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Ultra-processed Food Consumption by Pregnant Women: The Effect of an Educational Intervention with Health Professionals

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Abstract

Objectives Nutrition during pregnancy is related with many maternal and child outcomes. To investigate the consumption of ultra-processed foods is one of the newest methods to evaluate food consumption, but these studies in pregnant women are rare. *Methods* We conducted a non-randomized controlled educational intervention on healthy eating and physical activity during pregnancy in primary health care units of Botucatu, São Paulo, Brazil. The sample comprised two groups of pregnant women with low obstetric risk, an intervention group (n = 181) and a control group (n = 172). The health professionals that assisted the pregnant women from the intervention group were trained to promote five healthy food practices during the prenatal care appointments: consumption of three fruits; two portions of vegetables; two portions of beans, at least 5 days per week; and restriction of soft drinks and industrially processed cookies. All pregnant women answered two 24-h dietary recalls per trimester, one face-to-face, another by telephone. The foods consumed by pregnant women were classified according Nova. The impact of the intervention on the ultra-processed food consumption was evaluated by multilevel linear regression analysis. *Results* A quarter of the energy consumed by the pregnant women provided from ultra-processed foods. The intervention reduced these percentage of energy between the first and second trimester of pregnancy by 4.6 points (p = 0.015). This effect was not observed in the third trimester of pregnancy. *Conclusions for Practice* Training health care professionals to promote healthy food practices is a viable and sustainable alternative to reduce ultra-processed foods during pregnancy.

Keywords Pregnant women · Ultra-processed foods · Dietary modifications · Pregnancy · Educational intervention

Significance

The consumption of ultra-processed foods has been discouraged worldwide in all populations, but few studies investigate this consumption in pregnant women. In this study, a nutrition education intervention was delivered to Brazilian pregnant women by health professionals during routine prenatal health care consultations. By discouraging the consumption of soft drinks and industrially processed cookies and encouraging the consumption of fruits, vegetables and beans, the pregnant women reduced the percentage of energy from ultra-processed products by 4.6 points (19.3%). These results show that training health care professionals to promote healthy food practices is an effective, viable and sustainable alternative for reducing ultra-processed foods during pregnancy.

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Introduction

Many dietary components act on perinatal outcomes (Barger 2010) and may influence the health of the woman and child (Procter and Campbell 2014). Generally, negative outcomes are associated with a woman's excessive weight gain before pregnancy, that is, pregestational nutritional status (Aune et al. 2014; Schummers et al. 2015) or developed during pregnancy (Dzakpasu et al. 2015; Haugen et al. 2014; IOM and NRC 2009).

According to the Institute of Medicine guidelines (IOM and NRC 2009), approximately half of Brazilian pregnant women gain excessive weight during pregnancy (Carvalhaes et al. 2013; Godoy et al. 2014). This percentage is similar to percentages reported for Canadians (48.7%) (Kowal et al. 2012) and Americans (52%) (Yan 2015), but a higher percentage was verified among Chinese women (57%) (Li et al. 2013). Nowadays, excessive weight gain during pregnancy is a severe public health problem, which increases the odds of pre-eclampsia, gestational diabetes, caesarean delivery, postpartum weight retention, fetal macrosomia, infant mortality, and childhood obesity (Crane et al. 2009; Drehmer et al. 2013; IOM and NRC 2009; Scholl et al. 1995; Sherrard et al. 2007; Viswanathan et al. 2008; Yan 2015).

One of the newest means of studying food consumption and its relationship with health is investigating the percentage of energy provided by ultra-processed foods (Monteiro et al. 2009, 2016, 2018). The definition of food processing used by *Nova*, is the group of physical, biological, and chemical processes applied to foods after their separation from nature and before they are submitted to culinary preparation or consumption (Monteiro et al. 2016).

The *Nova* classification divides foods into four groups based on the extent and purpose of processing: (1) unprocessed or minimally processed foods, such as fruits, fresh vegetables, meats, beans; (2) processed culinary ingredients, such as salt, sugar, vegetable oils, butter; (3) processed foods, such as canned vegetables, salted or smoked meats, unpackaged freshly made breads; and (4) ultra-processed foods (Monteiro et al. 2016). Ultra-processed foods are usually ready-to-eat products, packaged attractively and marketed intensively, that require little or no preparation. The production process combines multiple sequences of processes (with no domestic equivalents) and many ingredients. The overall purpose of ultra-processing is to create food products designed to displace all other food groups: they are usually convenient (durable, ready to consume), attractive (hyper-palatable), and made of low-cost ingredients (Monteiro et al. 2010, 2018). Examples of ultra-processed foods include soft drinks, ice creams, packaged cookies, cakes, sausages, sliced sandwich breads and hot dog buns.

Most ultra-processed foods are nutritionally unbalanced as they have high energy density, low fiber content, and are high in sodium, free sugar, fat, and saturated fat contents (Louzada et al. 2018; Marrón-Ponce et al. 2018; Moubarac et al. 2014; Poti et al. 2015), characteristics that can lead to excess energy intake and consequently to weight gain. Ultra-processed food consumption has been associated with obesity (Canella et al. 2014; Costa et al. 2018; Louzada et al. 2015a; Mendonça et al. 2016) and with a diet of lower nutritional quality (Batal et al. 2018; Moubarac et al. 2017). Thus, the hypothesis that this dietary habit could also affect gestational weight gain seems pertinent and may influence the health of the woman and child. Relationships between the consumption of certain food groups that could be classified as ultra-processed—sweets, snacks, soft drinks, packaged cookies, pizza, fast food sandwiches—and weight gain during pregnancy (Renault et al. 2015) or postpartum weight retention (Martins and Benicio 2011) have also been reported.

Pregnancy is good time to promote and adopt healthier food practices. Many studies show that nutritional interventions during this period can potentially produce positive effects (Muktabhant et al. 2015; Skouteris et al. 2010). Nutritional interventions are often provided by dietitians or health professionals that have been especially prepared for implementation during pregnancy (Dodd et al. 2014; Gresham et al. 2016; Hill et al. 2013), but interventions provided by routine prenatal care providers are not found. In Brazil, the latest food guide specifically recommends avoiding ultra-processed foods (Brasil 2014) and the impact of a nutrition education intervention on ultra-processed food consumption has yet to be tested.

The purpose of this study was to investigate the effect of a prenatal care related educational intervention on the consumption of ultra-processed foods during pregnancy applied to health professionals.

Methods

Design and Population

This study investigated the effectiveness of a public health intervention focused on nutrition and physical activity education (Habicht et al. 1999). This non-randomized controlled intervention study followed low-risk pregnant women, from first to third trimester of pregnancy, who attended prenatal care clinics in public primary health units in Botucatu (Impact of an intervention for promotion leisure-time walking and healthy eating among pregnant women in antenatal care—Trial Registration: RBR-4mkg73). Botucatu is a municipality with a predominantly urban population (93%)

of approximately 140,000 inhabitants, located in southeastern Brazil.

Two groups of pregnant women were compared. The intervention group consisted of 181 pregnant women attended by physicians and nurses of the seven municipal health units of the Family Health Program (PSF). The control group (N = 172) consisted of pregnant women who received prenatal care in any of the eight traditional primary health care units. All pregnant women who registered for prenatal care in public health care units from November 2012 to June 2013 were invited to participate in the study. Together, these two groups constituted a representative sample of pregnant women who received prenatal care in the public primary health care (PHC) network of the municipality.

The current PHC model in Brazil is centered on the PSF, implemented by a team consisting of general physicians, nurses, nursing technicians, and community health agents (Paim et al. 2011). Since PSF professionals have monthly administrative and scientific meetings, where they can exchange information on the intervention, we could not randomize the health care units without a high risk of contaminating the intervention. Thus, we recruited the control group at the traditional health care units, where professionals did not receive the training and applied the intervention to the PSF health professionals.

The PSF health professionals received training to promote five food practices during prenatal care appointments: consumption of three fruits; two portions of vegetables (one raw and one cooked); two portions of beans (one at lunch and one at dinner, at least 5 days per week); and restriction of soft drinks and industrially processed cookies (once a week at most). The promotion of leisure-time walking, at least 5 days a week, was also stimulated (Malta et al. 2016). The health professionals from traditional primary health care units assisted pregnant women according Brazilian guidelines for prenatal care to low-risk pregnant women. These guidelines contain general guidance on the importance of healthy eating during pregnancy (Brasil 2012).

The inclusion criteria were pregnant women aged 18 or over, in the first trimester of pregnancy (< 14 weeks) and enrolled in the low-risk prenatal care of the public PHC network. Women with multiple gestation, the presence of diseases or complications identified during the study, such as diabetes, hypertension, cardiomyopathy, or any adverse condition that required rest or reduced physical activity were excluded.

Nutrition and Physical Activity Education Intervention

The intervention with the health professionals from the intervention group lasted 8 months and comprised an immersion course of 8 h and three workshops that lasted 4 h. This course aimed to train physicians and nurses to promote leisure-time walking and the five food guidelines described previously during the routine care provided to pregnant women. The workshops aimed to design a plan for systematizing the promotion of leisure-time walking and healthy eating within local, routine prenatal care. We conducted the workshops at each family health unit with the entire staff. Therefore, these health professionals were trained to use the transtheoretical model of health behavior change in all prenatal consultations (Prochaska and Velicer 1997) and the techniques of motivational interview (Miller and Rollnick 2002) to promote healthy practices regarding food and physical activity, selected in previous studies conducted in the same municipality. Thus, the consultation time dedicated to these actions was tailored by the professional. In case they deemed necessary, we made available a handout with this content to be delivered to the pregnant women.

The positive impact of the intervention on the knowledge and practices of the prenatal care providers is described in detail in another paper. The trained health professionals showed improvement in their knowledge and practices, and pregnant women in the intervention group reported receiving the dietary counseling more frequently than the other group (Malta et al. 2016). These findings support potentially favorable outcomes in the population treated by these professionals.

Although the intervention was not designed to train the professionals to specifically discuss problems associated with the consumption of all ultra-processed foods with the pregnant women, this effect was expected, since the women were discouraged from consuming soft drinks and industrially processed cookies, two types of ultra-processed foods consumed frequently by Brazilians (Louzada et al. 2015b) and by pregnant women (Gomes et al. 2015). Moreover, by encouraging the consumption of beans, fruits and vegetables, the intervention also contributed to reducing the consumption of ultra-processed foods that tend to replace meals based on natural or minimally processed foods (Monteiro et al. 2011).

Ethics

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 Research Ethics Committee of Botucatu Medical School, under protocol CAAE: 32407314.0.0000.5411. Written informed consent was obtained from all the women prior to their inclusion in the study.

Study Variables

Data were collected from November 2012 to February 2014. The pregnant women were interviewed in person, at their homes, at each trimester of pregnancy, by trained interviewers. In the first interview, before the first prenatal care appointment, the women answered a questionnaire containing demographic, obstetric and lifestyle questions and signed a term of informed consent required for enrollment in the study.

The following variables were collected: age (18 or 19 years old; 20–30 years old; 30 or over), education level (≥ 11 years; 8–11 years; < 8 years), socioeconomic position (class B; class C; class D/E), employment status (yes or no), living with partner (yes or no), parity (primiparous, yes or no), white skin color (yes or no); pregestational tobacco use (yes or no); and pregestational nutritional status (underweight; normal weight; overweight; obese). Economic class was assessed according to the classification criteria provided by the Brazilian Association of Research Institutes (ABEP) divided into A, B, C, D, and E, with A being the highest economic class, considering both household assets (i.e. car, television, washing machine, etc.) and the education level of the head of the household (ABEP 2015), and pregestational nutritional status was assessed using World Health Organization criteria (WHO 1998).

After the application of each questionnaire, the field supervisor conducted a critical review of the data collected and sent questionnaires to double entry, followed by data consistency analysis.

Food Consumption

We applied two 24-h recalls (24hR) in each trimester of pregnancy. The data collection date was strictly controlled to better estimate habitual consumption: whether the in-person 24hR referred to a weekend day or holiday, the telephone 24hR referred to a weekday, and vice versa.

All food recalls were administered using the Multiple Pass Method (MPM) (Moshfegh et al. 2008), which reduces dietary measurement errors by helping the interviewees remember what they consumed on the previous day with detailed reporting (Raper et al. 2004).

The dietary data were entered in the software Nutrition Data System for Research (NDSR), version 2010, after the foods and preparations were converted into grams or milliliters and standardized using the tables which contain the vast majority of the preparations consumed by Brazilians (Fisberg and Villar 2002; Pinheiro et al. 2008). In order to correct and minimize errors, and avoid under or overestimating consumption, after entering each food recall, the data were analyzed for consistency, paying special attention to the measurement units of foods and preparations and checking for the number of servings, weight, energy and nutrient outliers.

Home-cooked dishes that included unprocessed or minimally processed foods and processed culinary ingredients were not decomposed into their single ingredients were included in Group 1. The foods consumed were classified into three groups: (1) unprocessed and minimally processed foods and their culinary preparations; (2) processed foods; and (3) ultra-processed foods (Monteiro et al. 2010, 2016).

To operationalize this classification, we initially grouped the foods consumed by the pregnant women in the same way as other Brazilian studies that have also used the *Nova* classification (Canella et al. 2014; Louzada et al. 2015b). These food subgroups are available in the supplementary appendix (Supplementary Table 1).

The outcome, percentage of calories from ultra-processed foods, was expressed continuously. All quantifications took into account the trimester of pregnancy and intervention group. We also evaluated the percentage of calories from eight food subgroups to the total energy provided by ultra-processed food group (Supplementary Table 2).

Data Analysis

The socioeconomic, demographic, and behavioral profiles of the control and intervention groups were compared. Baseline differing variables were included as potential confounders in the intervention effect analyses. The percentage of consumption of ultra-processed foods was compared according to the characteristics of the pregnant women, and factors with significant differences were included as possible confounders.

The impact of the intervention was assessed by multilevel linear regression analysis, hierarchically organized into three levels: third level = health care unit; second level = pregnant woman; first level = trimester. The third level contains the intervention group variable, characterizing the intervention as present or absent; the second level contains the characteristics of the pregnant women selected as potential confounders (education level, economic class, employment status, living with partner, age, parity, skin color and pregestational nutritional status); and the first level contains the variable trimester, which represents information repeated over time (before pregnancy, second and third trimesters of pregnancy). The interaction term between intervention group and trimester was also included.

The final multiple regression model was constructed based on the "full" model with all possible confounders. All analyses were performed by the software Stata, version 14.0.

Results

A total of 365 women met the inclusion criteria, 185 in the intervention group and 177 in the control group; 181 and 172 women in the intervention and control groups, respectively, answered the questionnaires in the first trimester of pregnancy; 140 and 141, respectively, answered the questionnaires in the second trimester of pregnancy; and 134 and 133, respectively, answered the questionnaires in the third trimester of pregnancy. Most losses were due to miscarriages (7.2%), changing health care provider, going from public to private provider or high-risk provider (4.7% and 4.9%, respectively), and moving to another city (3.6%). The refusal rate was only 3.0%. Figure 1 shows the numbers for each group.

Even though the groups differed with respect to education level ($p = 0.009$) and socioeconomic position ($p = 0.011$), the largest category for both groups was women with 11 years or more of formal education (43.9% and 55.2%) and from economic class C (63.6% and 72.8%). Most women in the intervention group were homemakers (61.9%), in contrast to the control group (41.3%) ($p < 0.001$). The other characteristics showed no significant differences. Most women in the intervention and control groups lived with a partner (73.5% and 74.4%), were not primiparous (60.8% and 54.7%), reported being white (62.9% and 65.7%), and did not smoke (74.6% and 73.4%) or consume alcoholic beverages before conception (63.0% and 59.9%). The most prevalent pregestational nutritional status was normal weight, but the prevalence of excess weight was very high in both groups (42.1%, intervention; and 52.6%, control) (Table 1).

Regardless of intervention group or gestational trimester, 24.6% of the energy consumed by the pregnant women came from ultra-processed foods (Supplementary Table 1). The percentage of energy provided by ultra-processed foods differed by age, education level, living with a partner, primiparity, skin color and pregestational nutritional status (Table 2). Younger women, with a lower education level, who did not live with a partner, and were primiparous, white and non-obese had the highest percentage of energy coming from ultra-processed foods.

Figure 2 shows the mean percentage of energy provided by ultra-processed foods according to trimester of pregnancy and group. In the first trimester, the mean percentage of energy from ultra-processed foods in the intervention (23.9%) and control (26.0%) showed no significant difference ($p = 0.176$). In the second trimester, the mean percentage of energy in the intervention (20.6%) and control

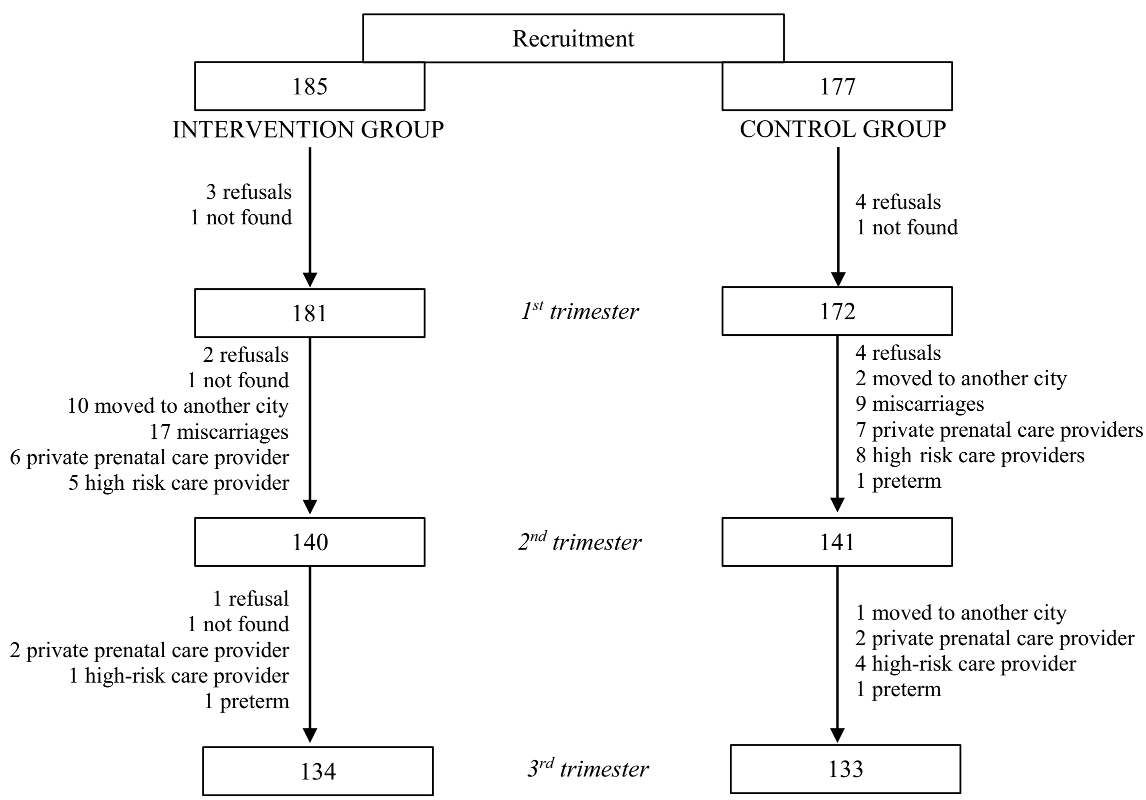

Fig. 1 Flowchart of the pregnant women who participated in the study by group and trimester of pregnancy. Botucatu, SP, Brazil 2012–2014

Table 1 Socioeconomic, demographic, obstetric, and nutritional status characteristics of the pregnant women according to group. Botucatu, SP, Brazil, 2012–2014

Characteristics	Intervention group N = 181 (%)	Control group N = 172 (%)	p value
Age (years)			0.282
18–19	17.7	12.2	
20–30	59.1	59.9	
30+	23.2	27.9	
Education level (completed years)			0.009
≥ 11 years	43.6	55.2	
8–11 years	28.2	29.7	
< 8 years	28.2	15.1	
Socioeconomic position[a]			0.011
Class B	8.0	11.8	
Class C	63.6	72.8	
Classes D/E	28.4	15.4	
Employment status			< 0.001
Employed	38.1	58.7	
Homemaker	61.9	41.3	
Living with a partner			0.841
Yes	73.5	74.4	
No	26.5	25.6	
Primiparity[b]			0.244
Yes	39.2	45.4	
No	60.7	54.6	
Skin color[c]			0.588
White	62.9	65.7	
Non-white	37.1	34.3	
Pregestational tobacco use[d]			0.971
Yes	25.4	26.6	
No	74.6	73.4	
Pregestational nutritional status[e]			0.295
Underweight	4.7	5.4	
Normal weight	53.2	42.5	
Overweight	25.1	32.3	
Obese	17.0	19.8	

[a]Lost purchasing power data $n = 8$

[b]Lost parity data = 3

[c]Lost skin color data $n = 3$

[d]Lost smoker status data $n = 3$

[e]Lost BMI data $n = 15$

(27.3%) groups was significantly different ($p < 0.001$). A significant difference was also observed in the third trimester, with 22.8% and 26.7% of the energy consumed by the intervention and control groups, respectively, coming from ultra-processed foods ($p = 0.022$).

The ultra-processed food subgroups 'cookies and ultra-processed sweets' (27.0%), 'sugar-sweetened beverages' (18.7%) and 'reconstituted meats' (12.7%) contributed the most to the total percentage of ultra-processed foods consumed during pregnancy by all the women studied (Supplementary Table 2).

The intervention had a positive impact on the second trimester, with a clear decrease in the consumption of ultra-processed foods by the intervention group compared with the control group. This effect persisted after adjustments for potential confounders: education level, economic class, employment status, living with a partner, age, parity, skin color and pregestational nutritional status.

The women in the intervention group reduced their energy intake from ultra-processed foods by a mean of 4.55% (95% confidence interval − 8.20 to − 0.90) between the first and second trimesters of pregnancy ($p = 0.015$). Between the first and third trimesters, the energy provided by ultra-processed foods in the intervention group also decreased ($\beta = -1.79$; 95% CI − 6.60 to 3.00), but not significantly ($p = 0.463$) (Table 3).

Discussion

The intervention had a positive impact on the consumption of ultra-processed foods, reducing the energy provided by such foods by an average of 4.6 percentage points between the first and second trimesters of pregnancy, after adjustment for pregestational nutritional status, age, education level, economic class, marital status, parity, skin color and health care unit. Nevertheless, this effect was not observed in the third trimester of pregnancy, where a decrease occurred but it was not statistically significant.

The intervention was delivered to the pregnant women by the health professionals during routine health care consultations and not by researchers. Thus, a positive characteristic of this study is the design of a nutrition intervention applied to physicians and nurses working with the public health service who provide care to pregnant women in routine prenatal visits, which is easily replicable.

To our knowledge, this study is the first to assess the impact of a prenatal educational intervention on ultra-processed food consumption and walking among pregnant women. By discouraging the consumption of only two ultra-processed food groups (soft drinks and industrially processed cookies) and encouraging the consumption of fruits, vegetables and beans, the women shifted the energy distribution of their diets towards less processed foods. The mean percentage of energy coming from ultra-processed foods in the intervention group was 23.9% in the first trimester of pregnancy. We observed an absolute reduction of 4.6 percentage points in the second trimester, to 19.3% of

Table 2 Mean percentage of energy provided by ultra-processed foods according to the women's characteristics and not separated by group

Characteristics	Mean % of energy from ultra-processed foods	95% CI	p value
Age (years)			< 0.001[a]
18–19	29.9	27.5–32.3	
20–30	25.1	23.9–26.3	
30+	20.3	18.6–22.0	
Education level (completed years)			< 0.001[a]
≥ 11 years	20.5	18.6–22.4	
8–11 years	24.4	22.6–26.2	
< 8 years	26.5	25.2–27.8	
Socioeconomic position			0.189[a]
Class B	26.9	23.7–30.2	
Class C	24.6	23.4–25.7	
Classes D/E	23.6	21.5–25.7	
Employment status			0.095[b]
Employed	25.4	24.1–26.8	
Homemaker	23.8	22.5–25.1	
Living with a partner			< 0.001[b]
Yes	23.5	22.4–24.6	
No	27.7	25.8–29.6	
Primiparity			< 0.001[b]
Yes	26.6	25.1–28.1	
No	23.2	22.0–24.4	
Skin color			0.043[b]
White	25.4	24.1–26.6	
Non-white	23.3	21.9–24.8	
Pregestational tobacco use			0.110[b]
Yes	24.2	23.1–25.2	
No	25.9	23.9–28.0	
Pregestational nutritional status			0.008[a]
Underweight	26.4	22.6–30.2	
Normal weight	25.4	24.1–26.7	
Overweight	24.9	23.1–26.1	
Obese	21.1	18.8–23.3	

[a]ANOVA

[b]Student's *t* test

energy from ultra-processed foods. Therefore, the proportion of energy consumption from ultra-processed foods was reduced by 19%. This reduction has the potential to influence the nutritional characteristics of the diet, as the results of Louzada et al. (2015b) suggest: the increase of one percentage point in ultra-processed food consumption implied a statistically significant reduction in fiber consumption, and increases the participation of free sugar, trans fat, saturated fat and total fat in 1000 calories.

The present intervention with health professionals was conducted before the follow-up of the groups of pregnant women and relied on few reinforcements during the study (Malta et al. 2016). This fact could explain the lower impact of the intervention in the third gestational trimester; the dietary recommendations provided by the health professionals became less emphatic over time. Another hypothesis is that during the third trimester of pregnancy, prenatal care focuses more on testing and monitoring maternal and fetal health, which means the nutritional recommendations proposed by our intervention were given a lower level of importance. Thus, similar future interventions with health professional should be formulated to reemphasize such actions/interventions on various occasions.

Simultaneously, with a favorable environment, such as easy access to fresh foods, encouragement of the culinary skills of pregnant women, control of ultra-processed food advertising and widespread dissemination of the potential harm of these food products, a nutrition education

Fig. 2 Mean percentage and confidence interval (95% CI) of dietary percentage of ultra-processed foods by group and trimester of pregnancy

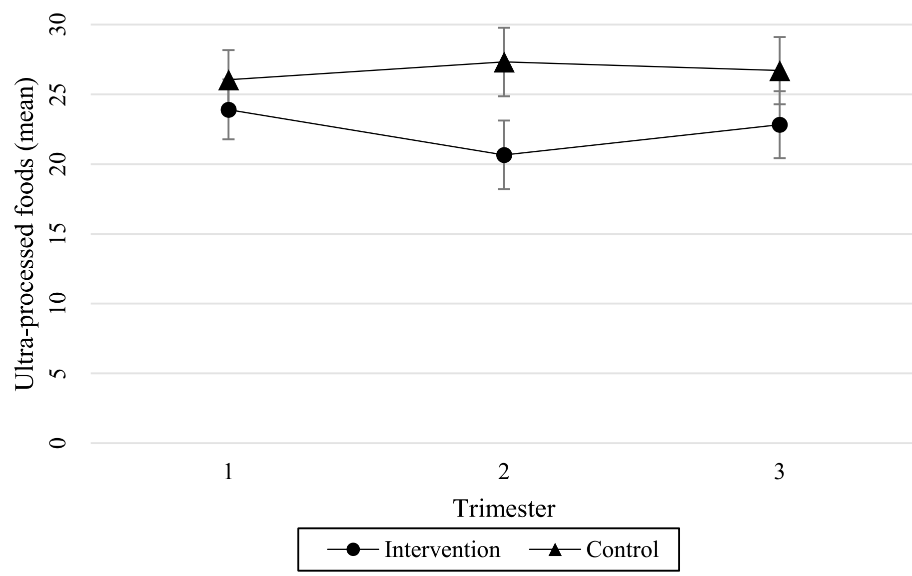

Table 3 Crude and adjusted multilevel linear regression models for the percentage of energy provided by ultra-processed foods. Botucatu, SP, Brazil 2012–2014

Model	Crude model			Adjusted model[a]		
	β	95% CI	p	β	95% CI	p
Group						
Control	–			–		
Intervention	− 2.11	− 5.79 to 1.56	0.260	− 2.08	− 4.89 to 0.73	0.148
Trimester						
First trimester	–			–		
Second trimester	1.29	− 1.55 to 4.14	0.372	1.30	− 1.31 to 3.90	0.330
Third trimester	0.63	− 3.16 to 4.42	0.744	1.15	− 2.78 to 5.08	0.565
Group#Trimester interaction						
Intervention # 2nd trimester	− 4.51	− 8.72 to − 0.30	0.036	− 4.55	− 8.20 to − 0.90	0.015
Intervention # 3rd trimester	− 1.63	− 6.67 to 3.40	0.525	− 1.79	− 6.60 to 3.00	0.463

[a]Adjusted for: education level, economic class, employment status, living with a partner, age, parity, skin color, and pregestational nutritional status

intervention in primary health care could be enhanced. Thus, raising awareness in our society, including among politicians, managers and administrators of public funds, for the creation of national, regional and local policies that facilitate an environment propitious to healthy eating is fundamental (Alves and Jaime 2014; Jaime and Lock 2009).

Our intervention only covers the sphere of interpersonal determinants through the promotion and guidance of healthy eating by professionals in primary health care units. This option was chosen because many studies have demonstrated that among several factors that can influence dietary behavioral changes, the guidance and support provided by health professionals is most influential (Jersey et al. 2013; Prochaska and Velicer 1997).

The two foods whose consumption were discouraged during the intervention belong to the two groups that provide the highest percentage of energy among ultra-processed foods: ultra-processed cookies and sweets (27.0%) and sugar-sweetened beverages and powdered drinks (18.7%) (Supplementary Table 2). Therefore, these two foods are indeed a critical target for nutritional interventions, especially among Brazilian pregnant women.

Although food consumption categorization based on characteristics of food processing is relatively recent, studies comparable to ours already exist, such as the study mentioned earlier of Brazilians aged 10 years or more, using POF data (Louzada et al. 2015b). Our percentage of energy of ultra-processed foods (total data) is slightly higher than reported by that study (24.6% vs. 21.5%). The percentages of energy coming from sugar-sweetened beverages were also lower in the general Brazilian sample (4.6% vs. 2.6%).

The most similar Brazilian study published so far with pregnant women had different findings. The percentage of energy provided by ultra-processed foods was much higher

(41.3%), but the food group with industrially processed cookies and soft drinks provided less energy than they did to our sample (5.6% and 2.3%, respectively) (Alves-Santos et al. 2016). However, important differences in food classification were observed. For example, they considered white bread rolls, a common food in the Brazilian diet, an ultra-processed food rather than a processed food, as recommended in *Nova* (Monteiro et al. 2016).

According to *Nova*, ultra-processed food consumption in pregnant woman in other countries is higher than verified by our results. Canadians obtain 47.7% of their energy intake from ultra-processed foods (Moubarac et al. 2017), while in the United States it is 57.9% (Martínez Steele et al. 2016).

Regardless of the intervention, the women with the highest consumption of ultra-processed foods were younger, White, non-obese, and primiparous, who had a higher education level and lower income, and did not live with a partner. Few studies have conducted very similar investigations, but a 1982 study of a cohort from Pelotas, with a mean age of 22.8 years old, reported that sex, marital status, education level, changes in income and body mass index influenced the consumption of ultra-processed foods (Bielemann et al. 2015). Age, a factor studied more often than the others, really seems to be an important aspect of ultra-processed food consumption, given that it is higher amongst younger adults (Adams and White 2015; Louzada et al. 2015a, b; Moubarac et al. 2017), as corroborated in our study. These findings may help future studies to target specific populations for interventions and to understand the influence of these characteristics on ultra-processed food consumption. The relationship of ultra-processed food consumption with short- and long-term pregnancy, obstetric, and maternal and child health outcomes should also be investigated, as the results may provide even more evidence of the importance of actions that reduce the consumption of such foods.

Some aspects that could influence the internal validity of our study deserve consideration. Losses to follow-up were of similar magnitude in the intervention and control groups. In addition, we compared socioeconomic, obstetric, and behavioral characteristics of the women who completed the study and those who were lost during follow-up and no significant differences were observed. For these reasons, we believe there is no selection bias in this study. However, some differences in the characteristics of the pregnant women in the two groups (intervention and control) were verified, and these variables were adjusted in the statistical analysis to control for their possible confounding effects.

We consider the two study groups to be representative of women of low obstetric risk, who received prenatal care within the public health care network of the municipality. Wealthier Brazilians form a smaller portion of the population—around 20% in the municipality—and they prefer to use the private health care network (Paim et al. 2011). This fact limits extrapolation of the results to this stratum of the population, especially because income has an important influence on ultra-processed food consumption (Canella et al. 2014; Louzada et al. 2015a). Therefore, other intervention strategies may be required for this population.

The use of two 24hR per trimester of pregnancy is a positive methodological quality of the present study. Although many studies use the food frequency questionnaire, the quantification of consumption is less accurate and can be influenced by the ability of individuals to estimate their mean consumption of a given food over a long period of time (Bingham et al. 1994).

Most studies that aim to promote healthy behaviors among pregnant women involve the researchers rather than health professionals. The provision of personal diet plans, recipe books and two meetings with dietitians increased the consumption of fruits and vegetables by pregnant Australian women (Dodd et al. 2014). Regarding diet, the clinical assay protocol that investigated lifestyle interventions and health outcomes for the woman and her newborn indicated nutritional counseling by telephone, distribution of leaflets on healthy foods, evening meetings and use of an interactive website (Sagedal et al. 2013). Thus, another advantage of our intervention is that the study population will continue to benefit from the knowledge acquired by the health professionals even after the study ends.

Conclusion

The intervention reduced the percentage of energy provided by ultra-processed foods in the second trimester of pregnancy by 4.6 points (19.3% reduction). Therefore, an intervention consisting of training health care professionals to promote relatively simple food practices seems to be a viable and sustainable alternative, besides being effective in one trimester of pregnancy.

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