Can the pregnant woman's food intake be influenced by her clinical condition during pregnancy?

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Abstract

Objectives: to evaluate the association between dietary intake during pregnancy and different gestational clinical conditions (hypertensive, diabetics, smokers, having intrauterine growth restriction and a control group) and associated factors.

Methods: cross-sectional study nested in a cohort study from 2011 to 2016 that occurred in three hospitals in Porto Alegre (Brazil). Sociodemographic conditions and prenatal were investigated and maternal feeding practices were analyzed by the Food Frequency Questionnaire. To calculate the caloric percentage from food groups, food items were categorized into:unprocessed or minimally processed, processed and ultra-processed foods. The Kruskal-Wallis test with Dunn's post-hoc compared food consumption between the groups and the Poisson regression evaluated the association between the variables.

Results: there was no statistical difference in food intake among 303 mothers of different gestational clinical conditions, but diabetic pregnant women had lower caloric contribution value of ultra-processed foods. In addition, pregnant women from all groups showed adequate consumption in relation to the percentage of caloric contribution of macronutrients in the total energy value.

Conclusions: there was no difference in energy consumption according to different gestational clinical conditions.In diabetic, smokers and hypertensive pregnant women, associations between total energy intake and different sociodemographic factors were observed between the groups.

Key words *Pregnant women, Maternal and child health, Prenatal nutrition, Food consumption, Nutrition assessment*

http://dx.doi.org/10.1590/1806-93042020000200011

Introduction

In order to ensure adequate weight gain and favorable intrauterine environment, pregnant women should meet nutritional requirements.[1] Insufficient gestational weight gain is associated with greater risk of low birth weight and prematurity, while excessive gain is related to newborns considered large for gestational age and cesarean sections.[2]

Besides the influence in maternal and neonatal outcomes, inadequate maternal nutrition may also develop an unfavorable intrauterine environment, which is related to increased incidence of cardiovascular disease, type 2 *diabetes mellitus* (DM), obesity and systemic arterial hypertension in the offspring.[3]

The World Health Organization (WHO) recommends adequate nutrition and physical activity for pregnant women to stay healthy and to prevent excessive weight gain during pregnancy.[4] Thus, dietary interventions in prenatal care, when necessary, are important to ensure adequate health in pregnancy and to ensure appropriate gestational weight gain in order to promote beneficial obstetric and neonatal results.[5] The Food Frequency Questionnaire (FFQ) is one of the instruments indicated for assessing food consumption in epidemiological studies with previous validation for specific populations. The instrument is able to assist in indicating associations between food and health and in analyzing nutritional deficiencies in populations.[6] In addition, it is possible to carry out an assessment taking into account food processing level.[7]

According to the Food Guide for the Brazilian Population, unprocessed and minimally processed foods should be the basis of diet, while processed and ultra-processed foods should be limited and avoided, respectively.[8]

Consistent evidence provides positive association of ultra-processed food intake with overweight/obesity in the population in general,[9] as well as between ultra-processed food consumption and gestational weight gain.[10] However, it remains unclear whether associations can be attributed to processing itself or the nutritional content of ultra-processed foods.[9]

Particularly, pregnancy is a period when women suffer hormonal, emotional and social influences, constituting an opportune moment for the development of effective actions to promote healthy eating.[11] The importance of adequate nutritional intake during prenatal care and its impact on maternal and child health is well established. However, there is a lack of studies that investigate the relationship between pregnant women nutrition with different clinical conditions. The current study aimed to investigate the association between food consumption and dietary pattern during pregnancy and different gestational clinical conditions. It is also intended to identify possible factors that may be associated with maternal food consumption.

Methods

This is a cross-sectional analysis nested in a larger observational birth cohort, the"Impact of perinatal environment variations on the health of newborns at first 6 months of life (IVAPSA)".[12]

The initial recruitment occurred from September 2011 to January 2016. We selected parturients residing in the city of Porto Alegre, and full-term newborns between 24 and 48 hours after delivery in three public hospitals in Porto Alegre (RS, Brazil). The three participating hospitals were: *Nossa Senhora da Conceição and Fêmina*, both from Conceição Hospital Group (GHC – Portuguese acronym), and *Hospital de Clínicas de Porto Alegre* (HCPA). The three hospitals provide regular pre, peri and neonatal care and are referral centers for high-risk pregnancies.

The follow-up of mothers and their newborns in the first six months after delivery was carried out through home visits and interviews at the Clinical Research Center of Porto Alegre Teaching Hospital. The interviews occurred at seven and fifteen days, in the first, third and sixth months of the child's life. Children of women who tested positive for HIV (Human Immunodeficiency Virus), newborn from twin gestations, preterm infants, and infants with congenital diseases or requiring hospitalization were excluded.[12]

The sample included mother-child pairs subdivided into five groups distributed by the following maternal gestational conditions: diabetic, hypertensive, with intrauterine growth restriction through the birth of small babies for gestational age (SGA), smokers and the control group. Mothers from the *diabetes mellitus* (DM) group had a clinical diagnosis of diabetes (gestational, type 1 and 2). The hypertension (HYP) group included mothers diagnosed with hypertensive disorders during pregnancy (preeclampsia, eclampsia, preeclampsia superimposed on chronic hypertension, chronic hypertension, or gestational hypertension). In the intrauterine growth restriction (IUGR) group, newborns that had birth weight below the 5th percentile according to the fetal growth curves proposed by Alexander *et al*.[13] and, therefore, classified as SGA, were included. Tobacco group included women who smoked during pregnancy, regardless of the duration and the number of cigarettes. The control group included mothers who did not have any of the conditions of the other intrauterine exposure groups.

Sociodemographic, pre-, peri- and neonatal information was collected at the hospital through an interview in the first 48 hours postpartum and complemented with information from medical records. In the following interview, at 7 days of life, the Food Frequency Questionnaire (FFQ) was applied, which assessed consumption and dietary pattern of women during pregnancy. The instrument contains 96 food types and intake frequency ranged from "never" to "more than three times a day". The questionnaire was adapted from another FFQ previously validated for pregnant women in Brazil.[14] Food portions were determined by standard measurements according to the Table for Assessment of Food Consumption in Home Measures.[15] We used the United States Department of Agriculture (USDA) Food Composition Database to calculate the nutritional composition of foods.[16] To compare percentage adequacy of caloric contribution of each macronutrient to the total energy value, we used recommendations from the Institute of Medicine (IOM) of the United States National Academy of Sciences.[17] Food items were categorized into three groups, according to the adapted classification by Monteiro *et al*.[18] and the Food Guide for the Brazilian Population[8]: unprocessed or minimally processed foods (vegetables, fruits, cereals, milk, eggs, among others), including recipes based on these foods; processed foods (syrup fruits, dried meat, cheese, bread, among others); and ultra-processed foods (cookies, ice cream, candies, instant noodles, among others). Afterwards, we calculated the total caloric percentage from food groups according to the processing degree.

Pre-gestational weight was obtained from Maternity Handbook of the Ministry of Health and height was obtained from medical records. Then, pre-gestational Body Mass Index (BMI) was calculated from this information. Gestational weight gain was calculated from the difference between weight before delivery (obtained from medical records) and pre-pregnancy weight.

Categorical variables were expressed as absolute and relative frequency and continuous variables as means and standard deviations (SD) if distributed parametrically and as median (P_{25} - P_{75}) and confidence interval if nonparametric. In order to compare groups, we performed ANOVA with Tukey's post-hoc test for parametric variables and Kruskal-Wallis with Dunn's post-hoc test for non-parametric variables. We used the chi-square test to detect associations between categorical variables. The Poisson regression model was used to test for associations between variables. The significance level and confidence interval were set at $p<0.05$ and 95%, respectively. Database processing and analysis were performed using Statistical Package for the Social Sciences (SPSS) software, version 18.0.

The Research Ethics Committees of Porto Alegre Teaching Hospital(number 11-0097) and Conceição Hospital Group (number 11-027) approved the IVAPSA project. Puerperal women who agreed to participate in the study signed the Informed Consent Form (ICF). The study was carried out according to the ethical precepts of the Resolution of the National Health Council (CNS) 466/2012.[19]

Results

This sample included 303 mother-child pairs. They were distributed as follows: 62 (20.5%) DM, 30 (9.9%) HYP, 61 (20.1%) tobacco, 30 (9.9%) IUGR, and 120 (39.6%) control group. Pregnant women who reported consumption above 10,000 Kcal were removed from the sample because we consider extreme values of energy consumption, and therefore, unreliable.

Table 1 shows the distribution of maternal and neonatal characteristics according to gestational clinical conditions. Participants had a mean (± SD) maternal age of 27 (± 6.7) years and maternal education of 9.4 (± 2.7) years. Median (25th; 75th percentile) for family income was R$ 1,500 (1,000; 2,400). Most women lived with their partners (80.2%), were multiparous (60.7%) and had vaginal delivery (64.4%). Regarding maternal sociodemographic characteristics, mean age was significantly higher in the HYP group (30.4 years) compared to tobacco (25.4 years), IUGR(24 years) and control (26.6 years) groups. Women in the control group had significantly higher family income (R$ 2,000) compared to tobacco (R$ 1,244). The tobacco group showed lower proportion of women living with a partner (60.7%) than DM group (87.1%) and control group (85.8%). Regarding obstetric data, primiparity was significantly more prevalent in the IUGR group (60%) when compared to HYP (23.3%). There was no difference in type of delivery among DM, tobacco, IUGR and control groups; however, HYP group presented higher proportion of cesarean sections. Women in the DM (10 ± 3), HYP (9 ± 2) and control (8 ± 3) groups had significantly higher median of prenatal consultations, compared to

Table 1

Sociodemographic; perinatal; maternal and neonatal anthropometric characteristics of the sample according to the gestational clinical condition; IVAPSA cohort – Porto Alegre (RS), Brazil – 2011 – 2016.

	DM Group (62)	**HYP Group (30)**	**TOBACCO Group (61)**	**IUGR Group (30)**	**Control Group (120)**	**Total (303)**	***p***
Maternal age (years), $\bar{X}$±SD	29.2^{ac} ± 5.8	30.4^{a} ±6.0	25.4^{b}±6.1	24.0^{b}±5.3	26.6^{bc}±7.2	27.0 ±6.7	<0.001*
Maternal education (years), $\bar{X}$±SD	9.8±3.2	9.1±2.7	8.7±2.5	9.8±2.1	9.5±2.6	9.4±2.7	0.127*
Number of prenatal	10±3^{a}	9±2^{ab}	6±3^{c}	8±3^{bc}	8±3^{a}	8±3	<0.001*
consultations, $\bar{X}$±SD	10±3^{a}	9±2^{ab}	6±3^{c}	8±3^{bc}	8±3^{a}	8±3	<0.001*
Family income (reais), median (P_{25};P_{75})	1,500 (1,000; 2,500)^{ab}	1,700 (800; 2,300)^{ab}	1,244 (800; 1,800)^{b}	1,405 (1,000; 3,000)^{ab}	2,000 (1,200; 3,000)^{a}	1,500 (1,000; 2,400)	0.006†
Lives with partner:							0.001¥
Yes, n (%)	54 (87.1)^{a}	24 (80)^{ab}	37 (60.7)^{b}	25 (83.3)^{ab}	103 (85.8)^{a}	243 (80.2)	
No, n (%)	8 (12.9)^{a}	6 (20)^{ab}	24 (39.3)^{b}	5 (16.7)^{ab}	17 (14.2)^{a}	60 (19.8)	
Number of children:							0.005¥
Primiparous, n (%)	20 (32.3)^{ab}	7 (23.3)^{a}	18 (29.5)^{ab}	18 (60)^{b}	56 (46.7)^{ab}	119 (39.3)	
Multiparous, n (%)	42 (67.7)^{ab}	23 (76.7)^{a}	43 (70.5)^{ab}	12 (40)^{b}	64 (53.3)^{ab}	184 (60.7)	
Type of delivery:							<0.001¥
Cesarean, n (%)	26 (41.9)^{a}	22 (73.3)^{b}	18 (29.5)^{a}	10 (33.3)^{a}	32 (26.7)^{a}	108 (35.6)	
Vaginal, n (%)	36 (58.1)^{a}	8 (26.7)^{b}	43 (70.5)^{a}	20 (66.7)^{a}	88 (73.3)^{a}	195 (64.4)	
Child's gender:							0.906¥
Female, n (%)	30 (48.4)	16 (53.3)	30 (49.2)	17 (56.7)	65 (54.2)	158 (52.1)	
Male, n (%)	32 (51.6)	14 (46.7)	31 (50.8)	13 (43.3)	55 (45.8)	145 (47.9)	
Birth weight (g), median (P_{25};P_{75})	3,373 (3,090; 3,805)^{b}	3,218 (2,955; 3,630)^{ab}	3,165 (2,875; 3,330)^{a}	2,565 (2,410; 2,680)^{c}	3,280 (2,988; 3,640)^{b}	3,220 (2,905; 3,520)	<0.001†
Length at birth (cm), $\bar{X}$±SD	49.1^{ab}±2.0	48.0^{bc}±2.1	48.1^{c} ±2.3	46.2^{d}±1.6	49.3^{a}±2,0	48.6 ±2.2	<0.001*
Pre-gestational BMI (kg/m²), median (P_{25};P_{75})	28 (25; 31.2)^{a}	27.2 (24; 32.8)^{a}	23.8(22.1; 26.6)^{b}	21.7 (19,8; 26.1)^{b}	23.8 (20.8; 27.6)^{b}	25.1 (22; 28.6)	<0.001†

DM = *diabetes mellitus*; HYP = hypertension; IUGR = intrauterine growth restriction; SD = standard deviation; CI = confidence interval; BMI=body mass index; Different letters represent statistically different means/medians; *ANOVA withTukey's post-hoc; † Kruskal–Wallis with Dunn's post-hoc; ¥ Chi-square.

women in the tobacco (6 ± 3) and IUGR groups (8 ± 3). Median pre-gestational BMI was significantly higher in the DM and HYP groups compared to the other groups.

Maternal energy and macronutrient consumption according to different gestational clinical conditions are shown in Table 2. There was no statistically significant difference in energy and macronutrient consumption among the groups. Median (P_{25} - P_{75}) energy (kcal), carbohydrates (g), proteins (g) and fats (g) consumption was, respectively: 4,628.4 kcal (3,541.1; 6,099.2), 653.8g (498.4; 897.0), 140.2g (114.4; 186.6) and 144.1g (104.7; 192.6). Regarding the contribution to total energy intake of food groups according to processing degree, unprocessed or minimally processed and ultra-processed foods intake was different between groups. The DM group had lower caloric contribution from ultra-processed foods compared to the tobacco and control groups, however, the DM group showed higher consumption of unprocessed or minimally processed foods.

Median (P_{25} – P_{75}) values of percentage from macronutrients caloric contribution were: 58.4% (26.51; 88.75) for carbohydrates, 12.8% (3.65; 22.04) for proteins and 28.2% (10.5; 63.5) for fats.

The variables related to total energy consumption are shown in Table 3. In the DM group, higher pre-gestational BMI was associated to lower caloric consumption (p = 0.016; β = -111.39) and higher gestational weight gain to higher maternal caloric intake (p = 0.015; β = 64.88). In the HYP group, higher maternal education (p = 0.040; β = -267.3) and higher family income (p = 0.045; β = -0.51) were associated with lower gestational energy

Table 2

Macronutrients and energy intake in pregnancy and food processing degree analysis; IVAPSA cohort – Porto Alegre (RS), Brazil – 2011 – 2016.

	DM Group (62)	HYP Group (30)	TOBACCO Group (61)	IUGR Group (30)	Control Group (120)	Total (303)	*p*
Total kilocalories (kcal), median (P_{25};P_{75})	4,352.9 (3,239.6; 5,641.8)	5,103.0 (3,570.9; 6,866.5)	4,755.5 (3,701.7; 6,235.0)	4,825.5 (3,477.0; 5,825.3	4,268.3 (3,604.5; 6,134.6)	4,628.4 (3,541.1; 6,099.2)	0.434
Carbohydrates (g/day), median (P_{25};P_{75})	614.6 (408.8; 869.1)	795.4 (502.0; 995.5)	696.7 (549.1; 855.7)	631.1 (575.4; 915.5	631.1 (575.4; 915.5)	653.8 (498.4; 897.0)	0.225
Proteins (g/day), median (P_{25};P_{75})	139.9 (110.1; 186.8)	150.8 (109.6; 204.6)	137.4 (115.4; 171.2)	140.7 (123.8; 188.6	140.7 (123.8; 188.6)	140.2 (114.4; 186.6)	0.952
Fats (g/day), median (P_{25};P_{75})	134.3 (91.3; 193.8)	151.4 (101.6; 212.5)	143.6 (105.5; 197.0)	152.8 (98.9; 195.0	152.8 (98.9; 195.0)	144.1 (104.7; 192.6)	0.772
Fats:							
Saturated (g/day), median (P_{25};P_{75})	42.0 (29.5; 62.7)	48.5 (36.6; 69.3)	45.6 (32.2; 64.9)	45.5 (33.0; 62.0	45.5 (33.0; 62.0)	44.5 (31.7; 61.4)	0.636
Polyunsaturated (g/day), median (P_{25};P_{75})	22.1 (15.3; 32.7)	28.2 (17.5; 39.5)	27.1 (18.4; 37.7)	24.6 (17.9; 38.1	24.6 (17.9; 38.1)	25.0 (17.8; 37.3)	0.700
Monounsaturated (g/day), median (P_{25};P_{75})	56.0 (36.4; 75.8)	63.6 (39.6; 85.5)	59.1 (42.0; 76.9)	59.3 (41.2; 78.6	59.3 (41.2; 78.6)	57.5 (40.8; 76.8)	0.736
Unprocessed foods and culinary ingredients, $\bar{X}$±SD	59.55 ± 14.74[a]	50.15 ±10.9[b]	49.54 ±14.74[b]	52.95 ±13.71[ab]	50.93 ±14.39[b]	52.54 ±14.55	**<0.001**
Processed foods, median (P_{25};P_{75})	15.57 (15.20; 18.8)	17.45 (16.12; 22.15	17.36 (17.02; 21.12)	19.40 (16.51; 22.33)	17.10 (17.15; 20.22	16.94 (17.60; 19.37)	0.353
Ultra-processed foods, median (P_{25};P_{75})	20.82 (19.78; 27.61)	30.13 (26.42; 34.97)	28.39 (27.84; 34.91)	28.14 (23.55; 31.68	26.82 (27.70; 33.04)	26.82 (27.70; 33.04)	**0.040**

DM = *diabetes mellitus*; HYP = hypertension; IUGR = intrauterine growth restriction; Values in bold correspond to statistical significance (p<0.05);Kruskal–Wallis test with Dunn's post-hoc.

consumption. For the tobacco group, women who had higher number of children (*p* = 0.013; β = 1282.10) and lower family income (*p* = 0.008; β = -0.884), presented higher daily energy consumption.

Discussion

In the current study, no difference was observed in caloric, protein, carbohydrate and fatgestational intake among different gestational conditions. On the other hand, contribution of ultra-processed foods to total energy intake was different across groups. In addition, this study found differences between intrauterine groups regarding to maternal age, family income, living with a partner, number of children, number of prenatal consultations, type of delivery and pre-gestational BMI.

The evaluation of food processing degree proposed by Monteiro *et al.*[18] has been a useful tool to assess quality of population's diet. Considering all women analyzed in the current study, the contribution of energy from ultra-processed foods was lower (26.8%) compared to other studies with Brazilian

Table 3

Values of *p*, β and CI from variables related to energy intake during pregnancy according to gestational clinical condition; IVAPSA cohort – Porto Alegre (RS), Brazil – 2011 – 2016.

	DM Group	HYP Group	TOBACCO Group	IUGR Group	Control Group
Age					
p	0.360	0.120	0.180	0.210	0.116
β	-34.04	-93.95	53.56	-79.12	-34.51
IC	-107.8; 39.7	-213.9; 26	-25.5; 132.6	-205.4; 47.2	-77.6; 8.5
Education					
p	0.594	**0.040**	0.256	0.745	0.224
β	-36.25	-267.3	108.77	-52.45	-73.50
IC	-171.7; 99.1	-521.9; -12.6	-80.9; 298.4	-379.9; 275.0	-192.4; 45.4
Number of children					
p	0.985	0.924	**0.013**	0.604	0.998
β	8.97	-82.58	1,282.10	-351.40	-0.64
IC	-911; 929	-1,832; 1,666.8	279.3; 2,284.8	-1,724.8; 1,022.0	-627.8; 626.5
Family income					
p	0.396	**0.045**	**0.008**	0.442	0.982
β	0.89	-0.51	-0.884	-0.17	-0.002
IC	-0.11; 0.29	-1; -0.01	-1.5; -0.2	-0.6; 0.2	-0.2; 0.1
Pre-gestational BMI					
p	**0.016**	0.809	0.789	0.154	0.079
β	-111.39	16.48	-14.36	91.05	-57.19
IC	-201.5; -21.2	-121.9; 154.8	-121.4; 92.7	-36.5; 218.6	-121.0; 6.6
Number of prenatal consultations					
p	0.095	0.794	0.218	0.107	0.155
β	-104.7	44.2	101.26	-170.83	-75.70
IC	-228.1; 18.6	-300.1; 388.7	-61.6; 264.1	-380.8; 39.2	-180.5; 29.0
Gestational weight gain					
p	**0.015**	0.579	0.543	0.912	0.589
β	65.88	34.12	-24.85	-6.22	-12.59
IC	13.15; 116.6	-90.5; 158.8	-106.2; 56.5	-121.4; 109.0	-59.6; 33.4

DM = *diabetes mellitus*; HYP = hypertension; IUGR = intrauterine growth restriction; CI = confidence interval; Values in bold correspond to statistical significance ($p<0.05$);Poisson regression.

pregnant women, which found values of 32 and 41.3%.[7,20] Among all groups, women in the DM group showed the lowest daily energy percentage from ultra-processed foods (20.8%).

However, the caloric contribution of unprocessed and minimally processed foods (52.5%) was similar to that of studies with pregnant women previously mentioned, which found values between 50.5% and 55% of calories from unprocessed foods.[7,20] Once more, the DM group showed healthier dietary pattern, since it had greater energy contribution from unprocessed and minimally processed foods (59.5%) compared to other groups.

Hence, this analysis provided a better overview of food consumption of the studied pregnant women, as it showed that kilocalories consumed were predominantly derived from unprocessed and minimally processed foods. Therefore, though indicating high energy consumption, the pregnant women studied showed higher consumption of healthy foods according to processing degree.

A systematic review[21] compared women's dietary changes between the pre-gestational period and the gestational period. Most studies included found increase in energy intake and fruits and vegetables consumption, as well as decrease in intake of eggs, fried and fast foods, coffees and teas. In addition, the authors reported that maternal age, education and pregnancy intention are associated with healthier dietary changes.[21] In Brazil, Alves-Santos *et al.*[7] demonstrated that ultra-processed food consumption decreased, while minimally and unprocessed food consumption increased from preconception to gestational period. In another cohort study conducted in Rio de Janeiro, Brazil, the authors found that pregnant women with higher monthly per capita family income, lower parity and higher maternal age were more likely to adhere to the healthy dietary pattern.[22]

A systematic review found evidence that nutrition-based intervention in prenatal care has significant impact on preventing excessive gestational weight gain compared with routine prenatal care.[23] At national level, the survey "Nascer no Brasil" (Being born in Brazil) showed high coverage of prenatal care (98.7%); however, the quality of care has proved to be insufficient. Still, it is important to note that most pregnancies of the interviewed women were considered to be of low risk.[24] Our results, together with previous published studies regarding changes in diet during pregnancy, confirm the importance of nutritional assistance in prenatal care.

Comparing to recommendations from the Institute of Medicine (IOM) of the United States National Academy of Sciences,[17] pregnant women showed adequate percentage of caloric contribution from macronutrients in the total energy value.

Carbohydrates are important sources of calories during pregnancy and glucose is the main fuel used for intrauterine growth.[1] Consumption of carbohydrates represented 58.4% of the total energy intake and achieved the recommendation of 45 to 65%.[17] A previous study demonstrated adequate carbohydrate consumption among pregnant women;[25] however, in another Brazilian study with hypertensive pregnant women, carbohydrates consumption was higher than the recommended.[26] During intrauterine growth, proteins provide structural components for human cells and for the synthesis of enzymes, which helps to ensure proper function of these cells.[1] Again, pregnant women had percentage of 12.8% energy from proteins according to the recommendation established in the literature (10 to 35%).[17] The studies with Brazilian pregnant women mentioned above also demonstrated results of protein intake in accordance with the guidance.[25,26] Also, in another study in Mesquita (Rio de Janeiro, Brazil) with low-income pregnant women, an average protein intake of 118g/day was found. Besides, negative association between protein intake and gestational weight gain was observed.[27]

In pregnancy, fats are important for fetus development and neuronal plasticity, for the growth and transport of fat-soluble vitamins.[1] A percentage of 28.2% energy from fat intake was found, reaching the recommendation of 20 to 35%.[17] The studies already mentioned also showed conformity of fat intake.[25,26] Despite the elevated energy intake among pregnant women, the contribution of energy from macronutrients was adequate, indicating a balanced calorie diet.

Regarding intrauterine groups and the quantitative analysis, the results of the current study demonstrated that the total energy intake from DM, HYP and tobacco groups was influenced by different factors.Women in the DM group with higher pre-pregnancy BMI had lower caloric consumption. These pregnant women had a higher number of prenatal consultations; therefore, they may have received more guidance and thus had greater care in relation to food intake compared to other groups.

As already strongly demonstrated in the literature,[1] positive association was found between energy intake and gestational weight gain among women from the DM group. Thus, the elevated caloric intake is concerning, since it is probably contributing to excessive weight gain during the gestational period in women with this disease.Despite higher minimally and unprocessed food consumption, the positive association between energy intake and gestational weight gain shows that energy intake has greater influence in gestational weight gain.

Furthermore, some studies have shown that weight gain below the guidancehad a protective effect on macrosomia in women with gestational DM (GDM). The authors of these studies suggest that weigh gain recommendations for pregnant women with GDM should be lower than the recommendation for women with normal glucose tolerance.[28] Thus, considering the importance of greater gestational weight gain control in women with GDM and the metabolic changes present due to this condition, prenatal nutritional assistance becomes even more important, especially in this group, to avoid excessive weight gain.

Regarding hypertensive pregnant women, those with less education level had higher caloric consumption. Another study showed similar result: an association between higher education level and healthier dietary pattern in pregnant women[22] Previous studies have shown the positive influence of family income in healthy food choices,[22,29] corroborating the association between family income and energy intake in HYP and tobacco groups.

Among the tobacco group, a positive association between energy intake and parity was found. Results from other studies have also shown an inverse association between healthy food choices and number of parturitions.[22,30] While analyzing these results, it is possible to conclude that primiparous women are more aware of the importance of healthy eating during pregnancy. In the current study, no relationship was found between maternal age and energy intake, contrary to previous publications that demonstrated this association.[22,29]

The elevated values of nutrient and calorie consumption may be partly explained by the instrument used, since the FFQ made it possible to evaluate the retrospective dietary intake of the entire pregnancy. Therefore, the information is subject to memory bias, which is a limitation of this study. Moreover, questionnaires with high number of questions can make the interview tiring and influence the final result.[6] As already demonstrated by Giacomello *et al.*,[14] the FFQ used in the current study probably overestimated caloric, protein, carbohydrates and fats intake of participants. Considering that the questionnaire was not originally designed to evaluate food items according to industrial processing, it can be considered a limited instrument in this type of analysis.[7]

In addition, most women had low education level and socioeconomic status. This fact may have influenced the overestimation of results, as already recorded in a previous survey.[14] Another factor may have led to extreme results. Pregnancy is a period when women idealize healthy eating and thus end up overestimating consumption compared to non-pregnant women.[14] However, results from a review of Brazilian studies about different FFQs validation comparing to other reference methods (such as 24-hour recall) have found high correlation between calories and carbohydrates.

Despite limitations, our study also has strengths to be considered in results interpretation. The originality and quality of the collected data, in addition to the originality of conducting a follow-up cohort containing three different types of clinical gestational conditions (diabetes mellitus, smoking and hypertensive disorder) should be highlighted.

Considering the results of reported studies and the current study, it can be deduced that pregnancy is a period whenwomen start being more careful regarding food intake. This was evidenced by the high percentage of unprocessed and minimally processed food consumption and by the change in dietary pattern from pre-conception to gestational period. Also, sociodemographic variables may have influenced dietary intake of pregnant women and, therefore, the results found in the present study.

Thus, considering the importance of an adequate caloric intake to avoid excessive gestational weight gain[1] and possible adverse outcomes (abortion, GDM and pre-eclampsia in pregnant women and obesity and type 2 DM in children), gestational energy intake must fit recommendations of a healthy dietary pattern.[3]

In this study, an association between some maternal characteristics (pre-gestational BMI, education level, family income, parity and gestational weight gain) and energy consumptionwas found. However, this association was only observed in some groups (DM, HYP and tobacco). Although we found elevated energy intake among pregnant women, caloric contribution from each macronutrient in total energy value was adequate comparing to current recommendations.Despite the high energy consumption, we observed that pregnant women with a diagnosis of diabetes had healthier dietary pattern. This was evidenced by the analysis of caloric contribution of food groups according to processing degree. Among all pregnant women, the DM group received more counseling during prenatal care.

In conclusion, our findings demonstrated some important points about the dietary profile of pregnant women. These points are essential to improve quality of nutritional counseling in prenatal care through the development of new public health programs and policies aiming to better assist pregnant women.

Author's contribution

Becker PC and Mariot MDM contributed to the work design, planning and interpretation of statistical analyzes; writing the article. Kretzer DC participated in the planning and interpretation of statistical analyzes; writing the article. Bosa VL, Goldani MZ, Silva CH carried out a drawing of the original IVAPSA project; writing of the article; work orientation. Bernardi JR designed the original IVAPSA project; conception and orientation of work; planning and interpretation of statistical analyzes; writing the article. All authors approved the final version of the article.

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Received on November 11, 2019

Final version presented on March 8, 2020

Approved on April 13, 2020