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Prepregnancy Healthy Dietary Pattern Is Inversely Associated with Depressive Symptoms among Pregnant Brazilian Women[1–3]

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Abstract

Dietary patterns before pregnancy may be associated with depressive symptomatology during pregnancy. The aim of this study was to identify dietary patterns before pregnancy and to examine the association between these dietary patterns and depressive symptoms during pregnancy. A prospective cohort of 248 healthy pregnant women were followed at 5–13, 20–26, and 30–36 gestational weeks. Dietary intake was obtained by using a food-frequency questionnaire administered between 5 and 13 gestational weeks, which referred to the 6 mo preceding gestation, and factor analysis (principal components) was applied to identify dietary patterns. The Edinburgh Postnatal Depressive Scale (EPDS) was used to evaluate depressive symptoms during 3 follow-up pregnancy points. A multiple linear mixed-effects model was applied to verify the association between dietary patterns and depressive symptoms adjusted for obstetric factors, socioeconomic status, and energy intake. Three prepregnancy dietary patterns were identified: common-Brazilian, healthy, and processed. Together, these patterns explained 36.1% of the total percentage of variance; the eigenvalues were 2.88, 2.12, and 1.86, respectively. Mean depressive symptom scores were 9.0 (95% CI: 8.4, 9.6), 7.2 (95% CI: 6.5, 7.8), and 7.0 (95% CI: 6.4, 7.7) for trimesters 1, 2, and 3, respectively. The rate of decrease in depressive symptoms was −0.088/wk (95% CI: −0.115, −0.061; $P < 0.001$). In the multiple longitudinal linear regression model, the healthy dietary pattern before pregnancy was inversely associated with depressive symptoms (β: −0.723; 95% CI: −1.277, −0.169; $P = 0.011$). High adherence to the healthy pattern before pregnancy was associated with lower EPDS scores during pregnancy in women from Rio de Janeiro, Brazil. J. Nutr. 144: 1612–1618, 2014.

Introduction

During pregnancy, women undergo environmental, psychological, and metabolic changes, increasing the likelihood of mental health disorders (1). The prevalence of depressive symptoms during pregnancy varies from 10% to 20% in developed and developing countries (2). Depressive symptoms increase the risk of maternal and fetal adverse outcomes, such as inadequate prenatal care, insufficient gestational weight gain, low birth weight, and postpartum depression (PPD)[10] (3–5).

Sociodemographic factors such as poverty and lack of a partner have been shown to be risk factors for depressive symptoms during pregnancy (1,6,7). In addition, nutrient and energy requirements often increase during pregnancy and many nutrients are critically important during this period (8,9), with deficiencies associated with depressive symptoms (10–13).

Different from the single-nutrient–based approach, the evaluation of dietary patterns identifies dietary habits on the basis of an assessment of food group intake. This method enables a broader analysis of the diet, including the associations and interactions between nutrients (13,14). In this way, this type of

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[3] Supplemental Tables 1–3 are available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://jn.nutrition.org.

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[10] Abbreviations used: ALSPAC, Avon Longitudinal Study of Parents and Children; EPDS, Edinburgh Postnatal Depressive Scale; LME, longitudinal mixed-effects; PCA, principal components analysis; PPD, postpartum depression.

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dietary analysis may be a useful tool to evaluate the association between nutritional status and depression during pregnancy.

On the basis of this context, some studies recently investigated the association between dietary intake during pregnancy and depressive symptoms during pregnancy and postpartum (10,11,15,16). Chatzi et al. (15) evaluated 529 pregnant women and observed that the women's adherence to a "health-conscious" dietary pattern during pregnancy was associated with lower postpartum depressive symptom scores. Similarly, a study that evaluated 1745 pregnant women found that a higher intake of fish and PUFAs (EPA and DHA) was independently associated with a lower prevalence of depressive symptoms during pregnancy (11). Studies investigating dietary patterns among nonpregnant populations showed a lower likelihood of depression among women with higher adherence to dietary patterns considered as "healthy" or "traditional" (12,17,18). Le Port et al. (17) assessed the dietary patterns of 3132 French women aged 35–59 y and found a protective association of higher adherence to the "healthy" and "traditional" dietary patterns with less likelihood of reporting depressive symptoms both at study baseline and at 9 y of follow-up, whereas higher adherence to the "snacking" pattern was directly associated with depressive symptoms. Jacka et al. (18) evaluated 1046 women aged 20–93 y and found that a "traditional" pattern, which was characterized by healthy food, was inversely associated with major depression, whereas the "Western" pattern was directly associated with major depression.

Considering the prevalence of depressive symptoms during pregnancy and the relations previously shown between dietary patterns and depressive symptoms among nonpregnant populations, the aim of this study was to identify dietary patterns before pregnancy and to examine their longitudinal association with depressive symptoms. We hypothesized that a higher adherence to a dietary pattern composed of healthy foods before pregnancy is associated with lower depressive symptoms during pregnancy.

Participants and Methods

This study comprised a prospective observational cohort of pregnant women who received prenatal care at a public health center in Rio de Janeiro, Brazil. Pregnant women seeking prenatal services were invited to participate and were recruited for enrollment if they met the following eligibility criteria: *1*) between 5 and 13 wk of pregnancy during the enrollment period, *2*) aged between 20 and 40 y, *3*) free from any chronic diseases (except for obesity measured as prepregnancy ≥30 kg/m^2), *4*) free from infectious diseases, *5*) singleton pregnancy, *6*) residence near the study catchment area, and *7*) had prenatal care where the study was performed. Recruitment occurred between November 2009 and October 2011 in the Heitor Beltrão public health center. The pregnant women were followed up 3 times during pregnancy, at 5–13, 20–26, and 30–36 gestational weeks.

A total of 299 pregnant women were recruited for this study. After entering the study, we excluded women who changed their prenatal care health unit (n = 1), had twin pregnancies (n = 4), were diagnosed with an infectious or noncommunicable disease (n = 12), presented missing data at baseline (n = 15), were at >13 gestational weeks (n = 16), and reported miscarriage (n = 3). After exclusions, the total sample comprised 248 pregnant women.

After the trimester 2 visit (weeks 20–26 of gestation), a subsample of 61 women were invited to participate in a clinical trial that aimed to investigate the effect of ω-3 FA supplementation on PPD and was nested within the cohort. Thirty-four of these women were administered the ω-3 FA supplementation. These women were identified as being at risk of PPD on the basis of a past history of depression or a depressive symptom score ≥9 based on the Edinburgh Postnatal Depression Scale (EPDS). These data were obtained at baseline by using specific questionnaires. The women were randomly assigned to consume gelatin capsules containing ω-3 FA (fish oil) or a placebo composed of soybean oil, the most commonly used cooking oil for the Brazilian population. The treatment group capsules contained a total dose of 1.8 g of ω-3 FAs/d (1.08 g of EPA and 0.72 g of DHA). Only 41 women completed the supplementation trial, and 20 were administered supplementation.

Dietary patterns

Dietary intake was obtained through a semiquantitative FFQ that included 82 food items and nonalcoholic and alcoholic beverages and was based on an FFQ validated for the adult population of Rio de Janeiro (19). This FFQ was administered between 5 and 13 wk of gestation and referred to the 6 mo preceding the gestational period.

The FFQ had 8 frequency options: *1*) >3 times/d, *2*) 2–3 times/d, *3*) 1 time/d, *4*) 5–6 times/wk, *5*) 2–4 times/wk, *6*) 1 time/wk, *7*) 1–3 times/mo, and *8*) never or hardly ever. The frequency options were transformed into daily frequencies as follows: *1*) 4, *2*) 2.5, *3*) 1, *4*) 0.79, *5*) 0.43, *6*) 0.14, *7*) 0.07, and *8*) 0 times/d. Daily energy intake in kilocalories and nutrient intake was obtained by using DietSys software, version 4.02 (20). We used the Brazilian Food Composition Table (21) and added food items from the USDA National Nutrient Database for Standard Reference (22).

Foods that were not regularly consumed by the subject (e.g., consumed by <20% of the women) were excluded. They included lard and alcoholic beverages (wine, beer, and vodka) and dried meat/codfish. These foods were not part of the regular diet of the subjects and had lower correlations with other defined food groups (13,23). The remaining 77 food items were combined into 19 food groups on the basis of similarities in nutrient composition, frequency of consumption, and the particular dietary habits of this population. Items that were consumed by ≥80% of the subjects (24) or presented differences in nutritional composition were kept separately (rice, beans, bread, sugar, fish, coffee, and tea).

The 19 food groups were as follows: *1*) rice; *2*) beans; *3*) breads; *4*) cakes and cookies/crackers; *5*) noodles, pasta, roots and tubers (noodles; gnocchi/lasagna/ravioli; baked/mashed potato; cassava/yam; cassava flour; and polenta); *6*) meats and eggs (pork; beef; chicken; barbecue; giblets: gizzard, heart, liver, stomach/tripe, kidneys; and eggs); *7*) vegetable spices (onion; garlic; and red, green, and yellow pepper); *8*) dairy products (cheese, milk, cottage cheese, and yogurt); *9*) green vegetables and legumes (lentils/peas/chickpeas, lettuce, cabbage, kale, cauliflower/broccoli, tomato, cucumber, chayote, squash, zucchini, carrots, beets, okra, and pea pods); *10*) fruits and fruit juices (orange/tangerine; banana, papaya, apple, watermelon/melon, pineapple, grape, mango, and fruit juices/pulp); *11*) fish; *12*) sausages and deli meats (sausage/frankfurter; cold cuts: bologna, ham, and salami; and bacon); *13*) fat (butter and margarine); *14*) fast food and snacks (pizza, hamburgers, French fries/chips/shoestring potatoes, mayonnaise, snacks, popcorn, fried/baked salted pastries, canned vegetables, and peanuts); *15*) coffee; *16*) tea; *17*) sodas; *18*) candies (ice cream, candies/caramels, chocolate powder, chocolate bars/bonbons, fruit jam/jelly, and sweet dairy); and *19*) sugar.

The sample size of the present study was sufficient to identify dietary patterns by applying principal components analysis (PCA). This dietary analysis requires at least 5 subjects for each food group when the FFQ has >15 food items (23,25). We aggregated the 19 food groups to identify the dietary patterns before pregnancy. Therefore, the analysis required at least 95 women. The number of subjects analyzed in this study was consistent with the method requirements.

Depressive symptoms

The EPDS was administered to measure depressive symptoms at all 3 gestational follow-up visits. This instrument consists of a 10-item screening scale that inquires about the mother's mood in the past 7 d. Each item has 4 answer options that are assigned a score from 0 to 3 (total scores range from 0 to 30). The EPDS was developed for use in the postpartum period (26) and has been validated for use in pregnancy (27).

Santos et al. (28) translated the EPDS scale into Portuguese and validated it in a sample of mothers from Pelotas, southern Brazil. In the

current study, depressive symptoms were measured by using the Portuguese version of the EPDS administered by trained interviewers. The internal consistency reliability of the EPDS for our study sample revealed a Cronbach's α of 0.74, 0.79, and 0.78 for trimester 1, 2, and 3 of pregnancy, respectively.

Covariates assessment

The following variables were included in the analysis: age (y), education (years of education), marital status (married/stable partnership or single), parity (number of deliveries), and unplanned pregnancy (no/yes). These data were obtained by using a structured questionnaire administered at baseline.

Gestational age (wk) was measured by using the first obstetric ultrasound if the age was assessed before 26 wk of gestation (n = 210; 84.7%). When the pregnant women did not have ultrasound available (n = 38; 15.3%), we used the reported date of the last menstrual period to calculate the gestational age.

Weight and height were measured by using standard methods by trained interviewers (29). Height was measured in duplicate by using a portable stadiometer (Seca). When the measurements differed by >0.5 cm, a third measurement was performed, and the mean of the 2 similar measurements was used. Height was measured only at the first follow-up visit. Weight was assessed in each gestational trimester with an electronic scale (Filizzola PL 150) with a 150-kg capacity and 0.1 kg variation. BMI [weight (kg)/height $(m)^2$] was calculated at all 3 follow-up visits. Total energy intake obtained by the FFQ before pregnancy was used as a covariable to adjust the longitudinal models.

Statistical analyses

Dietary patterns. PCA was used to identify dietary patterns before pregnancy. A correlation matrix was constructed to assess the correlation between the food groups. The Kaiser-Meyer-Olkin test (>0.6) and Bartlett's test of sphericity ($P < 0.05$) were applied to verify whether the PCA assumptions were all met (23,25).

Varimax rotation was applied to obtain orthogonal factors. Foods groups that had factor loadings >0.20 and communalities >0.20 were considered. A factor loading >0.20 indicates a meaningful strong association with the factor or pattern and has been previously used in other studies (30,31). A positive factor loading indicated that the food group had a positive association with the dietary pattern, whereas a negative factor loading indicated an inverse association. Food groups were kept in the dietary pattern if they had the higher factor loading, even if this was higher than 0.20 in another dietary pattern.

The number of factors extracted was based on eigenvalues >1.5 and scree test plots (25). Dietary patterns were labeled according to the food items included, the higher factor loading of foods in dietary patterns, and the interpretation of the dietary patterns. The factor score was obtained with PCA, and each pregnant woman received a factor score for each dietary pattern identified (13).

For some analyses, the pregnant women were classified in a specific pattern only. High adherence to each dietary pattern was classified according to quintiles. When a woman was classified in the fifth quintile she was considered as having high adherence for that pattern. For example, if a woman was classified in the fifth quintile of the "common-Brazilian" and "healthy" patterns, she was kept in the common-Brazilian pattern because of the lower range of dietary pattern scores for the common-Brazilian (−2.32 to 1.66) vs. the healthy (−2.36 to 3.15) pattern.

Descriptive and longitudinal analysis. The baseline characteristics of the sample were described by using means and 95% CIs for continuous variables. The categorical variables were described by frequencies. These variables were stratified according to the established dietary patterns identified on the basis of the greater adherence to each dietary pattern. ANOVA was used to compare means of the selected variables, and a chi-square test was applied to compare the frequencies of the categorical variables.

We used longitudinal mixed-effects (LME) regression models to evaluate the longitudinal associations between dietary patterns before pregnancy and depressive symptoms during pregnancy. Scores for depressive symptoms at the 3 follow-up waves were the outcomes of LME models. The LME model allows evaluating time-dependent and time-independent covariates and unbalanced time intervals. Furthermore, this model is adequate even if the study data contain missing values (32,33). The regression coefficient (β) and SE generated by the model provide a combined estimate of the effect between individuals (with respect to the association with time between the independent variables and depressive symptoms) and within individuals (representing the effect of the independent variable variation on changes in depressive symptoms throughout pregnancy) (34).

In all longitudinal models, gestational age (wk) was included as a random and fixed-effects variable to adjust for all-subject and individual depressive symptoms score variation over time. The dietary pattern scores and all other covariates were analyzed as fixed-effects variables. Dependencies in the data were handled with an unstructured covariance matrix (all variances and covariances were estimated separately) (32,33).

In the multivariable analyses, we conducted an independent LME regression model for each dietary pattern identified. All covariates (age, education, marital status, parity, unplanned pregnancy, pregnancy BMI, total energy intake before pregnancy, and gestational age) were selected on the basis of the biologic plausibility of an association with depressive symptoms. Marital status was considered a time-dependent variable because a woman could switch status over pregnancy. All other independent variables included in the models were time-independent. We used the restricted log-likelihood, Akaike's information criterion and Bayesian information criterion as global fit criteria to select the best LME model for each dietary pattern. During the modeling process, 3 types of plots were produced: scatter plots of residuals to check for specific patterns, quantile-quantile plots to check normality of the residuals, and plots to check the autocorrelation structure (32,33). Interaction terms between gestational age and dietary patterns were tested, with the aim of detecting differences in the variation in depression scores over time for each dietary pattern.

An appropriated statistical analysis was implemented considering that a clinical trial was originally nested within the observational cohort. In this regard, we performed statistical analyses to evaluate whether the data from the 41 women who were enrolled and completed the clinical trial could be included in the modeling process. The aim was to avoid selection bias due to exclusion of women at greater risk of developing depression and to increase the study's sample size. We fit 3 LME models:

1. Model 1 excluded information from the pregnant women who were enrolled in the clinical trial only from trimester 3 (period when supplementation was effective). We included data from these women from the trimester 1 and 2 follow-up visits. This model excluded the pregnant women at higher risk of depression, creating a selective loss of information bias (**Supplemental Table 1**).
2. Model 2 included all women (observational cohort and clinical trial) in all pregnancy trimesters in the longitudinal analysis (**Supplemental Table 2**).
3. Model 3 included all women (observational cohort and clinical trial) in all pregnancy trimesters but adjusted the analysis for a variable that classified the pregnant women on the basis of the type of study in which they were enrolled (observational cohort, treatment group, or placebo). The aim was to remove the effect of the supplementation from the analysis.

After conducting all 3 models, we compared the model results. We observed a small change across the associations (β-coefficients and corresponding P values) and decided to use model 3, considered the best model for this analysis. The final model considered only education as a socioeconomic status variable, because the model results did not improve with the inclusion of the variable total family income.

The pregnant women were compared regarding the final rate of losses to follow-up. This rate was calculated as the proportion between the number of losses to follow-up and the total number of observations at baseline. We calculated this rate for several variables including EPDS (≥11, <11), age (20–29, ≥30 y), education (≥8, <8 y), marital status (married, stable partnership), parity (0–1, ≥2), and pregestational BMI

(≥25, <25 kg/m^2). The chi-square test for proportions was used to assess patterns of nonrandom losses to follow-up. All analyses were performed with the use of Stata 12.0 (35).

Ethical approval

The study protocol was approved by Ethics Committee of Maternity Hospital (protocol: 0023.0.361.000-08) and the Institute of Psychiatry of the Rio de Janeiro Federal University (protocol: 0012.0.249.000-09), both from the Rio de Janeiro Federal University, and the Ethics Committee of the Municipal Secretary of Rio de Janeiro City (protocol: 0139.0.314.000-09). Written consent was obtained from all participants.

Results

A total of 248 pregnant women answered the EPDS and were considered for analysis at baseline. These subjects had a mean age of 26.7 y and an average of 8.8 y of education; 78.6% were married or had a stable partnership, and 22.7% had an unplanned pregnancy. Mean early pregnancy BMI was 25.1 kg/m^2, and mean total energy intake before pregnancy was 2250 kcal/d. The mean EPDS score was 9.0 (95% CI: 8.4, 9.6) (**Table 1**).

Three dietary patterns were identified from the data on 251 women who answered the FFQ. The Kaiser-Meyer-Olkin test (0.642) and Bartlett's test of sphericity ($P < 0.001$) showed that the correlation between the food groups was sufficient and appropriate for PCA. The first dietary pattern identified was labeled "common-Brazilian," and consisted of rice, beans, vegetable spices, and meats and eggs. The second pattern was labeled "healthy" and comprised dairy products, fruits and fruit juices, green vegetables and legumes, candies, fish, cakes and cookies/crackers, noodles, pasta, roots and tubers, and tea. The third pattern was labeled "processed" and was characterized by positive loadings of bread, fat, fast food and snacks, sugar, sausages and deli meats, soft drinks, and coffee. Coffee had the same factor loading as "healthy" and "processed" patterns, however, with negative and positive loading, respectively. Coffee was kept in the processed pattern. The percentage of variance explained by each dietary pattern before pregnancy was 15.2%, 11.2%, and 9.8%, respectively. Together, the 3 dietary patterns explained 36.1% of the percentage of variance. The eigenvalues in each dietary pattern were 2.88 (common-Brazilian), 2.12 (healthy), and 1.86 (processed) (**Supplemental Table 3**). Adherence to the common-Brazilian pattern was 36.7%, to the healthy pattern was 31.4%, and to the processed pattern was 31.8% (results not shown in tables).

Pregnant women with higher adherence to the prepregnancy common-Brazilian pattern had lower age (25.9 y) and total energy intake (2132 kcal/d) and higher early pregnancy BMI (25.5 kg/m^2) and years of education (9.1 y) than did the healthy or processed pattern. Women who adhered to the healthy pattern were older (27.4 y), were married or had a stable partnership (85.7%), were less likely to have an unplanned pregnancy (15.8%), and had low depressive symptom scores (8.3). We observed that women who had higher adherence to the processed pattern had higher depressive symptom scores (10.0) and total energy intake (2370 kcal/d) and fewer years of education (8.6 y) than did the other patterns (Table 1).

Depressive symptoms decreased during pregnancy trimesters according to the EPDS scores: trimester 1, 9.0 (95% CI: 8.4, 9.6); trimester 2, 7.2 (95% CI: 6.5, 7.8); and trimester 3, 7.0 (95% CI: 6.4, 7.7). This trend was confirmed in the longitudinal linear bivariate regression model (β: −0.723; 95% CI: −1.277, −0.169; $P = 0.011$) (results not shown in tables).

In the linear multiple longitudinal regression model, the prepregnancy healthy pattern was inversely associated with depressive symptoms during pregnancy (β: −0.723, 95% CI: −1.277, −0.169; $P = 0.011$). The common-Brazilian

TABLE 1 Characteristics of pregnant women followed up at a public health center stratified by dietary patterns at baseline between gestational weeks 5 and 13: Rio de Janeiro, Brazil (2009–2012)[1]

		Dietary pattern[3]			
	All ($n = 248$)[2]	Common-Brazilian ($n = 90$)	Healthy ($n = 77$)	Processed ($n = 78$)	P[4]
Continuous variables					
Depressive symptoms score[5]	9.0 (8.4, 9.6)	8.7 (7.7, 9.6)	8.3 (7.2, 9.3)	10.0 (8.9, 11.2)	0.06
Age, *y*	26.7 (26.1, 27.4)	25.9 (24.9, 27.0)	27.4 (26.2, 28.5)	27.0 (25.6, 28.3)	0.22
Education, *y*	8.9 (8.5, 9.2)	9.1 (8.5, 9.7)	8.8 (8.2, 9.5)	8.6 (7.9, 9.3)	0.53
Parity	1.0 (0.8, 1.1)	1.0 (0.8, 1.3)	0.8 (0.6, 1.1)	1.0 (0.8, 1.3)	0.41
Early pregnancy BMI,[6] *kg/m^2*	25.1 (24.5, 25.7)	25.5 (24.5, 26.5)	25.3 (24.3, 26.4)	24.5 (23.3, 25.6)	0.33
Gestational age, *wk*	9.6 (9.3, 9.8)	9.6 (9.1, 10.0)	9.5 (9.0, 9.9)	9.6 (9.1, 10.2)	0.85
Total energy intake,[7] *kcal/d*	2250 (2164, 2336)	2132 (2023, 2240)	2267 (2093, 2442)	2370 (2201, 2538)	0.08
Categorical variables, *n (%)*					
Marital status					0.040
Married or stable partnership	195 (78.6)	72 (80.0)	66 (85.7)	54 (69.2)	
Single	53 (21.4)	18 (20.0)	11 (14.3)	24 (30.8)	
Unplanned pregnancy					0.13
No	191 (77.3)	69 (76.7)	64 (84.2)	55 (70.5)	
Yes	56 (22.7)	21 (23.3)	12 (15.8)	23 (29.5)	

[1] Values are means (95% CIs) unless otherwise indicated.
[2] A total of 251 pregnant women had their food intake assessed and 248 women had information on depressive symptoms; however, 3 of the 248 were missing reports of food intake.
[3] Women were classified into only 1 dietary pattern according to the highest quintile of each dietary pattern score.
[4] *P* values for continuous variables were determined by using ANOVA, and *P* values for categorical variables were determined by using a chi-square test.
[5] Depressive symptoms were assessed by the Edinburgh Postnatal Depression Scale.
[6] BMI obtained at baseline.
[7] 1 kcal/d = 4.184 kJ/d.

(β:−0.227; 95% CI: −0.708, 0.253; $P = 0.35$) and processed (β: 0.413; 95% CI: −0.161, 0.986; $P = 0.15$) patterns were not associated with depressive symptoms during pregnancy (**Table 2**).

The final rate of losses to follow-up was 22% (54 of 245). The analysis of data from the study participants who were lost to follow-up showed no departure from a random process (non-informative) for almost all of the variables except for marital status and education. The final follow-up rate for pregnant women living without a partner or with higher education was higher than that for married or less-educated women (results not shown in tables). Interaction terms between gestational age and dietary patterns on depressive symptom scores were tested, but they were not significant and were removed from the final models.

Discussion

This prospective cohort study investigated the association between dietary patterns before pregnancy and depressive symptoms during pregnancy and had 3 main findings. First, 3 dietary patterns were identified. The patterns were labeled "common-Brazilian," "healthy," and "processed." The dietary patterns were labeled according to the main food groups' factorial loadings. Second, we observed that the prepregnancy healthy pattern had an inverse association with depressive symptoms measured at 3 time points during pregnancy. Women who adhered to this pattern were less likely to report depressive symptoms throughout pregnancy. However, the other 2 dietary patterns did not have significant associations with EPDS scores. Finally, the study corroborates previous observations that mean EPDS scores decreased progressively during pregnancy. It is worth noting that this is the first study to our knowledge that examined the association between prepregnancy dietary patterns and prospective depressive symptoms assessed at all 3 pregnancy trimesters.

There are some limitations to the present study that need to be mentioned. The first relates to the loss of subjects from follow-up. Although this may be considered a limitation, this drawback is commonly observed in prospective studies. Our final rate of losses to follow-up was 22%, but there was no departure from a random process for almost all of the variables, with the exception of marital status and education, variables that were controlled for in the analysis. Another limitation is that the factor analyses used to identify the dietary patterns depend on several decisions made by the researcher, such as food group combinations, number of factors to be retained, and names assigned to the retained factors.

Despite all of these limitations, the present study has important strengths such as the use of high-quality and validated instruments to measure dietary intake, depressive symptoms, and social and behavioral data. Another strength includes the use of the LME procedure, a robust statistical technique for longitudinal analysis that was used to verify the associations. Previous studies that assessed dietary patterns and depression used cross-sectional designs and evaluated depressive symptoms only during the postpartum period (15,16). The external validity of our study is likely to be high considering that ~75% of all pregnant women in Brazil receive prenatal care from public health centers (36) and the socioeconomic profile of women included in the present study is similar to that of women who attend Brazilian public health centers.

We observed that the pregnant women in our study presented higher depressive symptom scores than those in other studies. However, the prevalence of depression in developing countries is usually higher than in developed ones (37). Our findings of a decrease in depressive symptoms throughout pregnancy are in line with previous investigations (38–40). Some authors have

TABLE 2 Multiple longitudinal regression model with mixed effects between prepregnancy dietary patterns and depressive symptom (EPDS) changes in pregnant women followed up at a public health center in Rio de Janeiro, Brazil (2009–2012)[1]

	Dietary pattern					
	Common-Brazilian[2]	P[3]	Healthy[4]	P[3]	Processed[5]	P[3]
Fixed-effects						
Intercept	8.042 (3.797, 12.287)	<0.001	6.779 (2.447, 11.112)	0.002	9.025 (4.631, 13.419)	<0.001
Dietary pattern scores	−0.227 (−0.708, 0.253)	0.35	−0.723 (−1.277, −0.169)	0.011	0.413 (−0.161, 0.986)	0.16
Age (y)	−0.050 (−0.145, 0.044)	0.30	−0.040 (−0.134, 0.053)	0.40	−0.050 (−0.144, 0.044)	0.30
Education (y)	−0.013 (−0.187, 0.161)	0.88	−0.010 (−0.183, 0.162)	0.91	−0.019 (−0.193, 0.155)	0.83
Marital status (married or stable partnership/single)	2.115 (1.015, 3.215)	<0.001	1.931 (0.829, 3.033)	0.001	2.039 (0.933, 3.145)	<0.001
Parity (number of deliveries)	0.503 (0.003, 1.004)	0.05	0.404 (−0.087, 0.896)	0.12	0.475 (−0.018, 0.968)	0.06
Unplanned pregnancy (no/yes)	2.381 (1.216, 3.546)	<0.001	2.402 (1.250, 3.555)	<0.001	2.363 (1.199, 3.527)	<0.001
Pregnancy BMI (kg/m^2)	0.059 (−0.036, 0.154)	0.22	0.058 (−0.036, 0.152)	0.23	0.063 (−0.032, 0.157)	0.20
Total energy intake[6] (kcal/d)	−0.000 (−0.001, 0.001)	0.79	0.000 (−0.000, 0.001)	0.35	−0.001 (−0.001, 0.000)	0.23
Gestational age (wk)	−0.092 (−0.123, −0.061)	<0.001	−0.093 (−0.124, −0.062)	<0.001	−0.093 (−0.124, −0.062)	<0.001
Random-effects						
Gestational age	0.005 (0.001, 0.033)	<0.001	0.005 (0.001, 0.034)	<0.001	0.005 (0.001, 0.033)	<0.001
Intercept	9.212 (4.751, 17.863)	<0.001	8.468 (4.190, 17.114)	<0.001	8.850 (4.466, 17.538)	<0.001
Residual	8.744 (7.178, 10.650)	<0.001	8.758 (7.191, 10.666)	<0.001	8.754 (7.186, 10.664)	<0.001

[1] Values are longitudinal regression coefficients (95% CIs) and were adjusted by a variable that classified the pregnant women into the type of study in which they were enrolled (clinical trial vs. observational cohort). Number of observations = 627, number of groups = 246, mean of 2.5 observations per group. AIC, Akaike's information criterion; BIC, Bayesian information criterion; EPDS, Edinburgh Postnatal Depressive Scale.
[2] Likelihood = −1744.5, AIC = 3521.0, BIC = 3592.0.
[3] P value refers to restricted maximum likelihood estimator.
[4] Likelihood = −1741.7, AIC = 3515.4, BIC = 3586.4.
[5] Likelihood = −1743.9, AIC = 3519.9, BIC = 3590.9.
[6] 1 kcal/d = 4.184 kJ/d.

suggested that a decrease in depression may be due to familial and social support and coping behavior and skills (41,42).

Some studies assessed depressive symptoms during the last gestational trimester through the postpartum period (38–40). Micali et al. (38) evaluated depressive symptoms in 11,731 women at 18 and 32 wk of pregnancy and at 8 wk and 8 mo postpartum on the basis of the EPDS. The authors observed that depression scores decreased significantly over time. These results are consistent with those observed in the current study. Our results are also consistent with those reported by the Obstetrics Outpatients Unit from Porto, Portugal, which showed a decrease in depressive symptoms and prevalences of EPDS scores $\geq$10 that were 20.0%, 19.6%, and 17.4% in gestational trimesters 1, 2, and 3, respectively (39).

A cohort study conducted by Teixeira et al. (40) in Portuguese women reported a significant decrease in depressive symptoms from 6.6 to 6.2 (from trimester 1 to trimester 2), which further decreased to 5.6 from trimester 2 to trimester 3. Most of the studies observed a decrease in depressive scores; however, Evans et al. (43) verified a small increase in EPDS scores (6.6 to 6.7) from the week 18 to week 32 in British pregnant women investigated by the Avon Longitudinal Study of Parents and Children (ALSPAC). The difference between ALSPAC and our study can be attributable to socioeconomic profile. Furthermore, the EPDS mean score increase observed in ALSPAC seems not to be clinically relevant.

The healthy pattern identified before pregnancy in our study was composed of prudent foods, such as noodles, pasta, roots and tubers, green vegetables and legumes, fruits and fruit juices, dairy products, fish, and tea. This pattern has had an inverse association with prospective changes in EPDS scores during pregnancy. Similarly, intake of the "health-conscious" pattern (characterized by vegetables, fruits, grain legumes, nuts, dairy products, and olive oil) prevented depressive symptoms in postpartum women from the Rhea project, a prospective cohort study in pregnant women and their children in Crete, Greece (15). However, in pregnant women from the Osaka Maternal and Child Health Study, there was no association between a healthy pattern, comprising green and yellow vegetables, seaweeds, white vegetables, potatoes, fish, fruits, shellfish, and sea products, and depressive symptoms (16).

In our study, we observed that some factors, such as years of education, marital status, and unplanned pregnancy, were risk factors for depressive symptoms in pregnant women. These results agree with those from Hein et al. (44) who evaluated a prospective cohort of women from The Franconian Maternal Health Evaluation Studies and showed that partnership status, previous pregnancies, educational status, income, and accommodation status were risk factors for depressive symptoms during and after pregnancy. Miyake et al. (11) verified in Japanese women from the Kyushu Okinawa Maternal and Child Health Study that the intake of healthy foods rich in EPA and DHA was associated with a lower prevalence of depressive symptoms during pregnancy, and the intake of this dietary pattern was positively associated with age, number of children, unemployment status, household income, and educational level.

The food groups that comprised the healthy pattern in the present study resulted in a dietary intake rich in several antioxidant compounds (e.g., flavonoids, vitamins, and minerals), which are important nutrients that protect the brain from the effects of oxidative stress implicated in depression (45), and long-chain essential n–3 PUFAs (e.g., fish), which are known to be a necessary component for optimal neurologic function (46). Thus, it is possible that this pattern resulted in a healthy diet that possibly prevents neurocognitive impairments that reflect in mood changes during pregnancy such as depressive symptoms.

The 2 other dietary patterns identified before pregnancy, common-Brazilian and processed, did not have a significant association with depressive symptoms throughout pregnancy. A higher intake of total fat and SFAs was associated with an increased prevalence of depressive symptoms in pregnant Japanese women (11).

The processed pattern in this study was characterized by a higher intake of fat and carbohydrates and did not have a significant association with EPDS scores, even for the women who adhered more frequently to this pattern. These women had higher mean depressive symptoms scores and number of deliveries, had fewer years of education, and were predominantly single—i.e., risk factors that increase depressive symptoms during pregnancy (1,7,44).

In summary, we observed that depressive symptoms decreased progressively during pregnancy, and some risk factors, such as single marital status, increased EPDS scores. We verified that a prepregnancy healthy pattern was inversely associated with depressive symptoms evaluated prospectively throughout pregnancy.

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G.K. and J.d.S.V. designed the research; A.A.F.V., D.R.F., I.E., J.d.S.V., and A.B.F.-S. conducted the research; A.A.F.V., D.R.F., and A.B.F.-S. analyzed the data; A.A.F.V. and G.K. wrote the manuscript and had primary responsibility for the final content; and M.B.T.C., M.T.A.O., S.P.M., and A.A.M.d.S. contributed suggestions to improve the manuscript, and reviewed and modified the text when necessary. All authors read and approved the final manuscript.

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