Eating Habits During Pregnancy of Women Giving Birth Very Prematurely: An Exploratory Analysis

Hábitos Alimentares Durante a Gravidez em Mulheres com Parto Muito Pré-Termo: Uma Análise Exploradora

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ABSTRACT
Introduction: Preterm birth is increasing worldwide, representing a major cause of death and long-term loss of human potential among survivors. Some morbidities during pregnancy are well-known risk factors for preterm labor, but it is not yet known whether deviations from adequate dietary patterns are associated with preterm delivery. Diet may be an important modulator of chronic inflammation, and pro-inflammatory diets during pregnancy were reported to be associated with preterm birth. The aim of this study was to assess the food consumption during pregnancy of Portuguese women giving birth very prematurely and the association between the food consumption and the major maternal morbidities during pregnancy related with preterm delivery.
Methods: A single-center cross-sectional observational study including consecutive Portuguese women giving birth before 33 weeks of gestation was conducted. Recall of eating habits during pregnancy was obtained within the first week after delivery, using a semi quantitative food frequency questionnaire validated for Portuguese pregnant women.
Results: Sixty women with a median age of 36.0 years were included. Of these, 35% were obese or overweight at the beginning of pregnancy, 41.7% and 25.0% gained excessive or insufficient weight during pregnancy, respectively. Pregnancy-induced hypertension was present in 21.7% of cases, gestational diabetes in 18.3%, chronic hypertension in 6.7%, and type 2 diabetes mellitus in 5.0%. Pregnancy-induced hypertension was significantly associated with increased daily consumption of pastry products (31.2 *vs* 10.0 g, p = 0.022), fast food (39.6 *vs* 29.7 g, p = 0.028), bread (90.0 *vs* 50.0 g, p = 0.005), pasta, rice and potatoes (225.7 *vs* 154.3 g, p = 0.012). In a multivariate analysis, only bread consumption maintained a significant, albeit weak, association (OR = 1.021; 1.003 – 1.038, p = 0.022).
Conclusion: Pregnancy-induced hypertension was associated with increased consumption of pastry products, fast food, bread, pasta, rice, and potatoes, although only bread consumption had a weak but statistically significant association with pregnancy-induced hypertension in a multivariate analysis.
Keywords: Feeding Behavior; Hypertension, Pregnancy-Induced; Pregnant Women; Premature Birth

RESUMO
Introdução: A prevalência do nascimento pré-termo tem aumentado em todo o mundo, representando uma das principais causas de morte e perda do potencial humano a longo prazo entre os sobreviventes. Algumas morbilidades na gravidez são fatores de risco conhecidos para o desencadeamento do parto pré-termo. Ainda não se sabe se os desvios de um padrão alimentar adequado se associam ao parto prematuro. A dieta por si só pode ser um importante modulador da inflamação crónica e dietas pró-inflamatórias durante a gravidez podem estar associadas ao parto pré-termo. Este estudo teve como objetivo determinar o consumo alimentar durante a gravidez de mulheres portuguesas que tiveram parto muito pré-termo e analisar a associação entre o consumo alimentar e as principais morbilidades durante a gravidez relacionadas com o parto pré-termo.
Métodos: Foi realizado um estudo observacional transversal, num único centro, incluindo casos consecutivos de mulheres portuguesas que tiveram o parto antes das 33 semanas de gestação. O recordatório dos hábitos alimentares durante a gravidez foi obtido na primeira semana após o parto, utilizando um questionário semi-quantitativo de frequência alimentar validado para grávidas portuguesas.
Resultados: Foram incluídas 60 mulheres com idade mediana de 36,0 anos. Destas, 35% eram obesas ou com excesso de peso no início da gravidez, 41,7% e 25,0% tiveram aumento excessivo ou insuficiente de peso durante a gravidez, respetivamente. A hipertensão induzida pela gravidez esteve presente em 21,7% dos casos, a diabetes gestacional em 18,3%, a hipertensão crónica em 6,7% e a diabetes *mellitus* tipo 2 em 5,0%. A hipertensão induzida pela gravidez associou-se significativamente ao aumento do consumo diário de produtos de pastelaria (31,2 *vs* 10,0 g, p = 0,022), *fast food* (39,6 *vs* 29,7 g, p = 0,028), pão (90,0 *vs* 50,0 g, p = 0,005), massas, arroz e batatas (225,7 *vs* 154,3 g, p = 0,012). Na análise multivariável, apenas o consumo de pão manteve uma associação significativa, embora fraca, com a hipertensão induzida pela gravidez (OR = 1,021; 1,003 – 1,038, p = 0,022).
Conclusão: A hipertensão induzida pela gravidez associou-se ao aumento do consumo de produtos de pastelaria, fast food, pão, massas, arroz e batata, embora apenas o consumo de pão tivesse mantido uma associação fraca, mas significativa, com a hipertensão induzida pela gravidez, na análise multivariável.
Palavras-chave: Hábitos Alimentares; Hipertensão Induzida Pela Gravidez; Mulheres Grávidas; Parto Pré-Termo

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INTRODUCTION

In countries with reliable trends data, preterm births – which represent a major cause of death and long-term loss of human potential among survivors – are increasing.[1] In particular, infants born very prematurely deserve special attention since each additional week of gestation confers benefits in terms of survival and morbidity.[2] An inverse association between gestational age at birth and economic burden to society has been reported.[3]

Infection is a well-known direct cause of preterm labor and delivery.[4] However, the reasons for an important proportion of noninfectious preterm births remain unexplained.[5] Preeclampsia, pregnancy induced hypertension, gestational diabetes *mellitus*, excessive or insufficient weight gain during pregnancy, and urinary tract infections are among the factors associated with preterm labor.[6-9]

Both animal and human studies suggest that maternal undernutrition may play a role in decreasing gestation length.[5] However, it is not yet known whether the associations between maternal malnutrition and preterm delivery are related to deviations from an adequate dietary pattern or an inadequate intake of a particular nutrient.[10] Excess or insufficiency of a particular food or nutrient has been reported to be associated with decreased gestation length and risk of preterm birth.[5,11-14] Nevertheless, dietary patterns, based on composition, are thought to provide a more comprehensive approach for assessing these associations in relation to the insufficient intake of particular macro- or micronutrients.[10,15] Diet may be an important modulator of chronic inflammation, and pro-inflammatory diets during pregnancy have been found to be associated with preterm birth.[16,17]

The primary aim of this study was to examine food consumption during pregnancy in Portuguese women giving birth very prematurely. The secondary aim was to determine the relationship of food consumption with morbidities associated with preterm delivery, particularly gestational diabetes, pregnancy-induced hypertension, and excessive or insufficient gestational weight gain.

METHODS

Study design and ethical issues

A single-center cross-sectional observational study including consecutive Portuguese women who gave birth before 33 weeks of gestation was conducted between December 2019 and November 2020 at Maternidade Dr. Alfredo da Costa, Centro Hospitalar de Lisboa Central. This central maternity hospital is a referral center for high-risk pregnant women, with some coming from local hospitals, while others are referred from more remote hospitals. This secondary analysis is part of an observational mixed-cohort study in very preterm infants, registered on ClinicalTrials.gov as NCT04400396. Approval was obtained from the institutional ethics committee (Nr 558/2018) and the participants gave written informed consent to participate in the study. Sixty (86%) out of the 70 invited women agreed to participate.

Data collection

Recall of eating habits during pregnancy was obtained from women within the first week after delivery, using a semiquantitative food frequency questionnaire (FFQ), validated for Portuguese pregnant women and composed of 86 food items, consumed during the previous six months (the first and second trimesters) and during the third trimester in women with more than 25 weeks of pregnancy.[18] Frequency of consumption was recorded in nine pre-specified categories from "never or less than once per month" to "six or more times per day". Each food item was allocated a pre-specified portion size. The usual intake of a given food was estimated by multiplying its frequency of intake by its portion size (in grams) and, if appropriate, by a seasonal variation factor.[18] Dairy products, vegetables, fruit, grain legumes, meat, fish and eggs, cereals and derivatives, nuts and fats and oils were grouped in portions and in grams consumed per day to determine if they met the food consumption recommendations for pregnant women.[19]

Self-reported height and weight at the beginning and at the end of pregnancy were recorded. In 40 (60%) participants, height was measured by the same observer (MC) and this value prevailed in relation to the reported value. The weight at the beginning of pregnancy was used to calculate the pre-pregnancy body mass index (BMI) and to assign the participants to a category: underweight (< 18.5 kg/m^2), normal (18.50 – 24.99 kg/m^2) and overweight (≥ 25 kg/m^2).[20,21] Gestational weight gain was calculated by subtracting the final weight from the weight at the beginning of pregnancy. The classification of gestational weight gain adequacy was based on the Institute of Medicine recommendations, according to the duration of the pregnancy.[22]

Data related to maternal comorbidities (gestational diabetes, type 2 diabetes *mellitus*, pregnancy-induced hypertension, or chronic hypertension) were collected from the electronic clinical files.

Statistical analysis

Before the analysis, the database was cleared of outliers of reported food consumption values in the order of thousands (in g). A descriptive analysis is presented in the form of frequencies and percentages for categorical variables. Considering quantitative variables, the Kolmogorov-Smirnov test was used to evaluate the normality of the distribution. The results are expressed in medians and interquartile ranges since variables had a non-normal distribution. The Mann-Whitney and the Kruskal-Wallis tests

were used to test hypotheses about equality of medians of independent groups. Univariate and multivariate logistic regression modeling was used to gain a more thorough understanding of the factors associated with pregnancy-induced hypertension. In the multivariate logistic regression models, the dependent variable was the presence or absence of pregnancy-induced hypertension, and the independent variables were those that had a *p*-value < 0.25 in the univariate analysis. The multicollinearity analysis was performed between the different variables. Bread and pastry consumption (g) were similar. Therefore, two multivariate logistic regression models were created, one including the consumption (g) of bread, fast food, and potatoes, rice and pasta, and the other including pastries, fast food, potatoes, rice and pasta.

Statistical significance was considered at *p* = 0.05. Statistical analysis was performed using Software Package for Social Sciences® (SPSS) for Windows® Version 25.0.

RESULTS

Sixty women with a median (min. – max.) age of 36.0

(22.0 – 50.0) years were included.

Their pre-pregnancy nutritional status and comorbidities during pregnancy are shown in Table 1. At the beginning of pregnancy, 35% of women were obese or overweight, 1.7% were underweight, and the remaining were normal weight. During pregnancy, 41.7% gained excessive weight, 25.0% gained insufficient weight, and the remainder gained adequate weight. Pregnancy-induced hypertension occurred in 21.7% of women, gestational diabetes in 18.3%, chronic hypertension in 6.7%, and diabetes *mellitus* type 2 in 5.0%.

Table 2 describes food consumption by food group (dairy products, vegetables, fruit, grain legumes, meat, fish, eggs, cereals and derivatives, nuts, fats and oils) during the first and second trimesters, as well as during the third trimester in pregnant women with more than 25 gestational weeks.

Fig. 1 shows consumption by food group compared with the recommendations for women. The median of the alcoholic beverage consumption was rated between 'never' to '1 – 3 times a month'. Median consumption frequencies were 'once a week' for fast food and pastry products, and '5 – 6 times per week'/'once per day' for vegetables and fruits.

Table 1 – Nutritional status and comorbidities during pregnancy

		Total (n = 60)
Pregnant women		
Weight gain in pregnancy, kg **Median** (interquartile range)		8.3 (6.5)
Weight gain n (%)	Below	15 (25.0)
	Adequate	20 (33.3)
	Above	25 (41.7)
Pre-pregnancy BMI, kg/m² **Median** (interquartile range)		23.2 (4.6)
Pre-pregnancy BMI according to WHO recommendations, kg/m² n (%)		
< 18.5		1 (1.7)
18.5 – 24.9		38 (63.3)
≥ 25 – 29.9		21 (35.0)
Gestational diabetes, n (%)		
Yes		11 (18.3)
No		49 (81.7)
Type 2 diabetes mellitus, n (%)		
Yes		3 (5.0)
No		57 (95.0)
Pregnancy-induced hypertension, n (%)		
Yes		13 (21.7)
No		47 (78.3)
Chronic hypertension, n (%)		
Yes		4 (6.7)
No		56 (93.3)

Table 2 – Food consumption by food groups, expressed in grams per day, during the last six months of pregnancy

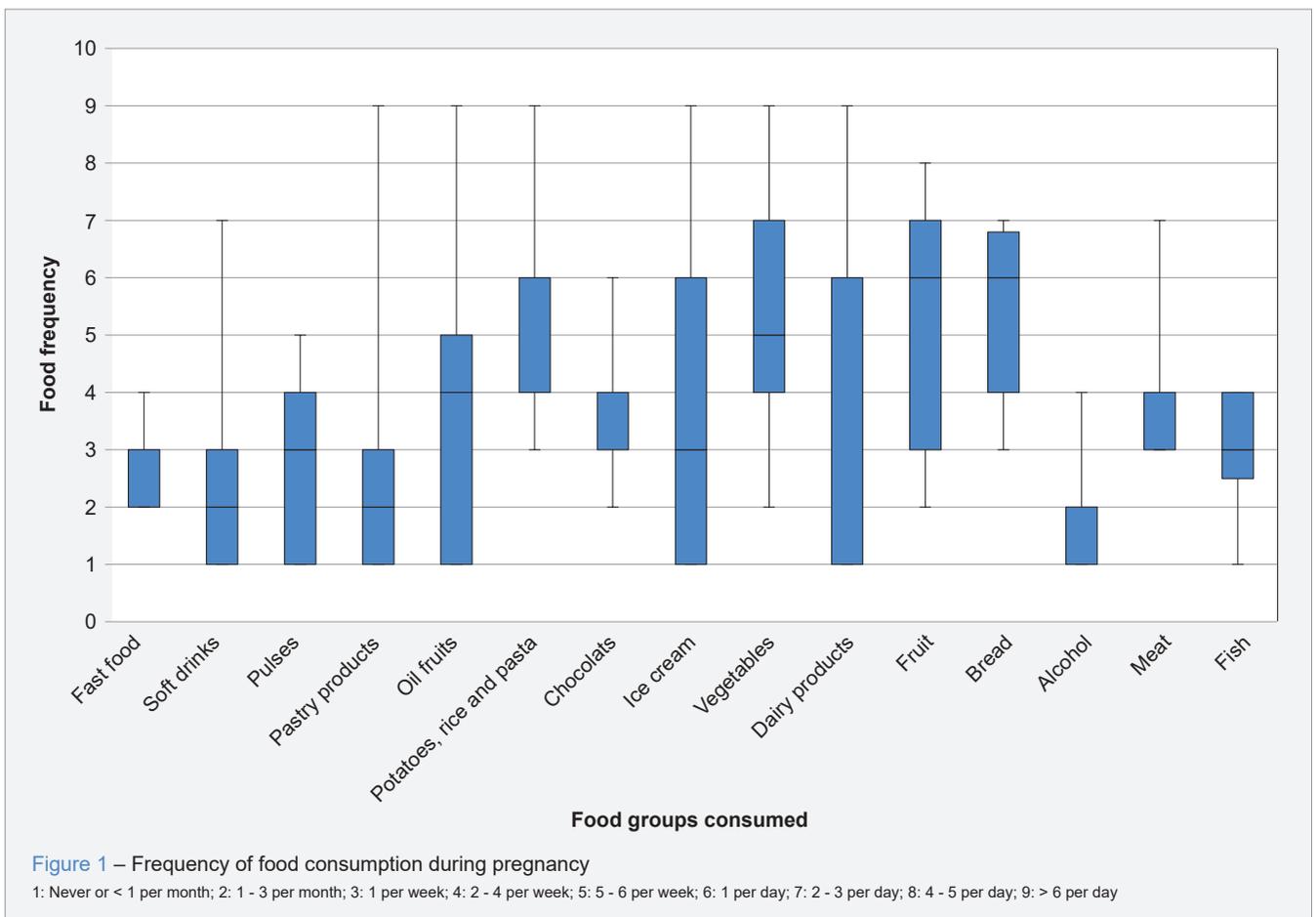| Food groups	g/day Median (IQR)	Minimum (g/day)	Maximum (g/day)
Dairy products	355.6 (304.6)	12.9	765.0
Vegetables	433.5 (268.2)	49.6	885.2
Fruits	300.5 (279.8)	0	738.6
Grain legumes	25.7 (65.1)	0	180.0
Meat, fish and eggs	208.8 (120.1)	67.6	771.0
Cereals and derivatives	256.3 (127.7)	91.2	651.6
Nuts	10.2 (51.1)	0	177.8
Fats and oils	25.6 (6.1)	2.2	161.4

IQR: interquartile range

Meat consumption frequency was greater than that of fish.

Fig. 2 shows median food consumption in portions by food groups, compared with national recommendations for pregnant women.[23] Consumption of some foods did not comply with the recommendations for pregnant women by the Portuguese Directorate General of Health,[23] particularly consumption below the recommended levels for dairy products (1 *vs* 3 portions), vegetables (2 *vs* 3 portions) and fruits

(1 *vs* 4 portions).

Table 3 describes the associations between food consumption expressed in grams, and morbidities during pregnancy. Pregnancy-induced hypertension had a significant median increase in consumption (in grams/day) of pastry products (31.2 *vs* 10.0, $p = 0.022$), fast food (39.6 *vs* 29.7, $p = 0.028$), bread (90.0 *vs* 50.0, $p = 0.005$) and potatoes, rice and pasta (225.7 *vs* 154.3, $p = 0.012$). No significant

Figure 1 – Frequency of food consumption during pregnancy
1: Never or < 1 per month; 2: 1 - 3 per month; 3: 1 per week; 4: 2 - 4 per week; 5: 5 - 6 per week; 6: 1 per day; 7: 2 - 3 per day; 8: 4 - 5 per day; 9: > 6 per day

Figure 2 – Median food consumption during pregnancy, expressed in daily portions, compared with the Portuguese recommendations

*: 2nd and 3rd trimester, according to recommendations during of pregnancy; †: according to recommendation for women in fertile age
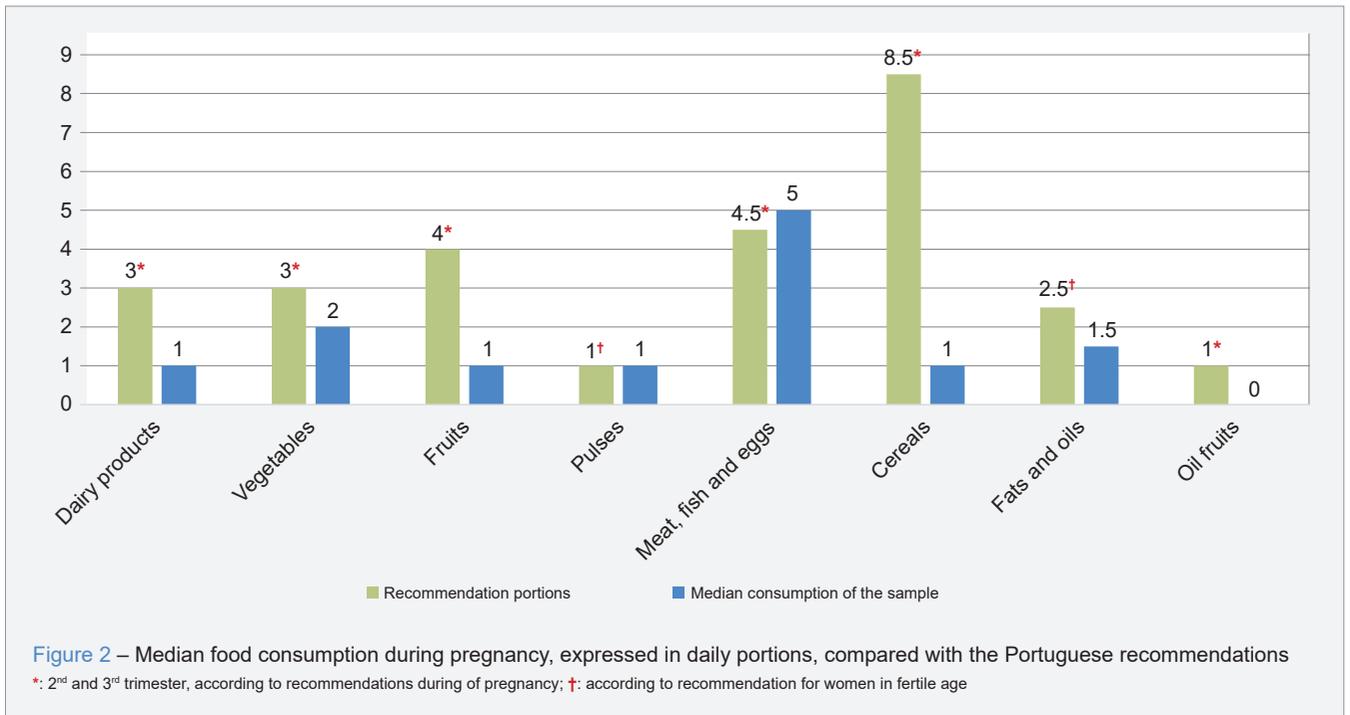
Table 3 – Association (univariate analysis) of food consumption expressed in grams, with gestational diabetes, pregancy-induced hypertension and weight gain during pregnancy

| | Gestational diabetes | | | Pregnancy-induced hypertension | | | Weight gain | | | |
| | Median (IQR) | | | Median (IQR) | | | Median (IQR) | | | |
	Yes	No	p	Yes	No	p	Below	Adequate	Above	p
Pastry products (g)	10.0 (18.9)	15.3 (26.8)	0.363[a]	31.2 (55.8)	10.0 (17.2)	**0.022[a]**	17.6 (25.9)	12.0 (33.9)	10.0 (21.5)	0.717[b]
Chocolats (g)	2.1 (6.4)	1.0 (6.3)	0.504[a]	1.0 (6.4)	1.0 (6.3)	0.861[a]	2.1 (6.4)	1.0 (2.1)	1.0 (5.4)	0.257[b]
Ice cream (g)	5.3 (11.4)	5.3 (7.0)	0.410[a]	5.3 (20.8)	2.9 (5.3)	0.070[a]	5.3 (11.4)	1.3 (5.4)	5.3 (7.1)	0.110[b]
Fast food (g)	31.9 (35.7)	31.3 (27.0)	0.916[a]	39.6 (68.9)	29.7 (19.6)	**0.028[a]**	33.1 (35.2)	30.7 (31.9)	31.9 (43.9)	0.202[b]
Carbonated drinks (g)	17.4 (17.4)	17.4 (37.3)	0.515[a]	17.4 (19.9)	17.4 (37.3)	0.441[a]	17.4 (37.3)	17.4 (37.3)	17.4 (9.9)	0.566[b]
Bread (g)	67.1 (51.4)	50.0 (50.4)	0.709[a]	90.0 (93.1)	50.0 (28.6)	**0.005[a]**	51.3 (47.4)	43.2 (51.4)	61.4 (78.3)	0.063[b]
Potatoes, rice and pasta (g)	239.8 (148.1)	366.8 (319.0)	0.113[a]	225.7 (147.2)	154.3 (83.0)	**0.012[a]**	154.9 (114.7)	168.6 (65.1)	170.6 (141.5)	0.611[b]
Dairy products (g)	314.3 (442.2)	366.8 (319.0)	0.962[a]	387.5 (345.7)	355.1 (260.2)	0.404[a]	361.4 (355.9)	381.3 (129.7)	222.4 (830.0)	0.477[b]
Fruits (g)	452.3 (290.8)	287.1 (273.9)	0.139[a]	438.7 (208.6)	277.3 (278.1)	0.080[a]	377.2 (283.4)	248.4 (277.1)	216.8 (238.7)	0.810[b]
Vegetables (g)	487.7 (318.8)	441.1 (254.2)	0.69[a]	509.2 (381.9)	425.0 (275.3)	0.125[a]	458.5 (264.4)	404.6 (344.7)	491.3 (658.4)	0.512[b]
Pulses (g)	25.7 (66.1)	25.7 (65.1)	0.644[a]	25.7 (77.2)	25.7 (65.1)	0.846[a]	25.7 (65.1)	12.0 (13.7)	25.7 (165.1)	0.458[b]
Nuts (g)	30.4 (173.1)	10.1 (25.7)	0.128[a]	10.1 (25.7)	10.2 (66.4)	0.578[a]	20.3 (51.1)	7.6 (25.7)	10.1 (122.1)	0.566[b]

a: Mann-Whtiney test; **b**: Kruscall-Wallis test

associations were found between other food and other morbidities during pregnancy. A multivariate model was carried out for outcome pregnancy-induced hypertension using the variables 'fast food', 'bread' and 'potatoes, pasta and rice'. Of the aforementioned multivariate logistic regression models, the one that included bread was considered the best, with no significant association being found in the other food products. Bread consumption showed a significantly weak association with pregnancy-induced hypertension (OR = 1.021; 1.003 – 1.038, p = 0.022).

DISCUSSION

In our study, 35% of women were obese or overweight at the beginning of pregnancy, 41.7% gained excessive weight and 25.0% insufficient weight during pregnancy, and 21.7% suffered pregnancy-induced hypertension. A proportion of women giving birth very prematurely did not comply with the national recommendations for pregnant women regarding the consumption of certain foods,[23] including low consumption of dairy products, vegetables, and fruit. The very low reported average of one portion ingested in the cereal group was surprising. Comparing this very low value with what is recommended for Portuguese pregnant women is not reliable, as it is known that the group of cereals and derivatives is the one that contributes the most to the Portuguese daily food intake (29.4%).[24]

Pregnancy-induced hypertension was the only condition found to be associated with food consumption. In a univariate analysis, this condition was significantly associated with the increased consumption of pastries, fast food, bread, pasta, rice, and potatoes. In a multivariate analysis, only bread consumption showed a significant, albeit weak, association with pregnancy-induced hypertension. As the nutrient content of foods was beyond the scope of our study, we cannot explain this association based on nutrient composition of bread consumed, particularly its salt content. It is reported that more anti-inflammatory or less pro-inflammatory diets may be associated with a lower risk of adverse outcomes during pregnancy, including preterm delivery.[16] This may probably be modulated by epigenetic mechanisms due to circulating cytokines that are particularly elevated in obese pregnant women.[17,25]

Conversely, high consumption of fruit, vegetables, nuts, legumes, low-fat dairy products, whole grains, and a low consumption of sodium, sweetened beverages, and red and processed meats, have been reported to have a potential role in controlling high blood pressure during pregnancy.[26] Under certain circumstances, the Mediterranean diet may have a protective effect against oxidative stress[27] and some authors have reported that a Mediterranean-type diet was associated with a lower risk of preterm delivery[28] while others did not find such an association.[29]

A systematic review and meta-analysis of 18 observational studies assessing the association of dietary factors with pregnancy-induced hypertension and pre-eclampsia[30] found a higher energy intake in pre-eclampsia and lower magnesium and calcium intake in hypertensive disorders of pregnancy.[29] In this review, however, the associations were unadjusted and not statistically significant, except for a significant association with calcium intake. A beneficial effect of a diet rich in fruit and vegetables on pre-eclampsia was described.[30] Among the conditions during pregnancy assessed in our study, pre-pregnancy obesity,[31] excessive gestational weight gain, and gestational diabetes[10] were among the risk factors for pregnancy-induced hypertension reported in the literature.

As limitations of this study, we should acknowledge that its cross-sectional nature did not allow the determination of a causal link. In addition, the sample size was not determined in this exploratory secondary analysis that was designed for a broader cohort study. This may have contributed to limit the detection of statistical significance of more associations. Finally, calculations of gestational weight gain and BMI relied on self-reported weight (in all cases) and height (in some cases). Although self-reported anthropometry may be reasonably accurate for estimating gestational weight gain and BMI, inaccuracies may have occurred.[32,33]

A strength of the study is that this is, to the best of our knowledge, the first study in Portugal, a country with specific dietary habits, to examine food consumption during pregnancy in women giving birth prematurely as well as its relationship with morbidities during pregnancy associated with preterm delivery.

Further prospective representative studies, adjusted to the main covariates are needed to confirm our findings.

CONCLUSION

In our sample of women giving birth very prematurely, pregnancy-induced hypertension was associated with an increased consumption of pastry products, fast food, bread, pasta, rice, and potatoes, although only bread consumption had a weak but statistically significant association with pregnancy-induced hypertension in a multivariate analysis.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their institution regarding patients' data publication.

DATA AVAILABILITY

No additional data available.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

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