bloodstream after meals, by the clearance time of the carbohydrates through insulin secretion, and by peripheral tissue sensitivity to the action of this hormone. Thus, the type and amount of dietary carbohydrates are key factors that influence the glycemic response. Studies have shown that pregnant women receiving advice and encouragement to consume a low-GI diet have longer gestational periods, as well as fewer preterm births, although no effects of these diets on infant birth weight have been found in groups at risk of macrosomia.

Another aspect to consider is the GL, which is calculated by multiplying the GI of foods by their glycemic carbohydrate content and reflects directly the quantity and quality of dietary carbohydrates. The GL is one of the most representative characteristics of the overall diet because it indicates the dietary fiber intake. No difference was observed among the GL values in the GI tertiles, probably because the GL quantifies the total effect of a given amount of carbohydrate on plasma glucose, representing the GI product of a food by its available carbohydrate content. The GL can provide a better reflection of the glycemic response of a specific food than the GI. The glycemic effect of foods varies with the composition of the food and with the methods of preparation.

The level of GI necessary to affect body composition remains unclear. Further elucidation of the mechanisms associated with the potential benefits of consuming carbohydrates, as measured by GI values, is essential before introducing this as a strategy for controlling obesity and its comorbidities, particularly during pregnancy, when weight gain can be expected. Moses et al found no significant differences in fetal and obstetric outcomes between subjects who followed a low-GI diet versus a higher-GI diet. A randomized controlled trial reported no difference in birth weight of newborns of mothers consuming a low-GI diet, whereas the gestational period was 10 days longer in the same group, suggesting that this type of diet may be an important factor for preventing prematurity. A meta-analysis that assessed 7 maternal and 11 newborn outcomes observed that low-GI diets may have beneficial effects on maternal outcomes for those at risk of developing high glucose levels, without causing adverse effects on newborn outcomes.

**Conclusion**

Based on the results of the present study, it can be concluded that high-GI diets were associated with excess weight in pregnant women in the first trimester of gestation.
Therefore, individualized nutritional consultations are recommended in this group to promote dietary improvements.

Contributors
Ellery T. H. P., Sampaio H. A. C., Carioca A. A. F., Silva B. Y. C., Alves J. A. G., Costa F. S., Araujo Júnior E. and Melo M. L. P. contributed with the project, the interpretation of data, the writing of the article, the critical review of the intellectual content, and with the final approval of the version to be published.

Conflicts of Interest
The authors have no conflicts of interest to declare.

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