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Adherence to dietary patterns during pregnancy and association with maternal characteristics in pregnant Brazilian women

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ABSTRACT

Objectives: The aim of this study was to investigate food consumption during pregnancy by determining dietary patterns, associations with maternal characteristics, and possible changes in adherence to patterns throughout pregnancy.
Methods: We prospectively followed two groups of pregnant women (N = 353) and collected, in each gestational trimester, two 24-h dietary recalls: one in person and another by telephone, with one of these recalls performed on a weekend or holiday. To determine the women's dietary patterns, principal component analysis was conducted using the combined data of groups and trimesters. The association between adherence to patterns and maternal characteristics was investigated using a logistic regression model, including covariates as potential confounders. Changes in adherence throughout the trimesters by the means difference test also were examined.
Results: Three dietary patterns were identified: traditional Brazilian; predominantly ultra-processed and beef; and whole grains, fruits, vegetables, low-fat milk, and dairy. Associations were found between adherence to patterns and not working outside the home, not being white, being younger, not living with a partner, drinking alcohol before pregnancy, years of formal education, and socioeconomic classification. Adherence to the traditional Brazilian pattern increased as gestational trimesters advanced, whereas the pattern that included whole grains, fruits, vegetables, low-fat milk, and milk derivatives decreased from the first to the second gestational trimester.
Conclusion: We found associations between maternal sociodemographic characteristics and adherence to different dietary patterns, as well as changes in adherence during pregnancy. This knowledge is relevant to creating specific and feasible guidelines for different population strata associated with the patterns.

Introduction

Food consumption during pregnancy has a major influence on maternal and child health, and improving the well-being of mothers and their children has a strong influence on the health of following generations [1].

A review study that investigated the effects of maternal dietary intake on the birthweight of infants concluded that, to maintain an adequate birthweight, consuming a diet composed of fruits, vegetables, skim milk, and lean meats appears to be beneficial [2]. Another systematic review highlighted the need to encourage healthy eating and living habits, especially considering the importance of adequate nutritional status before and at the beginning of pregnancy to reduce the risk for unwanted maternal and child health outcomes [3]. However, the effects of feeding also may be negative: dietary patterns are associated with increased risk for developing gestational diabetes [4] and depressive disorders or anxiety [5].

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Food choices are closely related to cultural, anthropological, socioeconomic, and psychological aspects that surround an individual's environment [6,7]. Thus, to know the dietary patterns and characteristics of the groups most adherent to each of them constitutes a step toward the definition of tailor-made interventions specific to each group. Such identification appears to be a suitable alternative to evaluate dietary exposures in nutritional epidemiology and allows for the identification of subgroups with more or less adherence to certain patterns [8,9].

In a large cohort of pregnant Norwegian women (N = 66 000), three dietary patterns were identified. Older women with more years of formal education scored more highly on the Prudent pattern, with lower scores found in women with higher body mass index (BMI) values. However, for the Western pattern, the highest scores were found among women who were younger, were smokers, had fewer years of formal education, were multiparous, had a history of prematurity, and were overweight [10]. A systematic review on this subject found that younger pregnant women with fewer years of formal education had inadequate food consumption; thus reiterating the need for more studies to gain a more robust understanding on this subject [11].

This way of assessing food consumption (i.e., investigating dietary patterns) offers a clear explanation of the food consumption and food habits of the populations studied. Effective measures of health promotion through food also can be better supported by this food consumption approach [9]. However, this method is scarcely used in Brazil when investigating the consumption of pregnant women, and little is known about the factors or characteristics associated with the different dietary patterns of pregnant women.

Here, we present the results of a prospective study that investigated the food consumption of pregnant Brazilian women; we adopted the methodological perspective of evaluating dietary patterns. We hypothesized that different socioeconomic and maternal demographic characteristics influence adherence to these patterns.

Methods

Design and study population

The data came from a study carried out in a Brazilian municipality. Details from the original study were previously outlined [12]. The study focused on two cohorts of pregnant women assisted in public prenatal care of Botucatu. Botucatu is a small town (140 000 inhabitants), located in the state of São Paulo in the southeast of Brazil. One cohort consisted of pregnant women who had prenatal care in units called USF and the other in units called UBS. The public health system of Brazil has two models of primary health care: the traditional model (where health units are called UBS) and the family health program (where health units are called USF) [13]. There are some differences in health assistance between these two models. Specific for prenatal care, consultations are made by physicians and nurses at USF, whereas only by obstetrical doctors at the UBS. There is still a difference between the cohorts, as USF professionals have undergone training to update their current recommendations for physical activity and healthy eating during pregnancy and to insert these recommendations into their prenatal care.

Pregnant women were approached immediately after enrolling in prenatal care and were followed up from the first to the third gestational trimester after signing an informed consent form. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Ethics Committee of Botucatu Medical School. Written informed consent was obtained from all patients. Data collection took place from November 2012 to February 2014.

The sample for this study comprised 353 pregnant women, considering two cohorts together. This sample is representative of pregnant women with low obstetric risk who underwent prenatal care in the 18 primary care units of the public health system, free of charge, in the city of Botucatu. However, we adjusted the results to the type of health unit where the pregnant woman was assisted during prenatal. This was done because there could be differences between them in terms of food consumption owing to the care model and the characteristics of the professionals who performed prenatal care, rather than the factors of interest (socioeconomic and demographic) in the present study.

All pregnant women enrolled in low-risk prenatal care in the public primary care network, ≥18 y of age and in the first trimester of pregnancy (<14 wk), were considered eligible and were invited to participate in the study. Pregnant women with twin pregnancies, those who had diseases that put their pregnancy at high obstetric risk (such as gestational diabetes or pregnancy-induced hypertension), or those with any adverse conditions that required rest or reduced physical activity [14] were excluded from the study.

At the baseline, 353 pregnant women were recruited. In the second and third trimesters, 281 and 267 women were followed, respectively. In the majority of cases, participants were lost during follow-up as a result of the following: abortions (7.2%); changes in prenatal care location, that is, private care or high-risk prenatal care (4.7% and 4.9%, respectively); and changes in city of residence (3.6%). The refusal rate was 3%.

Socioeconomic, demographic, obstetrical, and nutritional status variables of pregnant women were obtained by applying a personal questionnaire during their first gestational trimester. The following variables were used in the present study: age (18–19, 20–30, >30 y), schooling (≥11, 8–11, <8 y), socioeconomic level (class B; class D/E), working outside the home (yes or no), living with a partner (yes or no), number of births (0, 1, or ≥2), skin color (white, non-white), pregestational nutritional status (underweight, normal weight, overweight, or obese), health care assistance model (UBS or USF), and gestational trimester (first, second, or third).

The socioeconomic level was evaluated according to the economic classification criteria established by the Brazilian Market Research Association [15] and the pregestational nutritional status according to the criteria defined by the World Health Organization (WHO) [16].

All data were obtained through a face-to-face questionnaire and comprised the study sample. These data were concomitantly entered twice using the EpiData program. After correcting for any errors found via double typing, data consistency was also checked.

Dietary assessments

During each gestational trimester, two 24-h dietary recalls (24HR) were collected: one conducted face-to-face at the participant's home and the second by telephone. Information on beverages consumed also was collected during the 24HR. To accurately estimate habitual consumption, the date of retrieval of the 24HR was strictly adhered to, wherein the telephone interview occurred on a day that was not consecutive with the face-to-face 24HR. One of the recalls was conducted on a weekend or holiday, whereas the other was performed on a weekday. Information regarding the usual use of any kind of supplement was not collected. All 24HRs were applied using the multiple pass method [17]. The 24HR achievement in each trimester was a methodological option to estimate more accurate consumption of each pregnant woman, considering possible dietary changes throughout the gestational trimesters.

The 24HRs were checked weekly by the research supervision team. Dietary data were then entered into the Nutrition Data System for Research software, version 2010. To input the data into this software, foods and preparations (g or mL) were standardized and quantified according to tables listing the preparations consumed by the majority of the Brazilian population [18,19]. To verify the accuracy of the foods and preparations input, consistency analyses were performed, with special attention paid to the units of measurement and the presence of outliers for portions, weights, energy, and nutrients. These analyses were performed to correct for eventual failures in the collection and thus minimize errors and consequently the under- or overestimation of consumption.

Statistical analysis

We performed factorial analysis using the principal component analysis (PCA) method to determine dietary patterns. The definition of the patterns was performed for the total sample (i.e., with the data of the 24HR for the three gestational trimesters). In order to analyze more habitual consumption, we performed the mean consumption of each food group in each gestational trimester with the two 24HR periods. This decision was adopted to enable comparison of the food consumption of pregnant women because the patterns could not be comparable if they were independently determined during the gestational trimester. Likewise, any differences between the cohorts could also be identified. The Kaiser–Meyer–Olkin test was administered to test the suitability of the method, with a value >0.6.

The identification of the number of patterns to be retained was initially based on a scree plot test and eigenvalues. The scree plot suggested that the number of patterns was high (eight), and eigenvalues >1.5 were chosen. However, the fourth pattern (characterized by milk and chocolate powder) also made understanding the results difficult. Thus, considering the simplicity and interpretability of the patterns, a new factorial analysis was carried out, which established three factors to be retained.

To simplify the factorial matrix and to facilitate the interpretation of the data, varimax orthogonal rotation was performed. Later, in the formation of each food pattern, the food groups with factorial loads rotated >0.30 were considered significant. Factor naming was based on the constituent food groups.

After extracting factors, the individual factor scores of each pattern were obtained. The three patterns were adhered to differently by various subgroups of pregnant women. To describe these differences, the pattern scores were divided into tertiles:

- Tertile 1: low adherence to the pattern;
- Tertile 2: moderate adherence to the pattern;
- Tertile 3: high adherence to the pattern.

The association between intensity of adherence to patterns identified with maternal characteristics was investigated using a binary logistic regression model. Dependent variables (adhesion-pattern scores) were dichotomized as follows: tertile of high adhesion (tertile 3) and tertiles of low and moderate adhesion (tertiles 1 and 2 combined). Initially, regression analysis was performed with each of the exposure variables and the outcome, including only health unit care and trimester as an adjustment variable. All variables with association levels of $P < 0.20$ were considered potential candidates to compose the final model. Health care assistance model and trimester variables were retained in the final multivariate model, regardless of the level of significance in the initial analyses. We investigated the change of adherence over the trimesters in a single group, with the scores' means obtained in each pattern assessed by a means difference test.

All tests were performed using SPSS version 20 (IBM, Armonk, NY, USA), with $P < 0.05$ indicating statistical significance.

Results

The majority of pregnant women were between 20 and 29 y of age (59.5%), had ≥11 y of education (49.3%), belonged to class C (68.1%), did not work outside the home (51.8%), lived with a partner (73.9%), was primiparous (42.2%), was white (64.3%), and reported they did not smoke tobacco (74.5%) or drink alcohol (61.5%) before pregnancy. The majority of these women were of normal weight (47.9%); however, 47% were very close to overweight (Table 1).

Based on the related literature [10,20–22], nutritional value, function and use of foods, and after administering several initial groups of tests, we defined the 39 food groups for inclusion in the final analysis. The included food groups are shown in Table 2.

After factorial analysis, we identified three dietary patterns: traditional Brazilian; predominantly ultra-processed and beef; and whole grains, fruits, vegetables, low-fat milk, and dairy. Together they explain 19.3% of the total variance of the pregnant women's intake. Foods included in the traditional Brazilian pattern were rice; sugar; beans; coffee and teas; non-wholegrain breads, toasts, and crackers; oils and fats; whole milk; and vegetables. Soft drinks, sweets in general and sweet biscuits, cold cuts, sauces and condiments, chocolate powder, sandwiches, pizzas, salted pies, baked pastries, pasta, snacks, immersion frying foods, beef and beef offal, sausages, and processed meats characterized the predominantly ultra-processed and beef pattern. The whole grains, fruits, vegetables, low-fat milk, and dairy pattern was characterized by wholegrain breads, toast, and crackers; fruits; low-fat milk; vegetables; cereals and whole grains; cheeses and sour cream; dairy products; and milk beverages (Table 2).

In the initial analysis, which only adjusted for the type of health unit assistance that the pregnant woman received and her trimester (Table 3), adherence to the traditional Brazilian pattern was associated with schooling, working outside the home, number of births, skin color, and use of pregestational alcohol. The predominantly ultra-processed and beef dietary pattern was associated with age, schooling, presence of a partner, parity, skin color, pregestational alcohol use, and pregestational nutritional status. Schooling, socioeconomic classification, working outside the home, number of births, and pregestational smoking were associated with adherence to the whole grains fruits, vegetables, low-fat milk, and dairy pattern. All of these described factors were included in the multivariate analysis performed for each pattern, as well as those with P-values between 0.05 and 0.20 (Table 4).

Table 1
Socioeconomic, demographic, obstetric, and nutritional status characteristics of pregnant women (Botucatu, Brazil, 2012–2014)

Characteristics	%
Age (y)	
18–19	15
20–30	59.5
≥30	25.5
Education (y)	
≥11	49.3
8–11	28.9
<8	21.8
Socioeconomic class*	
B	9.9
C	68.1
D/E	22
Employed outside home	
Yes	48.2
No	51.8
Living with a partner	
Yes	73.9
Not	26.1
Number of births†	
0	42.2
1	27.8
≥2	30
Skin color‡	
White	64.3
Non-white	35.7
Pregestational tobbaco use§	
Yes	25.5
No	74.5
Pregestational alcohol consumption‖	
Yes	38.5
No	61.5
Pregestational nutritional status¶	
Underweight	5
Normal weight	47.9
Overweight	28.7
Obesity	18.3

*Information about purchasing power lost n = 8.
†Information on parity lost n = 3.
‡Information about skin color lost n = 3.
§Information about tobacco use lost n = 3.
‖Information about alcohol lost n = 3.
¶Information about body mass index lost n = 15.

Being employed and skin color were associated with the traditional Brazilian pattern regardless of the health care assistance model: Pregnant women who worked outside the home were 36% more likely to be in the tertile of greater adherence to this pattern (odds ratio [OR], 1.359; 95% confidence interval [CI], 1.012–1.824). Similar odds were found for those who were not white (OR, 1.353; 95% CI, 1.005–1.821).

Conversely, regardless of possible confounders and the health care assistance model, adherence to the predominantly ultra-processed and beef pattern was observed to be associated with the following maternal factors: age ($P = 0.002$), living with a partner ($P = 0.003$), skin color ($P < 0.001$), pregestational alcohol intake ($P = 0.006$), and pregestational nutritional status ($P = 0.052$). When compared with pregnant women between 20 and 29 y of age, pregnant women 18 to 19 y of age were 82.6% more likely to be in the tertile with the highest adherence to this pattern (OR, 0.665; 95% CI, 0.452–0.976). Those ≥30 y of age were 33.5% less likely to be in the same situation (OR, 1.826; 95% CI, 1.144–2.912). Not living with a partner and drinking alcohol in the pregestational period also increased the odds of greater adherence to this pattern ($P = 0.003$ and 0.006, respectively): The odds were 70.9% higher for

Table 2
Rotated factor loadings according to food group and dietary patterns identified (Botucatu, Brazil, 2012–2014)

Food groups	Dietary patterns*		
	Traditional Brazilian	Predominant ultra-processed and beef	Whole grains, fruits, vegetables, low-fat milk, and dairy
Spices	0.174	0.077	0.153
Oils and fats	**0.530**	0.212	−0.048
Fruits	0.241	−0.028	**0.477**
Green leaves	**0.404**	−0.105	0.325
Greenstuffs	0.233	−0.056	**0.404**
Canned vegetables	0.047	0.036	0.194
Tubers and roots	0.097	0.172	0.091
Cereals and whole grains	−0.023	0.018	**0.353**
Pasta	0.093	0.238	0.071
Rice	**0.696**	0.070	0.175
Beans	**0.674**	0.026	0.108
Other legumes and nuts	0.017	0.071	0.172
Poultry and poultry offal	0.285	−0.027	0.199
Beef and beef offal	0.253	**0.311**	0.154
Pork	0.083	0.117	0.092
Eggs	0.229	−0.030	0.003
Fish and seafood	−0.030	0.231	0.262
Sausages and processed meat	0.149	**0.310**	−0.032
Cold cuts	−0.014	**0.478**	0.121
Cheese and sour cream	−0.071	0.195	**0.347**
Whole milk	**0.458**	0.371	−0.041
Low-fat milk	0.012	−0.134	**0.445**
Dairy products and milk beverages	−0.095	0.166	**0.347**
Not whole-grain breads, toasts, and crackers	**0.597**	0.388	−0.075
Whole-grain breads, toast, and crackers	−0.056	−0.048	**0.503**
Sweets in general and sweet biscuits	0.080	**0.496**	0.101
Sandwiches, pies, savory snacks	−0.052	**0.367**	−0.044
Immersion fried foods	0.013	**0.336**	−0.074
Natural juices/Pulp/Concentrate	0.160	0.019	0.270
Artificial juices, nectars, and soybean base	−0.063	0.232	0.284
Soft drinks	−0.045	**0.661**	−0.052
Coffee and teas	**0.624**	−0.113	−0.117
Alcoholic beverages	−0.018	−0.010	0.011
Sugar	**0.682**	−0.017	−0.104
Sweeteners	−0.036	−0.002	0.112
Chocolate powder	0.083	**0.407**	0.099
Mixed preparations	0.035	0.066	0.050
Sauces and condiments	−0.119	**0.433**	0.125
Homemade soups and dehydrated soups	−0.014	0.085	−0.040
Number of groups	8	9	7
% variance explained	9.4	5.6	4.7
% cumulative variance explained	9.4	14.9	19.3

*Factor loadings ≥0.30 were included in the patterns (numbers in **bold**).

those not living with a husband/companion (OR, 1.709; 95% CI, 1.198–2.438) and 55.2% higher for those who consumed alcohol before pregnancy (OR, 1.552; 95% CI, 1.136–2.119). Conversely, non-white and overweight (versus eutrophic) women were 44.1% and 32.3% less likely, respectively, to be in the tertile of greater adhesion to the predominantly ultra-processed and beef pattern (OR, 0.559; 95% CI, 0.405–0.772, and OR, 0.677; 95% CI, 0.490–0.935, respectively).

Only years of education and socioeconomic classification maintained an independent association with adherence to the whole grains, fruits, vegetables, low-fat milk, and dairy pattern: Pregnant women with intermediate schooling, compared with those with ≥11 y of schooling, were 41.4% less likely to be in the highest tertile of this pattern (OR, 0.586; 95% CI, 0.417–0.835). When compared with class B, patients in classes C and D/E, were, respectively, 40.4% and 49.7% less likely to show greater adherence to this pattern (OR, 0.596; 95% CI, 0.372–0.953, and OR, 0.503; 95% CI, 0.283–0.896, respectively).

Adherence to the traditional Brazilian pattern increased from the first to second ($P < 0.001$) and third trimester ($P = 0.009$), with no statistical difference between the last two quarters ($P = 0.120$). Despite the increase in the mean of the adherence score with the advancement of gestational trimesters, no statistical difference between gestational trimesters in the predominantly ultra-processed and beef pattern was observed ($P > 0.05$). In the whole grains, fruits, vegetables, low-fat milk, and dairy pattern, adherence decreased from the first to the second gestational trimesters ($P = 0.042$), with no differences between the first and third ($P = 0.868$) or between the second and third trimesters ($P = 0.176$; Fig. 1).

Discussion

We identified three dietary patterns: traditional Brazilian; predominantly ultra-processed and beef; and whole grains, fruits, vegetables, low-fat milk, and dairy. These patterns are similar to dietary patterns identified in pregnant women from two municipalities of another Brazilian state (Rio de Janeiro) [23] and with patterns identified in the Norwegian Mother and Child Cohort [10]. The similarities are not based on food groups but rather on the type or nature of three patterns: One characterized by more traditional foods of the diet of each country; a second pattern characterized by products ready for consumption; and a third with the marked presence of whole foods, fruits, and vegetables.

Table 3
Logistic regression analysis between characteristics of pregnant women and dietary patterns* (Botucatu, Brazil, 2012–2014)

Variables	Traditional Brazilian			Predominantly ultra-processed and beef			Whole grains, fruits, vegetables, low-fat milk,and dairy		
	P-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI
Age (y)	0.599			**<0.001**			**0.182**		
18–19		1	–		1	–		1	–
20–30		0.909	0.660–1.252		**0.573**	**0.408–0.806**		1.198	0.874–1.642
≥30		0.826	0.554–1.231		**1.941**	**1.310–2.877**		0.784	0.521–1.179
Education (y)	**0.006**			**0.010**			**<0.001**		
≥11		1	–		1	–		1	–
8|–11		1.184	0.862–1.625		0.947	0.692–1.295		**0.521**	**0.378–0.718**
<8		**1.759**	**1.245–2.486**		**0.568**	**0.392–0.823**		**0.449**	**0.347–0.717**
Socioeconomic class	**0.089**			**0.118**			**0.002**		
B		1	–		1	–		1	–
C		**1.724**	**1.047–2.838**		0.980	0.576–1.433		0.566	0.360–0.889
D/E		**1.770**	**1.018–3.078**		0.644	0.380–1.090		0.397	0.236–0.669
Employed **outside home**	**0.006**			**0.051**			**0.018**		
Yes		1	–		1	–		1	–
No		**1.470**	**1.116–1.936**		0.760	0.577–1.002		**0.718**	**0.546–0.948**
Living with a partner	**0.092**			**<0.001**			0.430		
Yes		1	–		1	–		1	–
Not		0.766	0.562–1.045		**2.079**	**1.533–2.821**		0.884	0.650–1.202
Number of births	**0.003**			**<0.001**			**0.023**		
0		1	–		1	–		1	–
1		1.207	0.864–1.686		0.781	0.564–1.082		0.772	0.556–1.070
≥2		**1.733**	**1.258–2.387**		**0.451**	**0.322–0.632**		**0.639**	**0.462–0.884**
Skin color	**0.009**			**<0.001**			0.341		
White		1	–		1	–		1	–
Non-white		**1.450**	**1.098–1.914**		**0.594**	**0.445–0.793**		0.872	0.659–1.155
Pregestational tobbaco use	0.674			0.305			**0.035**		
Yes		1	–		1	–		1	–
No		0.935	0.684–1.278		1.177	0.862–1.606		**0.710**	**0.516–0.977**
Pregestational alcohol consumption	**0.034**			**<0.001**			0.960		
Yes		1	–		1	–		1	–
No		**0.740**	**0.560–0.977**		**1.771**	**1.343–2.335**		1.007	0.765–1.326
Pregestational nutritional status	0.458			**<0.001**			0.689		
Underweight		1	–		1	–		1	–
Normal weight		1.465	0.803–2.672		0.942	0.512–1.732		0.757	0.402–1.426
Overweight		1.023	0.773–1.354		**0.559**	**0.419–0.745**		0.980	0.741–1.295

*Adjustment per health care assistance model and trimester.

In the present study, as hypothesized, social and demographic factors were associated with pregnant women's adherence to different dietary patterns. For example, not working outside the home and not being white was associated with increased odds of greater adherence to the traditional Brazilian pattern (36% and 35%, respectively). In Brazil, these characteristics are indicative of unfavorable socioeconomic status [24,25]. The present findings are consistent with those of Hoffmann et al. [21], who studied pregnant women from southern Brazil. They found an association between the Common-Brazilian pattern, similar to our traditional Brazilian pattern, and lower income and schooling, being unemployed, not studying, and lower energy intake.

One possible explanation for the relationship between not working outside the home and greater adherence to the traditional Brazilian pattern is time to cook at home. Pregnant women working outside the home depend on the availability of meals from employers, restaurants, or snack bars, that is, places where foods characteristic of another pattern often are offered: ultra-processed foods or fried foods. This hypothesis is supported by data from a national study, the 2008–2009 Brazilian Household Budget Survey (HBS), that showed that feeding outside the home is characterized by foods such as sandwiches, soft drinks, and fried and baked snacks, with only ~12% of individuals eating rice and beans (food constituents of the traditional Brazilian pattern) on these occasions [26].

Also corroborating greater adherence to the traditional Brazilian pattern by non-white pregnant women was another Brazilian study that examined the adult population in general [27]. These differences in adherence to patterns relating to skin color appeared to be the result of people's own social and cultural differences, thus reflecting ethnic and racial inequalities in Brazil [28].

We looked for nomenclatures that characterized dietary patterns, in other words, that reflected the foods that predominantly make up each pattern. In this sense, the predominantly ultra-processed and beef pattern received nomenclature according to one of the latest food classifications, based in food processing, adopted in many recent epidemiological studies [29–31]. Thus, ultra-processed foods are usually ready-to-eat products that require little or no preparation, with a process of production combining a sequence of processes and many ingredients [32,33]. When assessing food consumption according to type of food processing, a high intake of ultra-processed foods is known to be related to a lower-quality diet [30]. The absence of a partner, being pregnant at a young age, and alcoholic beverage intake are factors observed to be related with worst-quality dietary patterns [23,34,35].

Specifically, the literature suggests that consumption of foods classified as ultra-processed are importantly linked to age, with higher consumption by younger people [36–38]. In the present study, this influence of age also was important and should be considered when creating nutrition and health policies. Ultra-processed foods are consumed in high amounts in childhood and adolescence [39], even relating to body fat [40]; this population also is more vulnerable to advertisements promoting these foods [41].

Table 4
Multivariate logistic regression analyses between characteristics of pregnant women and dietary patterns* (Botucatu, Brazil, 2012–2014)

Variables	Traditional Brazilian			Predominantly ultra-processed and beef			Whole grains, fruits, vegetables, low-fat milk, and dairy		
	P-value	OR	95% CI	*P*-value	OR	95% CI	*P*-value	OR	95% CI
Age (y)				**0.002**			0.084		
18–19					1	–		1	–
20–30					**0.665**	**0.452–0.976**		1.302	0.921–1.840
≥30					**1.826**	**1.144–2.912**		0.720	0.458–1.134
Education (y)	0.178			0.580			**0.007**		
≥11		1	–		1	–		1	–
8|–11		1.049	0.745–1.478		1.140	0.795–1.634		**0.586**	**0.417–0.835**
<8		1.470	0.965–2.238		0.897	0.563–1.429		0.686	0.447–1.053
Socioeconomic class	0.221			0.189			**0.054**		
B		1	–		1	–		1	–
C		1.483	0.884–2.488		1.201	0.725–1.987		**0.596**	**0.372–0.953**
D/E		1.221	0.661–2.254		0.833	0.449–1.548		**0.503**	**0.283–0.896**
Employed outside home	**0.041**			0.120			0.321		
Yes		1	–		1	–		1	–
No		**1.359**	**1.012–1.824**		0.779	0.569–1.067		0.861	0.641–1.157
Living with a partner	0.346			**0.003**					
Yes		1	–		1	–			
Not		0.848	0.602–1.194		**1.709**	**1.198–2.438**			
Number of births	0.074			0.183			0.124		
0		1	–		1	–		1	–
1		1.125	0.789–1.605		1.129	0.778–1.638		0.779	0.549–1.106
≥2		1.501	1.052–2.144		0.772	0.514–1.160			
Skin color	**0.046**			<**0.001**					
White		1	–		1	–			
Non-white		**1.353**	**1.005–1.821**		**0.559**	**0.405–0.772**			
Pregestational tobbaco use							0.231		
Yes								1	-
No								0.813	0.579–1.141
Pregestational alcohol consumption	0.147			**0.006**					
Yes		1	–		1	–			
No		0.800	0.591–1.081		**1.552**	**1.136–2.119**			
Pregestational nutritional status				**0.052**					
Underweight					1	–			
Normal weight					1.016	0.525–1.967			
Overweight					**0.677**	**0.490–0.935**			

*Adjustment per health care assistance model and trimester.

Understanding the association between overweight and lower adherence to the predominantly ultra-processed and beef pattern is not simple. In this case, reverse causality should be considered. In prenatal consultations, overweight pregnant women may have been more discouraged than normal-weight women to consume ultra-processed foods. Another possibility is that overweight pregnant women were more motivated than others to change their diet in relation to their pregestational habits. This behavior could be a positive reflection of actions directed at promoting healthy eating, which have been intensified in Brazil and worldwide [16,42]. Pregnant women in general constitute a group that is particularly worried about and motivated to adopt healthy behaviors [43–45], which may be reflected in better eating habits at this stage, as found in a study conducted in the same municipality as the present study [46].

Socioeconomic factors that positively influenced adherence to the whole grains, fruits, vegetables, low-fat milk, and dairy pattern were schooling and socioeconomic classification. These results are congruent with the findings of national and international studies examining pregnant women and the general population [8,47–50]. They are also in line with the results of the 2008–2009 national survey, with a positive association between the consumption of raw salads, fruits, skim milk, and milk products with income classes in Brazil [51].

Increased adherence to the traditional Brazilian pattern and reduction of adherence to the whole grains, fruits, vegetables, low-fat milk, and dairy pattern from the first to second trimester were observed. Explaining these changes in adherence to different dietary patterns throughout the gestational trimesters is difficult, with the most plausible hypothesis for the increase of adherence to the traditional Brazilian pattern being that nausea and vomiting that are frequently experienced at the beginning of pregnancy lead to dietary restrictions. Pregnant women also were investigated in a qualitative Brazilian study where meats and beans were defined as “hard” and nauseating foods [52]. This same reasoning also may explain decreasing adherence to the whole grains, fruits, vegetables, low-fat milk, and dairy pattern: After a phase of greater discomfort, feeding returns to a more traditional pattern.

Conversely, the absence of differences between adherence during pregnancy to the predominantly ultra-processed and beef pattern highlights the difficulties of changing after establishing one's food habit of consuming high-calorie and palatable foods. A similar result was found in an Irish study that identified, by cluster analysis, two dietary patterns in three gestational trimesters: healthy conscious and unhealthy [49].

The validity of the present results should be considered with caution. One cohort of pregnant women was captured in health units of professionals who participated in an educational action focused on their training to promote healthy eating. Therefore, we opted to include each analysis adjustment by health care assistance model to control for the eventual effect of intervention. That is, associations between characteristics of pregnant women and adherence to patterns were independent when they were assisted by health professionals who participated in educational action targeted at promoting healthy eating.

The sample size also may be considered a limitation. However, it should be emphasized that the pregnant women of the two

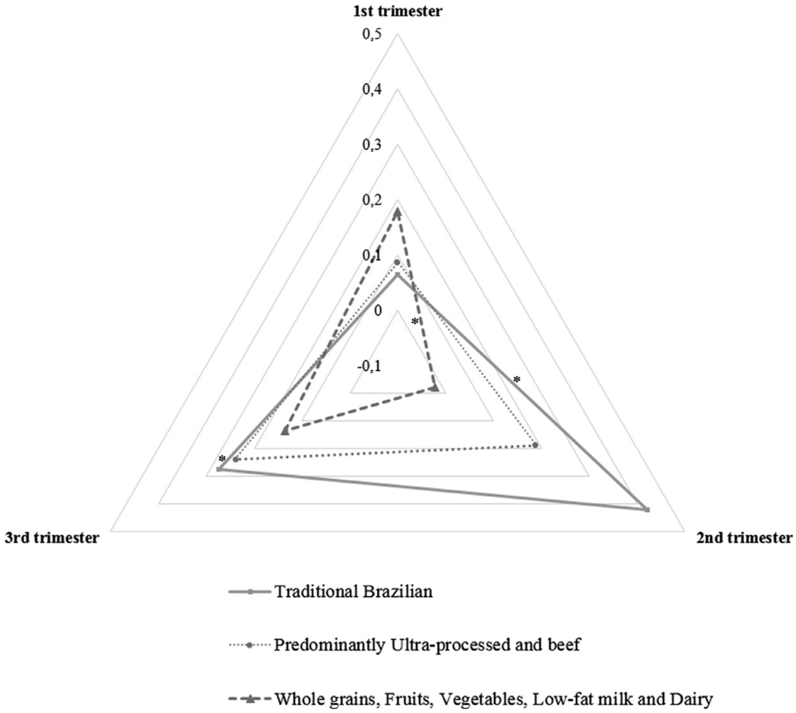

Fig. 1. Adherence to dietary patterns during the gestational trimesters. *Differ from the 95% level of significance defined by the means difference test.

health care units together are representative of pregnant women with low obstetric risk who perform prenatal care in the public network of the municipality studied.

Another relevant methodological aspect concerns the use of PCA. In PCA, as in all exploratory analyses, decisions are made by researchers when organizing food groups, and retaining factors may have influenced the results. However, it should be noted that these decisions are based on literature and always with the view to better interpret the results. In addition, PCA is the most widely used method for identifying and analyzing dietary patterns in non-pregnant and pregnant populations [22,47,50,53,54].

Supporting the validity of the presented results, it is worth highlighting the use of two 24HRs in each gestational trimester as a methodological quality of the present study. The alternative, the popular food frequency questionnaire, is a less accurate tool because it is influenced by an individual's cognitive ability to estimate their average consumption over a long period of time and to perform a less accurate quantification of their consumption [55]. In addition, the food frequency questionnaire does not appear to be the most appropriate tool for evaluating the consumption of Brazilian pregnant women [56].

Conclusion

We identified three dietary patterns among pregnant Brazilian women at low obstetric risk, regardless of the group to which they belonged. Pregnant women who did not work outside the home or who were not white tended to adhere to the traditional Brazilian pattern. Younger (18–19 y) women who did not live with a husband/companion or who reported pre-pregnancy alcohol use were more likely to adhere to the predominantly ultra-processed and beef pattern; whereas those with more years of formal education or higher socioeconomic classification showed greatest adherence to the whole grains, fruits, vegetables, low-fat milk, and dairy pattern. On average, adherence to the traditional Brazilian pattern increased with gestational trimester progress and adherence to the whole grains, fruits, vegetables, low-fat milk, and dairy patterns decreased from the first to second gestational trimester.

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References

[1] Procter SB, Campbell CG. Position of the Academy of Nutrition and Dietetics: nutrition and lifestyle for a healthy pregnancy outcome. J Acad Nutr Diet 2014;114:1099–103.
[2] Grieger J, Clifton V. A review of the impact of dietary intakes in human pregnancy on infant birthweight. Nutrients 2014;7:153–78.
[3] Ramakrishnan U, Grant F, Goldenberg T, Zongrone A, Martorell R. Effect of women's nutrition before and during early pregnancy on maternal and infant outcomes: a systematic review. Paediatr Perinat Epidemiol 2012;26:285–301.
[4] Shin D, Lee K, Song W. Dietary patterns during pregnancy are associated with risk of gestational diabetes mellitus. Nutrients 2015;7:9369–82.
[5] Paskulin JTA, Drehmer M, Olinto MT, Hoffmann JF, Pinheiro AP, Schmidt MI, et al. Association between dietary patterns and mental disorders in pregnant women in Southern Brazil. Rev Bras Psiquiatr 2017;39:208–15.
[6] Larsen MH. Nutritional advice from George Orwell. Exploring the social mechanisms behind the overconsumption of unhealthy foods by people with low socio-economic status. Appetite 2015;91:150–6.
[7] Antin TMJ, Hunt G. Food choice as a multidimensional experience. A qualitative study with young African American women. Appetite 2012;58:856–63.
[8] Newby PK, Tucker KL. Empirically derived eating patterns using factor or cluster analysis: a review. Nutr Rev 2004;62:177–203.
[9] Jacobs DR, Gross MD, Tapsell LC. Food synergy: an operational concept for understanding nutrition. Am J Clin Nutr 2009;89:1543–8.
[10] Englund-Ögge L, Brantsñter AL, Sengpiel V, Haugen M, Birgisdottir BE, Myhre R, et al. Maternal dietary patterns and preterm delivery: results from large prospective cohort study. BMJ Br Med 2014;348:1–18.

[11] Doyle I-M, Borrmann B, Grosser A, Razum O, Spallek J. Determinants of dietary patterns and diet quality during pregnancy: a systematic review with narrative synthesis. Public Health Nutr 2016:1–20.
[12] Malta MB, Carvalhaes MABL, Takito MY, Tonete VLP, Barros AJD, Parada CMGL, et al. Educational intervention regarding diet and physical activity for pregnant women: changes in knowledge and practices among health professionals. BMC Pregnancy Childbirth 2016;16:175.
[13] Paim J, Travassos C, Almeida C, Bahia L, Macinko J. The Brazilian health system: history, advances, and challenges. Lancet 2011;377:1778–97.
[14] American College of Obstetricians and Gynecologists. Exercise during pregnancy and the postpartum period. Clin Obstet Gynecol 2003;46:496–9.
[15] Brazilian Market Research Association. Brazil's Economic Classification Criteria Available at: http://www.abep.org/. Accessed May 10, 2015.
[16] World Health Organization. Obesity—preventing and managing the global epidemic: report of a WHO consultation. Geneva, Switzerland: Author; 1998.
[17] Moshfegh AJ, Rhodes DG, Baer DJ, Murayi T, Clemens JC, Rumpler WV, et al. The US Department of Agriculture automated multiple-pass method reduces bias in the collection of energy intakes. Am J Clin Nutr 2008;88:324–32.
[18] Pinheiro ABV, Lacerda EMA, Benzecry EH, Gomes MCS, Costa VM. Table for evaluation of food consumption in household measures. Atheneu; 2008 5th edition.
[19] Fisberg RM, Villar BS. Manual of recipes and homemade measures for the calculation of food surveys. São Paulo: Signus; 2002.
[20] França NAG, Camargo MBR, Lazaretti-Castro M, Peters BSE, Martini LA. Dietary patterns and bone mineral density in Brazilian postmenopausal women with osteoporosis: a cross-sectional study. Eur J Clin Nutr 2016;70:85–90.
[21] Hoffmann JF, Angélica M, Nunes A, Giselle S, Ozcariz I, Buss C. Dietary patterns during pregnancy and the association with sociodemographic characteristics among women attending general practices in southern Brazil: the ECCAGe Study. Cad Saude Publica 2013;29:970–80.
[22] Selem SSC, Castro MA, César CLG, Marchioni DML, Fisberg RM. Associations between dietary patterns and self-reported hypertension among Brazilian adults: a cross-sectional population-based study. J Acad Nutr Diet 2014;114:1216–22.
[23] Coelho NLP, Cunha DB, Esteves APP, Lacerda EMA, Theme Filha MM. Dietary patterns in pregnancy and birth weight. Rev Saude Publica 2015;49:1–10.
[24] Miquilin IOC, Marín-León L, Monteiro MI, Corrêa Filho HR. Inequalities in health services access and use among formal, informal, and unemployed workers, based on data from the Brazilian National Household Sample Survey, 2008. Cad Saude Publica 2013;29:1392–406.
[25] Nyarko KA, Lopez-Camelo J, Castilla EE, Wehby GL. Explaining racial disparities in infant health in Brazil. Am J Public Health 2013;103:1675–84.
[26] Bezerra IN, Souza ADM, Pereira RA, Sichieri R. Food consumption outside the home in Brazil. Rev Public Health 2013;47:200s–11s.
[27] Sichieri R, Castro JFG, Moura. Factors associated with the food consumption of the Brazilian urban population. Cad Saude Publica 2003;19:S47–53.
[28] Chor D, Lima CRDA. Epidemiological aspects of rcial inequalities in health in Brazil. Cad Saude Publica 2005;21:1586–94.
[29] Monteiro CA, Cannon G, Levy RB, Moubarac J-C, Jaime P, P MA, et al. NOVA. The star shines bright. World Nutr 2016;7:28–38.
[30] Louzada MLC, Ricardo CZ, Steele EM, Levy RB, Cannon G, Monteiro CA. The share of ultra-processed foods determines the overall nutritional quality of diets in Brazil. Public Health Nutr 2018;21:94–102.
[31] Monteiro CA, Moubarac J-C, Levy RB, Canella DS, Louzada MLC, Cannon G. Household availability of ultra-processed foods and obesity in nineteen European countries. Public Health Nutr 2018;21:18–26.
[32] Monteiro CA, Levy RB, Claro RM, Castro IRR, Cannon G. A new classification of foods based on the extent and purpose of their processing. Cad Saude Publica 2010;26:2039–49.
[33] Monteiro CA, Cannon G, Moubarac J-C, Levy RB, Louzada MLC, Jaime PC. The UN decade of nutrition, the NOVA food classification and the trouble with ultra-processing. Public Health Nutr 2018;21:5–17.
[34] Ferrer C, García-Esteban R, Mendez M, Romieu I, Torrent M, Sunyer J. Social determinants of dietary patterns during pregnancy. Gac Sanit 2009;23: 38–43.
[35] Cucó G, Fernández-Ballart J, Sala J, Viladrich C, Iranzo R, Vila J, et al. Dietary patterns and associated lifestyles in preconception, pregnancy and postpartum. Eur J Clin Nutr 2006;60:364–71.
[36] Moubarac J-C, Batal M, Louzada MLC, Martinez Steele E, Monteiro CA. Consumption of ultra-processed foods predicts diet quality in Canada. Appetite 2017;108:512–20.
[37] Louzada MLC, Baraldi LG, Steele EM, Martins APB, Canella DS, Moubarac J, et al. Consumption of ultra-processed foods and obesity in Brazilian adolescents and adults. Prev Med 2015;81:9–15.
[38] Adams J, White M. Characterisation of UK diets according to degree of food processing and associations with socio-demographics and obesity: cross-sectional analysis of UK National Diet and Nutrition Survey (2008–12). Int J Behav Nutr Phys Act 2015;12:160.
[39] Barcelos GT, Rauber F, Vitolo MR. Processed and ultra-processed food products and nutrient intake in children. Rev Ciência Saúde2 2014;7:155–61.
[40] Costa CS, Del-Ponte B, Assunção MCF, Santos IS. Consumption of ultra-processed foods and body fat during childhood and adolescence: a systematic review. Public Health Nutr 2018;21:148–59.
[41] Mallarino C, Gómez LF, González-Zapata L, Cadena Y, Parra DC. Advertising of ultra-processed foods and beverages: children as a vulnerable population. Rev Saude Publica 2013;47:1006–10.
[42] Ministry of Health, Secretary of Attention to Health, Department of Basic Attention. Food Guide for the Brazilian population. Brasilia: Author; 2014.
[43] Barker M, Baird J, Lawrence W, Vogel C, Stömmer S, Rose T, et al. Preconception and pregnancy: opportunities to intervene to improve women's diets and lifestyles. J Dev Orig Health Dis 2016;7:330–3.
[44] Cohen DJ, Clark EC, Lawson PJ, Casucci BA, Flocke SA. Identifying teachable moments for health behavior counseling in primary care. Patient Educ Couns 2011;85:e8–15.
[45] Phelan S. Pregnancy: a "teachable moment" for weight control and obesity prevention. Am J Obstet Gynecol 2010;202:135. e1–8.
[46] Gomes CB, Malta MB, Martiniano ACA, Bonifácio LPDi, Carvalhaes MABL. Eating habits of pregnant and non-pregnant women: are there differences? Rev Bras Ginecol e Obs 2015;37:325–32.
[47] Castro MBT, Freitas Vilela AA, Oliveira ASD, Cabral M, Souza RAGde, Kac G, et al. Sociodemographic characteristics determine dietary pattern adherence during pregnancy. Public Health Nutr 2015:1–7.
[48] Castro MBT, Souza RAG, Vilela AAF, Kac G. Association between sociodemographics factors and dietary patterns during pregnancy Associação entre fatores sociodemográficos e padrões de consumo alimentar. Rev Nutr 2014;27:173–81.
[49] McGowan Ca, McAuliffe FM. Maternal dietary patterns and associated nutrient intakes during each trimester of pregnancy. Public Health Nutr 2012;16: 97–107.
[50] Northstone K, Emmett P, Rogers I. Dietary patterns in pregnancy and associations with socio-demographic and lifestyle factors. Eur J Clin Nutr 2008;62:471–9.
[51] IBGE. Family budget search 2008-2009. Analysis of personal food consumption in Brazil. Rio de Janeiro: Author; 2011.
[52] Paim HHS. Brands in the body: pregnancy and motherhood in popular groups. In: Duarte L, Leal O, eds. Doença, sofrimento, perturbação Perspect. etnográficas, Rio de Janeiro: Editora FIOCRUZ; 1998:210.
[53] Gadgil MD, Anderson CA, Kandula NR, Kanaya AM. Dietary patterns are associated with metabolic risk factors in South Asians living in the United States. J Nutr 2015;145:1211–7.
[54] Micali N, Northstone K, Emmett P, Naumann U, Treasure JL. Nutritional intake and dietary patterns in pregnancy: a longitudinal study of women with lifetime eating disorders. Br J Nutr 2012;108:2093–9.
[55] Bingham SA, Gill C, Welch A, Day K, Cassidy A, Khaw KT, et al. Comparison of dietary assessment methods in nutritional epidemiology: weighed records v. 24 h recalls, food-frequency questionnaires and estimated-diet records. Br J Nutr 1994;72:619.
[56] Barbieri P, Crivellenti LC, Nishimura RY, Sartorelli DS. Validation of a food frequency questionnaire to assess food group intake by pregnant women. J Hum Nutr Diet 2015;28:38–44.