Association of dietary patterns and degree of food processing with feelings of depression in pregnancy

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Abstract

Objectives: to investigate the relationship of dietary patterns and degree of food processing with feelings of depression in pregnancy.

Methods: cross-sectional study conducted with 784 adult pregnant women in Ribeirão Preto, SP, between 2011 and 2012. Feelings of depression were obtained through a structured questionnaire. Two 24-hour dietary recalls were obtained (24th-39th weeks of gestation) and adjusted through the Multiple Source Method. Four dietary patterns were determined: "Brazilian traditional","snacks", "coffee", and "healthy". Adjusted logistic regression models were used to assess the relationship ofthe tertiles of dietary patterns and energy contribution (%E) of foods according to the degree of industrial processing with feelings of depression (always/most of the time vs. sometimes/never).

Results: 12% of the women reported feelings of depression during the pregnancy. Women with greater adherence to "Brazilian traditional"[OR= 0.54 (CI95%= 0.30-0.97)] and "healthy" patterns [0.53 (0.30-0.94)] and with higher %E from minimally processed foods [0.51 (0.28-0.93)] presented a lower chance of feelings of depression. A higher %E from ultra-processed foods [2.39 (1.29-4.41)] was directly associated with the outcome. No associations with the other patterns were found.

Conclusions: greater adherence to the"Brazilian traditional" and "healthy" dietary patterns was inversely associated with feelings of depression during pregnancy, possibly mediated by the degree of industrial processing of the foods.

Key words *Pregnant women, Dietary habits, Industrialized foods, Depression*

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Introduction

It is estimated that one in five women presents significant depressive symptoms during pregnancy[1,2] which may affect the health of future generations. Depression and other psychological disorders in the pregnant woman may expose the child to a higher risk of prematurity, low birth weight, cognitive deficits, speech disorders and depression in adult life.[3-7] Accordingly, the investigation of factors related to the occurrence of this disease is of paramount importance.

Dietary patterns determined by principal component analysis reflect the food behavior of the population, this being an option for a global investigation of diet that broadly considers the variety of food consumed.[8] In a meta-analysis of observational studies, a lower risk of depression was found in adults with greater adherence to patterns rich in fruits, vegetables, whole grains, fish, olive oil and low-fat dairy products and low in foods of animal origin.[9] In pregnant women, there are indications that adherence to healthy diets reduces the chance of depression, however, the number of studies is still considered insufficient.[10]

A cross-sectional study conducted in Japan found an inverse association between adherence to a dietary pattern rich in vegetables, mushrooms, legumes, seaweed, potatoes, fish, seafood, misoshiro, sugar and shellfish, and to a pattern rich in rice and misoshiro, and depressive symptoms during pregnancy.[11] Conversely, in a study conducted with English pregnant women no association between dietary patterns and depression was found.[12]

In Brazil, a cross-sectional study conducted with 712 pregnant women found that greater adherence to a dietary pattern rich in rice, pasta, bread, beans, meat, eggs, coffee, margarine and artificial juice was associated with a higher prevalence of depressive disorder when compared to greater adherence to a pattern rich in grains, cereals, tubers, breads, cakes, cookies, fruits and vegetables.[13] In a cohort study conducted with 248 pregnant women in Rio de Janeiro, it was observed that women with greater adherence to a dietary pattern rich in dairy products, natural fruits and juices, green vegetables, sweets, fish, cakes, biscuits, pasta, tubers, and tea prior to the pregnancy were at a lower risk of depression during pregnancy.[14]

In a previous national study conducted with 784 adult pregnant women, four dietary patterns were identified, two of which were characterized by high consumption of minimally processed foods and low consumption of ultra-processed products.[15] The so-called "Brazilian traditional" pattern was directly associated with the consumption of rice, beans, meat and vegetables and inversely associated with the consumption of snacks, pizzas, sandwiches, cheese and cream cheese and the "healthy" pattern was directly related to the consumption of vegetables, fruits and natural juice and inversely related to the consumption of artificial juices and sodas. The other dietary patterns were composed of both minimally processed and ultra-processed foods: the "snack" pattern (directly associated with the consumption of bread, butter, margarine, cold cuts, milk, yogurts, cheese, cream cheese, chocolate and sweets) and the "coffee" pattern"(directly associated with the consumption of coffee, sugar, butter and margarine).[15]

Evidence suggests that the consumption of fresh and/or minimally processed foods may play a protective role in the risk of perinatal depression.[16] Conversely, a high consumption of ultra-processed products has been associated with a higher occurrence of depression in pregnancy.[17] Accordingly, the consumption of minimally processed foods can be considered a marker of healthy eating, allowing the monitoring of diet quality according to recommendations of the food guide.[18]

Considering the undesirable effects of depression during pregnancy on the health of the mother-child binomial, it is essential, in the context of public health, to evaluate the factors associated with this disease. Therefore, the aim of the present study was to investigate the relationship between adherence to dietary patterns and feelings of depression or sadness during pregnancy. Additionally, the relationship between food consumption according to the degree of industrial processing and the investigated outcome was evaluated. The hypothesis of the present study was that greater adherence to dietary patterns characterized by high consumption of minimally processed foods and low consumption of ultra-processed products would present an inverse association with feelings of depression or sadness in pregnancy.

Methods

In the present study, data from a cross-sectional study conducted with 784 adult pregnant women attending prenatal care in Primary Health Units of Ribeirão Preto, SP, between 2011 and 2012, were used. Theaim of this original study was to investigate the relationship between maternal diet and gestational diabetes mellitus (GDM), as described in

detail by Barbieiri *et al*.[19]

The inclusion criteria for the study were: age: ≥20 years, gestational age ≥24 and pre-gestational body mass index (BMI) ≥20 kg/m^2. Pregnant women with pre-gestational BMI <20 kg/m^2 were excluded in order to select women with a higher chance of GDM. Women who reported having diabetes or diseases that could alter their food intake were excluded. To calculate the sample size, the prevalence of 20% of GDM was considered, this being the primary outcome of the study. Among the women assisted in the Brazilian National Health System,[20] considering a margin of error of 5%, a sample of at least 512 pregnant women was required. Of the 1,446 pregnant women contacted, 639 were excluded (288 due to being<20 years of age, 83 BMI <20 kg/m^2, 1 previous diabetes, 1 using corticosteroids, and 20 that did not complete the examination), 19 refused to participate in the study and 4 had incomplete data, totaling a sample of 784 pregnant women.

The women were interviewed at the time of the oral glucose tolerance test, between the 24th and 39th gestational weeks, by trained nutritionists, at which time they underwent an anthropometric evaluation and answered a structured questionnaire covering socioeconomic and lifestyle data.

The present study was approved by the Research Ethics Committee of the School Health Center of the Ribeirão Preto Medical School, University of São Paulo, (CAAE: 70689917.9.0000.5414).

During the interview, the pregnant women were asked about feelings of depression or sadness in the pregnancy using the question:"During the pregnancy did you have depression or sadness?", Having as response options:"Always", "most of the time", "sometimes" or "never".In the present study the answers were grouped into:"always" or "most of the time" (yes) "sometimes" or "never" (no). This methodology was validated and considered appropriate in screening for individuals at risk of disease,[21,22] with a previous study conducted among pregnant women showing a sensitivity of 91% and specificity of 52% regarding the diagnosis of the disease through Beck's Depression Inventory.[23] Although not a diagnosis of depression, it is considered suitable for use in epidemiological studies.[22]

The food intake was assessed by means of two 24-hour dietary recalls (24HRs) using the multiple-pass methodology in three stages.[24] The first 24HR was collected in person and the second through telephone contact with at least seven days apart, regardless of the day of the week or season. To estimate usual food intake, the Multiple Source Method (MSM) was used, this being a statistical modeling technique that uses the usual consumption distribution estimated by combining probability and quantity consumed.[25]

The dietary patterns were determined through principal component analysis using Varimax rotation, as described in detail by Zuccolotto *et al*.[15] Four dietary patterns were identified:"Brazilian traditional", "healthy", "snacks" and "coffee", the first two being characterized by a high consumption of minimally processed foods and low consumption of ultra-processed products, and the other dietary patterns composed of both minimally processed and ultra-processed foods.[15]

The classification of foods according to the degree of industrial processing (fresh or minimally processed, processed and ultra-processed) was defined according to the recommendations of the Food Guide for the Brazilian Population.[18] Minimally processed foods are foods that have been processed, but without substances added, or elements removed (i.e. coffee, natural fruit juice and pasteurized whole milk). Processed foods are foods manufactured industrially with the addition of salt, sugar, oil and fats (i.e. canned foods, cheese). Ultra-processed products are produced by the food industry using substances extracted from food or obtained by chemical synthesis (i.e. soft drinks, sugar, sugary drinks, crackers, cookies, instant noodles, flavored yoghurts).[18] Culinary preparations were classified according to the main component of the recipe.

The age (years), education of the pregnant woman and head of the household (in years of schooling), gestational week, marital status (married/with partner, single, separated or widowed), self-declaration of skin color, possession of items,[26] practice of physical activity (minutes per week of walking or exercise), smoking history (never smoked, former smoker or current smoker), alcohol consumption during pregnancy (yes or no) and sleep time were obtained through structured questionnaires.

The gestational week at the time of the interview was estimated based on the date of the last menstruation recorded on the pregnant woman's card, later corrected from the ultrasound data recorded in the medical record.

The amount of sleep was categorized as adequate (7 | -9 hours/day), insufficient (<7 hours/day) and excessive (≥9 hours/day).[27] For the classification of the economic stratum, the Economica Brasil Classification Criterion (CCEB – Portuguese acronym) was used, which defines the economic

strata from A (> level) to E (< level) based on the interviewee's responses regarding ownership of property, and education level of the head of the household.[26]

During the interview, women underwent an anthropometric evaluation, with weight (in kilos) and height (in meters) obtained using a digital scale (TANITA model HS302) and a portable stadiometer (SANNY model ES2040), respectively, adopting the protocol proposed by the Ministry of Health.[28] The pre-pregnancy weight (in kilos) of the women was obtained based on data recorded on the pregnant woman's obstetric monitoring card. The pre-gestational body mass index (BMI) was obtained through the ratio of weight (kg) by height (m) squared.

To investigate differences between the maternal characteristics according to feelings of depression or sadness, Student's t-test, the Mann Whitney test or the chi-square test were used.

The pregnant women's scores regarding adherence to each of the eating patterns were categorized into tertiles. Women classified in the first tertile were considered to have low adherence and in the third tertile, high adherence. The energy contribution (%E) of the foods according to the degree of industrial processing (minimally processed, processed and ultra-processed) was also expressed in tertiles. For the description of self-report of feelings of depression or sadness of the pregnant women according to adherence to dietary patterns and food consumption the chi-square test was used.

Adjusted logistic regression models were employed and odds ratio (OR) values and 95% confidence intervals (CI95%) were estimated to assess the relationship between adherence to dietary patterns and the %E of the foods according to the degree of industrial processing, and feelings of depression or sadness (yes, no) during the pregnancy. The adjustment variables considered were: age (years), education of the pregnant woman (years of schooling), marital status (single, married/with partner, separated/widowed), smoking (never smoked, former smoker, smoker), alcohol consumption (yes, no), practice of physical activity (minutes per week of walking or exercise), pre-gestational BMI classification (kg/m^2), amount of sleep per day (<7, 7|-9 , ≥9 hours per day), gestational week at the time of the interview (weeks) and total dietary energy (kcal). These variables were selected based on the theoretical framework of the influence on food consumption, as well as on the occurrence of depression. All the variables were simultaneously included in the models. The p value <0.05 was adopted as significant and the analyses were performed using the SPSS version 21 software.

Results

Of the 784 women interviewed, 94 (12%) reported feeling depressed or sadness during pregnancy, with these women presenting a mean (SD) age of 29 (6) years and 9 (3) years of schooling, the majority of them were married/with partner (69.1%), white (47.9%) and belonged to economic stratum C (64.9%) (Table 1). The women were interviewed on average during the 28th (3) gestational week, ranging from the 24th to 39th week.

Pregnant women who reported feeling depression or sadness "always" or "most of the time"presented a higher mean age, with a higher proportion reportingan insufficient amount of sleep (<7 hours/day), a higher percentage of smokers, and more reporting being divorced or widowed, when compared to those who reported feeling depressed or sad "sometimes" or "never" (Table 1). There was no difference regarding education level, pre-gestational BMI, gestational week at the time of the interview, economic status, self-report of skin color, alcohol consumption and practice of physical activity according to feelings of depression or sadness (Table 1).

It was found that there was no difference between self-reported feelings of depression or sadness during the pregnancy and adherence to the dietary patterns. There was a higher frequency of feelings of depression among the women who reported higher %E from ultra-processed foods (Table 2).

In the adjusted logistic regression models, women with greater adherence to the "Brazilian traditional" [OR= 0.54 (CI95%= 0.30-0.97)] and "healthy"[OR= 0.53 (CI95%= 0.30-0.94)] dietary patterns presented a lower chance of feeling depressed or sad when compared to those with lower adherence to these eating patterns, regardless of confounding factors (Table 3). There was no association between the "snack" and "coffee" patterns and feelings of depression or sadness during pregnancy.

After adjustments for confounding factors, it was found that the pregnant women categorized in the third tertile of %E from minimally processed foods had a lower chance of feeling depressed or sad [OR= 0.51 (CI95%= 0.28-0.93)] when compared to the pregnant women in the first tertile. In contrast, the pregnant women ranked in the third tertile of %E fromultra-processed foods had a higher chance of feeling depressed or sad [OR= 2.39 (CI95%= 1.29-4.41)], compared to those classified in the first tertile (Table 4).

Table 1

Characteristics of pregnant women according to the self-report of feelings of depression or sadness. Ribeirão Preto, SP. 2011-2012 (n = 784).

Maternal characteristics	Self report of feelings of depression or sadness			*p**
	All (n = 784)	Yes (n = 94)	No (n = 690)	
		Mean (SD)		
Age (years)	28 (5)	29 (6)	27 (5)	0.002
Education (years of study)	9 (3)	9 (3)	9 (3)	0.470
Pre-gestational BMI (kg/m^2)	26 (5)	26 (5)	26 (5)	0.290
Gestational week at interview	28 (3)	28 (3)	28 (3)	0.590
		n (%)		
Marital status				
Married/with partner	615 (78.4)	65 (69.1)	550 (79.7)	0.001
Single	143 (18.2)	20 (21.3)	123 (17.8)	
Separated/widowed	26 (3.3)	9 (9.6)	17 (2.5)	
Economic stratum				
A+B	154 (19.6)	20 (21.3)	134 (19.4)	0.880
C	526 (67.1)	61 (64.9)	465 (67.4)	
D+E	104 (13.3)	13 (13.8)	91 (13.2)	
Self-report of skin color				
White	349 (44.5)	45 (47.9)	304 (44.1)	0.230
Non-white	435 (55.5)	49 (52.1)	386 (55.9)	
Amount of sleep (hours/day)				
< 7	125 (15.9)	25 (26.6)	100 (14.5)	0.003
7l-9	326 (41.6)	41 (43.6)	285 (41.3)	
≥ 9	333 (42.5)	28 (29.8)	305 (44.2)	
Alcohol consumption during pregnancy	197 (25.0)	29 (31.0)	168 (24.0)	0.110
Smoking status				
Never smoked	623 (79.5)	68 (72.3)	555 (80.4)	0.005
Currently smokes	71 (9.1)	17 (18.1)	54 (7.8)	
Ex-smoker	90 (11.5)	9 (9.6)	81(11.8)	
		Median (P_{25}, P_{75})		
Physical activity (minutes/week)	40 (0.136)	60 (0.150)	40 (0.120)	0.180

* *p* value according to Student's *t*-test for continuous variables with normal distribution, Mann-Whitney *U* test for continuous variables without normal distribution or Chi-square test for categorical variables.

Table 2

Self-reported frequency of feelings of depression or sadness during pregnancy according to adherence to dietary patterns, and food consumption according to the degree of industrial processing. Ribeirão Preto, SP.2011-2012 (n=784).

	Self report of feelings of depression or sadness						*p**
	All (n = 784)		Yes (n = 94)		No (n = 690)		
	n	%	n	%	n	%	
Eating patterns (Tertiles)							
Traditional Brazilian							
1st	260	33.2	38	40.4	222	32.2	0.07
2nd	262	33.4	34	36.2	228	33.0	
3rd	262	33.4	22	23.4	240	34.8	
Snacks							
1st	260	33.2	28	29.8	232	33.6	0.13
2nd	262	33.4	40	42.6	222	32.2	
3rd	262	33.4	26	27.6	236	34.2	
Coffee							
1st	261	33.3	27	28.8	234	33.9	0.55
2nd	262	33.4	32	34.0	230	33.3	
3rd	261	33.3	35	37.2	226	32.8	
Healthy							
1st	260	33.2	38	40.4	223	32.3	0.22
2nd	262	33.4	31	33.0	231	33.5	
3rd	262	33.4	25	26.6	236	34.2	
Food consumption by degree of industrial processing (Tertiles)							
Minimally processed							
1st	261	33.3	38	40.0	223	32.4	0.12
2nd	261	33.3	33	35.1	228	33.0	
3rd	262	33.4	23	24.5	239	34.7	
Processed							
1st	261	33.3	29	30.9	232	33.6	0.86
2nd	261	33.3	32	34.0	229	33.2	
3rd	262	33.4	33	35.1	229	33.2	
Ultra Processed							
1st	261	33.3	21	22.3	240	34.8	0.04
2nd	261	33.3	33	35.1	228	33.0	
3rd	262	33.4	40	42.6	222	32.2	

*Chi-square test.

Table 3

Relationship between adherence to dietary patterns and self-reported feelings of depression or sadness during pregnancy. Ribeirão Preto, SP. 2011-2012 (n = 784).*

Eating patterns	1st Tertile	2nd Tertile	3rd Tertile	*p*
"Brazilian Traditional"pattern				
Crude model	1.00	0.87 (0.53, 1.43)	0.54 (0.31, 0.93)	0.03
Adjusted model**	1.00	0.92 (0.55, 1.54)	0.54 (0.30, 0.97)	0.04
"Snacks" pattern				
Crude model	1.00	1.49 (0.89, 2.50)	0.91 (0.52, 1.60)	0.76
Adjusted model**	1.00	1.54 (0.89, 2.66)	0.91 (0.49, 1.67)	0.76
"Coffee" pattern				
Crude model	1.00	1.21 (0.70, 2.08)	1.34 (0.79, 2.29)	0.28
Adjusted model**	1.00	1.28 (0.64, 1.98)	1.13 (0.65, 1.97)	0.67
"Healthy" pattern				
Crude model	1.00	0.79 (0.47, 1.31)	0.62 (0.36, 1.06)	0.08
Adjusted model**	1.00	0.73 (0.43, 1.23)	0.53 (0.30, 0.94)	0.03

*Odds ratio (OR) and 95% confidence interval (CI95%) obtained through logistic regression models; **Models adjusted for: age (years), education (years of schooling), marital status (single, married/with partner/widowed), smoking (never smoked, former smoker, smoker), alcohol consumption (yes/no), physical activity (minutes per week of walking or exercise), pre-gestational BMI (kg/m^2), amount of sleep (<7; 7l-9; ≥9 hours per day), gestational week at the time of interview (weeks) and total dietary energy (kcal).

Table 4

Relationship between the consumption of minimally processed, processed and ultra-processed foods and the self-report of feelings of depression or sadness during pregnancy. Ribeirão Preto, SP. 2011-2012 (n = 784).*

Food consumption (%E)	1st Tertile	2nd Tertile	3rd Tertile	*p*
Minimally processed				
Crude model	1.00	0.85 (0.51 - 1.40)	0.57 (0.33 - 0.98)	0.04
Adjusted model**	1.00	0.87 (0.51 - 1.47)	0.51 (0.28 - 0.93)	0.03
Processed				
Crude model	1.00	1.12 (0.66 - 1.91)	1.15 (0.68 - 1.96)	0.60
Adjusted model**	1.00	1.06 (0.61 - 1.83)	1.15 (0.66 - 1.98)	0.62
Ultra-processed				
Crude model	1.00	1.65 (0.93 - 2.94)	2.06 (1.18 - 3.60)	0.01
Adjusted model**	1.00	1.87 (1.01 - 3.43)	2.39 (1.29 - 4.41)	0.01

*Odds ratio (OR) and 95% confidence interval (CI95%) obtained through logistic regression models; **Models adjusted for: age (years), education (years of schooling), marital status (single, married/with partner/widowed), smoking (never smoked, former smoker, smoker), alcohol consumption (yes/no), physical activity (minutes per week of walking or exercise), pre-gestational BMI (kg/m^2), amount of sleep (<7; 7l-9; ≥9 hours per day), gestational week at the time of interview (weeks) and total dietary energy (kcal). TCV = Total caloric value.

Discussion

In the present study, it was observed that women with higher adherence to the "Brazilian traditional" and "healthy" dietary patterns had a lower chance of feeling depressed or sad "always" or "most of the time" during pregnancy, regardless of confounding factors. These patterns were characterized by high consumption of minimally processed foods and low consumption of ultra-processed products. An inverse relationship between the %E from minimally processed foods and feelings of depression during the pregnancy was verified,as was a direct relationship between the %E from ultra-processed foods and this outcome.

The findings of the present study agree with international evidence suggesting an inverse association between adherence to dietary patterns that are mainly composed of minimally processed foods and depression in adults[9] and pregnant women.[10,11] However, due to distinct characteristics of the dietary culture verified among the population studied, the comparison of the findings is limited, as the dietary patterns determined through principal component analysis identify the eating behavior of the study population.[8]

Comparing the results observed with Brazilian studies with culturally similar populations also presents limitations. The heterogeneity in the composition and nomenclature of the dietary patterns and the low number of studies make this task difficult.

The only national investigation identified that assessed the relationship between dietary patterns in pregnancy and depression was a cross-sectional study conducted by Paskulin *et al*.[13] with 712 pregnant women in southern Brazil. Three dietary patterns were identified, called "restricted", "varied" and "common Brazilian". The authors observed a higher prevalence of depressive disorder among pregnant women with lower fruit consumption and higher consumption of sweets and sugars, corroborating the results of the present study.

Because the findings of the present study suggested a relationship between the degree of industrial food processing and the outcome investigated, complementary analyses were conducted to test this hypothesis. There was an inverse relationship between %E from minimally processed foods and feelings of depression or sadness during the pregnancy, as well as a direct relationship between %E from ultra-processed foods and these feelings.

Evidence suggests that a high %E from ultra-processed foods is associated with increased gestational weight gain and neonatal body fat, which may cause several short- and long-term pregnancy and fetal problems, including problems related to mental health.[29] A descriptive study conducted with low-income, pregnant American women found that women that reported consuming fast foods ≥3 times a week were more likely to experience depression and stress during the pregnancy.[17] In contrast, natural and minimally processed foods are rich in micronutrients, such as folate, vitamin D, iron, selenium and zinc, which have been identified as possible protectors from depression during pregnancy.[16] Furthermore, there is evidence that adherence to dietary patterns rich in fruits, vegetables, fish and whole grains, and low consumption of processed meats, refined cereals and sweets is protective for depression in adults.[9]

One of the limitations of the present study is the cross-sectional design, which makes it impossible to assess the temporal relationship between the feelings of depression or sadness in pregnancy and the dietary patterns. There is a possibility that women who are at risk for depression may be less motivated to eat properly, therefore adhering to unhealthy eating patterns. Another limitation is the self-report of feelings of sadness and depression, theoutcome employed in the present study, which is not a diagnosis of depression but a screening for individuals at risk of developing the disease. Although the scale used was previously validated for pregnant women,[17,18] it was not evaluated in Brazil, which may partially explain the low prevalence of depression verified among the study participants. However, rapid screening methods, as used in the present study, are considered efficient for identifying individuals at risk of developing depression, with acceptable sensitivity and specificity regarding the diagnosis of the disease, and can be applied by any primary care professional.[19,20,21] It should be considered that the frequency of feelings of depression or sadness may not have been captured among the women with early gestational age, since the data collection occurred between the 24th and 39th gestational weeks. Only pregnant women with BMI ≥20 kg/m^2 were included and extrapolation of findings to women with lower BMI may be misleading. Data on weight gain during the first trimester of pregnancy were not collected, making it impossible to estimate the relevance of weight gain, therefore the models were adjusted by the pre-gestational BMI.

Among the strengths of the study, it should be highlighted that the present study was unprecedented in assessing the relationship between %E of foods according to the degree of industrial processing and

feelings of depression in pregnancy. It was possible to identify an inverse relationship between adherence to the dietary patterns characterized by high consumption of minimally processed foods and low consumption of ultra-processed products with feelings of sadness and depression during pregnancy.

Higher adherence to the "Brazilian traditional" and "healthy" dietary patterns, characterized by high consumption of minimally processed foods and low consumption of ultra-processed products, was inversely associated with feelings of depression or sadness during pregnancy. Data suggest an inverse relationship between %E from minimally processed foods and feelings of depression, as well as a direct relationship between %E of ultra-processed foods and this outcome. The other eating patterns were not associated with feelings of depression or sadness among pregnant women.

Authors' contribution

NLB and DSS were responsible for the study design, data analysis, interpretation and writing of the manuscript. LCC and DCCZ contributed to the data collection, analysis and interpretation, and reviewed the manuscript. All the authors approved the final version of the manuscript.

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