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ORIGINAL

Intake of antioxidants nutrients by pregnant womem: Associated factors

Ingestão de nutrientes antioxidantes por gestantes: fatores associados

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ABSTRACT

Objective

To evaluate the intake of antioxidant nutrients by pregnant women being cared for in the Brazilian public health system and associated factors.

Methods

A cross-sectional study was carried out with pregnant women cared for in the public health system in the city of *Maceió*, Brazil, in 2014, including 385 pregnant women and their newborns, and the collection of maternal information (socioeconomic, personal, prenatal, dietary and anthropometric data), and after the babies' birth (gestational age, birth weight and length). Food intake was assessed by two 24-hour dietary reminders per pregnant woman with subsequent adjustments by the Estimated Average Requirement method. Data were processed and Pearson's correlation was used to evaluate associations, considering $p<0.05$ as significant.

Results

A total of 388 pregnant women with a mean age of 24.06±5.92 years were studied, with inadequate intake and high variation of the following antioxidants: vitamin A (83.2%/62.7%), vitamin C (50.5%/75.7%), vitamin E (76.5%/60.2%), Selenium (60.8%/50.3%), Copper (98.5%/42.8%) and Zinc (79.6%/43.4%), respectively.

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Additionally, the following associations were observed: the intake of vitamin A (p=0.02), Copper (p=0.01), and Selenium (p=0.01) with the maternal Body Mass Index; the intake of vitamin A (0.04) and Selenium (p=0.02) with the birth weight; and between vitamin A (p=0.04) with the birth length.

Conclusion

The low intake of antioxidant nutrients by pregnant women is a reality, being associated to the maternal Body Mass Index and the birth weight and length of the newborn.

Keywords: Antioxidant. Food consumption. Nutrients. Pregnancy.

RESUMO

Objetivo

O objetivo deste estudo foi avaliar a ingestão de nutrientes antioxidantes por gestantes atendidas em rede pública de saúde e os fatores associados.

Métodos

Trata-se de estudo transversal com gestantes atendidas na rede pública de saúde do município de Maceió no ano de 2014, sendo incluídas 385 gestantes e seus recém-nascidos. Foram coletadas informações acerca das mães (dados socioeconômicos, pessoais, de pré-natal, dietéticos e antropométricos) e, após o parto, dos recém-nascidos (idade gestacional, peso e comprimento ao nascer). A ingestão alimentar foi avaliada por dois recordatórios alimentares de 24h, relatados pela gestante, com posteriores ajustes pelo método Estimativa de Requerimento Médio. Os dados foram processados, sendo utilizada a correlação de Pearson para avaliar associações, com p<0,05 como significativo.

Resultados

Foram estudadas 388 gestantes, com média de idade de 24,06±5,92 anos, com ingestão inadequada e alta variação da ingestão dos antioxidantes: Vitamina A (83,2%/62,7%), Vitamina C (50,5%/75,7%), Vitamina E (76,5%/60,2%), Selênio (60,8%/ 50,3%), Cobre (98,5%/42,8%) e Zinco (79,6%/43,4%), respectivamente. Adicionalmente, foi observada associação entre a ingestão de vitamina A (p=0,02), Cobre (p=0,01) e Selênio (p=0,01), e o Índice de Massa Corporal materno. Observou-se também associação entre a ingestão de vitamina A (0,04) e selênio (p=0,02) e o peso ao nascer; e de vitamina A (p=0,04) com comprimento ao nascer.

Conclusão

A baixa ingestão de nutrientes antioxidantes por gestantes é uma realidade, estando associada ao Índice de Massa Corporal materno e ao peso e comprimento do recém-nascido ao nascer.

Palavras-chave: *Antioxidantes. Consumo de alimentos. Nutrientes. Gestação.*

INTRODUCTION

Gestation entails necessary adaptations to the maternal organism, aiming at the adequate generation of the baby, being thus considered as a heterogeneous period within the physiological and metabolic aspects of the woman's life [1]. There are changes in the cardiovascular and hemodynamic systems of the pregnant woman, situations that, when deregulated, lead to the development of complications in this period [2].

Gestation is a pro-oxidant period, characterized by the presence of low-grade oxidative stress. However, the excessive production of reactive oxygen and nitrogen species, associated with the reduction of the antioxidant defense system, can affect endothelial function and thus, with some maternal and fetal disorders, such as preeclampsia, diabetes, preterm birth, spontaneous abortions, intrauterine growth restriction, among others [3,4].

The ingestion of dietary antioxidants can prevent the onset of gestational diseases that interfere with the oxidative stress, demonstrating the relevance of an adequate diet at this stage of life [5-7], and the importance of diet as a way of protection from the effects of this stress [8,9].

Realizing that antioxidants act in the control of reactive oxygen and nitrogen species involved in oxidative stress, and the impacts resulting from this condition in the gestational period, the present study aims to evaluate the intake of antioxidant nutrients by pregnant women cared for in the public health system and its associated factors.

METHODS

A cross-sectional study carried out at the Basic Health Care Units (50% of the total, which corresponded at the time of the study to 30 Basic Health Care Units, previously selected from a random draw) in the city of *Maceió*, Brazil, between February and August 2014, pregnant women carrying a single fetus, who resided in the city and who were cared for in the public health system. This study is part of a greater research, funded by the PPSUS/02/2013/ FAPEAL research project, approved by the Ethics and Research Committee, case n° 390.131.

The sample calculation was carried out with the aid of the Epi Info 7.0 software (Center of Disease Control and Prevention, Atlanta, Georgia, United States), and due to the absence of studies on the prevalence of the outcome of interest (oxidative stress during pregnancy), a prevalence of 50%, a sample error of 5% and a confidence interval of 95%, requiring a sample of 385 pregnant women.

After selecting the sample, made for convenience, pregnant women who were waiting for prenatal care on basic health care units and who were included in the inclusion criteria of the study were interviewed. For this purpose, a questionnaire of socioeconomic, personal, prenatal, dietetic and anthropometric data, previously tested by the research group, was composed of undergraduate nutrition students who were previously trained and supervised by a trained professional.

The socioeconomic factors were analyzed using the following variables: age group (≤19, 20-34 and ≥35), economic class (C/D/E) according to the *Associação Brasileira de Empresas de Pesquisas* (ABEP, Brazilian Association for Research's Companies) criteria [10] , employment (if working at home, or outside home), maternal education in years (<4, ≥4), monthly family income in relation to the minimum wage (BRL) (<1/2, 1/2-1, 1-2, ≥2) and per capita, taking into account the minimum wage for the year 2013 (BRL 678.00), the self-declared skin color (if the person declares himself as a person of color or not) and the number of members residing in the household (<5, ≥5).

For an anthropometric evaluation, performed in a reserved room within the Basic Health Care Unit, the weight and height variables were measured using a *Marte* LC200® (*Marte Científica, São Paulo*, Brazil) digital scale and portable stadiometer, which were used to calculate the Body Mass Index (BMI), considering the cut-off points established by Atalah Samur *et al*. [11]. We also investigated weight and pre-gestational BMI as well as weight gain during pregnancy considering the recommendations of the Institute of Medicine (IOM) [12].

Two 24-hour Dietary Recalls (Rec 24h) were applied to evaluate nutrient intake, the first being at the time of application of the questionnaire and the second by phone, performed at intervals of up to one month after the initial collection, and analyzed by the Avanutri 4.0® (Avanutri, *Rio de Janeir*o, Brazil). nutritional evaluation and prescription system, which compiles to the *Tabela Brasileira de Composição de Alimentos* (TACO, Brazilian Food Composition Table), the *Instituto Brasileiro de Geografia e Estatística* (IBGE, Brazilian Institute of Geography and Statistics) and the Phillip table to register the nutritional composition of foods.

The prevalence of nutrient intake inadequacies was estimated using the Estimated Average Requirement (EAR) as a cut-off point according to Vasconcelos *et al*. [13], aiming to increase the reliability of the figures, since it is performed from of a statistical approach that adjusts the

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distribution of the observed nutrient intakes and eliminates or at least attenuates the impact of daily, inter- and intrapersonal variations.

Below is the step by step of the EAR method according to Vasconcelos *et al*. [13]:

Step 1: Establishment of the mean intake of nutrients from the two 24-hour Dietary Recalls applied;

Step 2: Verification and confirmation of the normal distribution of nutrients by the Kolmogorov-Smirnov test, considering $p<0.05$ as significant;

Step 3: Determination of intrapersonal and interpersonal variances by the Analysis of Variance (ANOVA) test. The intrapersonal variance is equivalent to the intrapersonal quadratic mean (square root of the standard deviation). And the interpersonal variance is calculated through an equation involving the interpersonal quadratic mean and the intrapersonal variance;

Step 4: Calculation of the adjustment factor, which is defined as the ratio between the interpersonal standard deviation and the observed standard deviation. The calculation of the interpersonal standard deviation is performed by calculating the square root of the interpersonal variance; the observed standard deviation is calculated through the square root of the observed variance, the latter calculated by an equation taking into account the values of the interpersonal and intrapersonal variance;

Step 5: Adjustment of each nutrient of interest, considering the average intake of the studied population, individual intake and adjustment factor;

Step 6: Calculation of the inadequate intake frequency from previously adjusted nutrient values, comparing with the EAR values established in the literature for each nutrient.

Subsequently, an evaluation of the variation of food intake was carried out through the coefficient of variability, calculated from the ratio between the standard deviation by the mean intake of the nutrient in question [14].

The data of newborns (gestational age at birth (weeks), weight (kg) and birth length (C=cm)) and registered after birth in the city of *Maceió* Health Department Registration System.

Data were processed using the Statistical Package for the Social Sciences software 20.0 (SPSS Inc., Chicago, Illinois, United States) and expressed as means, standard deviations and frequencies. Kolmogorov-Smirnov tests were used to evaluate data normality and the Pearson correlation coefficient (r) to evaluate the linear correlation between the variables of interest (maternal data and perinatal outcomes), with $p<0.05$ as significant.

RESULTS

A total of 388 pregnant women, with a mean age of 24.06±5.92 years, ranging from 14 to 44, being the majority (86.1%) members of the lower classes, with more than four years of study (94.6%), stay-at-home-mothers (71.1%), overweight (42.0%) and with an excessive weight gain (65.4%) (Table 1).

As for food intake, the average intake of carbohydrate, lipid and vitamins A and C, and average lows for Zinc, Selenium, vitamin E and Copper was adequate for the pregnant women studied. Regarding the inadequacy of nutrient intake, the lowest percentages of inadequacy were observed for carbohydrate and vitamin C, with 1.80% and 50.5%, respectively. While copper and vitamin A were the highest, with 98.5% and 83.2%, respectively (Table 2). For Vitamin E, Zinc, and Selenium, inadequacy rates were 76.5%, 79.6%, and 60.8%, respectively.

Finally, there was a positive correlation between vitamin A ($r=0.12$, $p=0.02$), copper ($r=0.14$, $p=0.01$) and selenium ($r=0.15$; $p=0.01$) and the maternal BMI; between the intake of vitamin A ($r=0.11$, $p=0.04$) and selenium ($r=0.13$, $p=0.02$) with birth weight, and vitamin A with birth length ($r=0.12$, $p=0.04$) (Table 3).

Table 1. Data regarding the socioeconomic and nutritional status of pregnant women in the public health system in the city of *Maceió* (AL), Brazil, 2014.

Variables	N=388	%
Age group (years)		
≤19	94	24.2
20-34	265	68.3
≥35	29	7.5
Self-declared as a person of color		
Yes	73	18.9
No	314	81.1
No information	1	
Work outside home		
Yes	112	28.9
No	276	71.1
Monthly family income (minimum wage - BRL)		
≤1	213	57.1
>1	160	42.9
No information	15	
Social class (ABEP)		
C (middle class)	6	1.6
D (lower class)	46	12.3
E (the poor)	321	86.1
No information	15	
Family members living in the same house		
<5	344	88.7
≥5	44	11.3
Education (years)		
<4	21	5.4
≥4	367	94.6
Pre-gestational nutritional status		
Low weight	40	10.8
Eutrophic	233	63.1
Overweight	96	26.0
No information	19	
Gestational nutritional status		
Low weight	70	18.0
Eutrophic	155	39.9
Overweight	163	42.0
Gestational weight gain		
Insufficient	73	19.9
Adequate	54	14.7
Excessive	240	65.4
No information	21	

Note: ABEP: Associação Brasileira de Empresas de Pesquisa; BRL: Reais: R$ (Brazilian currency).

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Table 2. Intake of calories, macronutrients and antioxidant micronutrients by pregnant women in the public health system of the city of *Maceió* (AL), Brazil, 2014.

Variable	Nutritional recommendations*	Intake			Min - Max consumption	Inadequate intake (%)**	Coefficient of variability (%)
		M		SD			
Calories		1834.0	±	407.1	516.9-3392.5	79.9	21.2
Macronutrients							
CHO**	45-65%	56.7	±	3.9	37.6-68.3	1.80	12.1
Lip**	25-30%	25.1	±	4.3	10.0-36.8	62.1	22.3
Ptn**	10-15%	17.8	±	3.5	6.7-39.1	80.9	21.7
Antioxidant micronutrients							
Vitamin A	530-3000µg	1140.4	±	2981.4	391.5-21500.7	83.2	62.7
Vitamin C	66-2000mg	287.0	±	925.5	132.2-12132.2	50.5	75.7
Vitamin E	12-1000mg	9.8	±	33.6	2.9-647.7	76.5	60.2
Selenium	49-400µg	48.3	±	42.9	8.4-477.5	60.8	50.3
Copper	7.5-10.0mg	1.1	±	1.7	0.2-14.09	98.5	42.8
Zinc	9.5-40mg	9.1	±	23.6	0.3-455.6	79.6	43.4

Note: *DRI: Dietary Reference Intakes. **Expressed in percentage (%).
CHO: Carbohydrates; Lip: Lipids; Ptn: Protein; µg: microgram; Mg: milligram; SD: Standard Deviation; M: Mean; Min: Minimum; Max: Maximum.

Table 3. Correlation between maternal intake of antioxidants and maternal and newborn variables in the public health system of the city of *Maceió* (AL), Brazil, 2014.

Antioxidants	MA		FI		BMI		WG		BW		BL		GA	
	*r**	*P*	*r**	*P*	*r**	*P*	*r**	*p*	*r**	*p*	*r**	*p*	*r**	*p*
Vitamin A (µg)	-0.08	0.12	0.02	0.75	0.12	**0.02**	-0.02	0.75	0.11	**0.04**	0.12	**0.04**	0.05	0.34
Vitamin C (mg)	-0.06	0.20	-0.01	0.78	0.06	0.27	0.03	0.61	0.04	0.42	-0.08	0.16	-0.32	0.56
Vitamin E (mg)	-0.06	0.24	-0.02	0.71	0.04	0.37	-0.01	0.84	0.08	0.14	0.07	0.26	-0.03	0.62
Zinc (mg)	-0.03	0.59	-0.02	0.75	-0.01	0.98	0.04	0.45	-0.01	0.95	-0.01	0.91	-0.01	0.10
Copper (mg)	0.01	0.90	-0.02	0.64	0.14	**0.01**	-0.01	0.78	0.10	0.07	0.79	0.18	0.03	0.63
Selenium (µg)	0.01	0.93	0.03	0.49	0.15	**0.01**	0.02	0.63	0.13	**0.02**	0.05	0.41	0.07	0.17

Note: *Pearson's correlation, $p<0.05$ as significant.
MA: Maternal Age, in years; FI: Family Income (BRL); Gestational BMI: Body Mass Index, in Kg/m2; WG: Weight Gain (Kg); BW: Birth Weight (Kg); BL: Birth Length (cm); GA: Gestational Age, in weeks; µg: microgram; Mg: milligram. When in bold, it is a statistically significant result.

DISCUSSION

This study aimed to characterize the intake of antioxidant nutrients by pregnant women who are cared for in the public health system of the city of *Maceió*, Brazil. The relevance of this type of study is based on the existing associations between the low intake of antioxidants and the development of perinatal repercussions, causing a strong impact on maternal-fetal health [15-17].

Regarding the characterization of the socioeconomic profile and antioxidant intake, it was observed a low intake of basically all nutrients evaluated, a situation that may be associated with the low socioeconomic level of the studied group. It is known that the unfavorable socioeconomic pattern contributes to the selection of foods that are not nutritionally adequate [18,19], where in a study carried out with adult women in the city of *Duque de*

Caxias, in the state of *Rio de Janeiro*, Brazil, it was noticed, as the years of continuous study passed by, that there was an improvement in the consumption of fruits and vegetables [20].

The nutritional profile of pregnant women also raises concern due to the relationship between being overweight and increased inflammatory processes. This is due to increased production and secretion of pro-inflammatory adipokines by the adipose tissue, such as tumor necrosis factor alpha and interleukin 6 [21]. Additionally, excessive weight is directly related to oxidative stress, due to the intracellular accumulation of triglycerides, leading to mitochondrial dysfunction, a situation caused by the increase of electron transport and the generation of reactive oxygen and nitrogen species, potentializing the inflammatory process [22].

Among the antioxidant nutrients analyzed, vitamins C and A were the only ones that presented mean intakes within the recommendations, despite the low percentages of adequacy for the intake of these vitamins. The adequate average intake of vitamin C by the pregnant women studied can be explained, since the daily recommended intake of vitamin C is easily reached when the consumption of a fruit that is source of this nutrient is part of the eating habits. In a study carried out in Nigeria, it was verified that pregnant women with pre-eclampsia had reduced plasma levels of vitamin C when compared to normotensive pregnant women, demonstrating their importance to maternal health [23]. In another study, there was a negative correlation between serum levels of malondialdehyde, a biomarker of oxidative stress and vitamin A, showing greater attention to the consumption of this nutrient [24].

On the other hand, low daily intake means and a low percentage of individuals with adequate daily intake of vitamin E, Copper, Selenium and Zinc were observed. An in vitro study has shown that vitamin E potentiated cellular proliferation of placental cells, demonstrating a possible beneficial effect of this vitamin in pregnancy [25], and these women who consumed this vitamin, compared to placebo, had a lower risk of placental displacement [26]. However, selenium, zinc, and copper are trace elements considered as antioxidant agents because they are cofactors of antioxidant enzymes, such as selenium-dependent Glutathione Peroxidase (GPx) and Superoxide Dismutase (SOD), which is dependent on Copper and Zinc in the cytoplasm [27]. Reduced levels of these drugs in pregnant women are associated with an inadequate amount of GPx and SOD, and may contribute to the increase of oxidative stress and endothelial dysfunction, which precede the development of atherosclerotic alterations [5,6].

In this research there was an association between vitamin A intake and birth weight and length, and selenium and birth weight. In a study carried out with pregnant women in the cities of *Petrópolis* and *Queimados*, Brazil, it was observed that the consumption of foods rich in antioxidant nutrients, rich in energy, was positively associated with birth weight. However, this situation is also associated with an increased transfer of amino acids, glucose, free fatty acids and triglycerides to the fetus, a situation that may contribute to the onset of health problems in children [28].

On the other hand, the high coefficient of variability in the diet found in this research demonstrates the inequality in the food consumption of pregnant women who are cared for in the public health system. Our findings corroborate with those found in another study also carried out in the city of *Maceió*, Brazil, in a University Hospital, where a high variation in the intake of antioxidant nutrients was found, also highlighting a high disparity in vitamin C intake [7]. This finding is worrying because, in addition to the low consumption of antioxidant nutrients, the high percentages of variation in their intake indicate a high variation on the individual adequacy of these nutrients [29], which may be associated with increased oxidative stress, leading to endothelial dysfunction and to an

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increase in inflammatory processes, situations that may lead to the emergence of adverse outcomes for the binomial pregnant-concept [30].

Among the present limitations, it is worth noting the impossibility of applying more than two 24-hour Dietary Recalls (Rec 24h) per pregnant woman studied and the second 24-hour Dietary Recall was made by telephone, as well as the type of cross-sectional study, making it impossible to establish causal relationships between the low consumption of antioxidants and their related factors. Also, we highlight the limitation of information in the tables of composition regarding the nutritional composition of foods, which may have underestimated the consumption of some of the studied nutrients. However, we consider that the previous training of the team, as well as the standardization of the techniques used in the research, minimized biases that could exist due to the limitations of this study.

In addition, the present study corroborates with the knowledge that an adequate intake of antioxidants during gestation can prevent unfavorable perinatal outcomes. For this reason, public policies, the public health system, as well as the professionals involved, should be properly trained and sensitized to contribute to encouraging healthy dietary habits, which should include the consumption of foods which are sources of antioxidants.

Finally, it is important to carry out more studies in this area, and in different places of the country, in order to deepen the knowledge of dietary habits of pregnant women, including the foods most commonly consumed by this group, which are sources of antioxidants.

CONCLUSION

The low intake of antioxidant nutrients by pregnant women is a reality, being associated with the maternal BMI and the birth weight and birth length of the newborn. The role of these nutrients during and after gestation is highlighted, evidencing the need for better nutritional monitoring.

CONTRIBUTORS

LGR SILVA NETO and RC FERREIRA collaborated with data collection, tabulation and analysis, preparation of the manuscript and approval of the final version. MB TENÓRIO participated in the data analysis, preparation of the manuscript and approval of the final version. ACM OLIVEIRA contributed with the study conception and design, data collection and analysis, preparation of the manuscript and approval of the final version.

REFERENCES

1. Van Balen VAL, Gansewinkel TA, Haas S, Kuijk SM, Drongelen J, Ghossein-Doha C, *et al*. Physiologic adaptation of endothelial function to pregnancy: A systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2017;50:697-708. http://dx.doi.org/10.1002/uog.17431
2. De Haas S, Ghossein-Doha C, Kuijk SM, Drongelen J, Spaanderman ME. Physiologic adaptation of plasma volume during pregnancy: A systematic review and meta-analysis. Ultrasound Obstet Gynecol. 2016;49:177-87. http://dx.doi.org/10.1002/uog.17360
3. Ferguson KK, McElrath TF, Pace GG, Weller D, Zeng L, Pennathur S, *et al*. Urinary polycyclic aromatic hydrocarbon metabolite associations with biomarkers of inflammation, angiogenesis, and oxidative stress in pregnant women. Environ Sci Technol. 2017;51(8):4652-60. http://dx.doi.org/10.1021/acs.est.7b01252
4. Di Mascio D, Magro-Malosso ER, Saccone G, Marhefka GD, Berghella V. Exercise during pregnancy in normal-weight women and risk of preterm birth: A systematic review and meta-analysis of randomized controlled trials. Am J Obstet Gynecol. 2016;215(5):561-71. http://dx.doi.org/10.1016/j.ajog.2016.06.014
5. Negi R, Pande D, Karki K, Kumar A, Khanna RS, Khanna HD. Trace elements and antioxidant enzymes associated with oxidative stress in the pre-eclamptic/eclamptic mothers during fetal circulation. Clin Nutr. 2012;31(6):946-50. http://dx.doi.org/10.1016/j.clnu.2012.04.005

6. Halliwell B. The antioxidant paradox: Less paradoxical now? Br J Clin Pharmacol. 2013;75(3):637-44. http://dx.doi.org/10.1111/j.1365-2125.2012.04272.x

7. Oliveira ACM, Santos AA, Bezerra AR, Tavares MCM, Barros AMR, Ferreira RC. Ingestão e coeficiente de variabilidade de nutrientes antioxidantes por gestantes com pré-eclâmpsia. Rev Port Cardiol. 2016;35(9):469-76. http://dx.doi.org/10.1016/j.repc.2016.03.005

8. Brantsaeter AL, Haugen M, Samuelsen SO, Torjusen H, Trogstad L, Alexander J, *et al*. A dietary pattern characterized by high intake of vegetables, fruits, and vegetable oils is associated with reduced risk of preeclampsia in nulliparous pregnant Norwegian women. J Nutr. 2009;139(6):1162-8. http://dx.doi.org/10.3945/jn.109.104968

9. Sheykhi M, Paknahad Z, Hasanzadeh A. Dietary nutrient intake and antioxidant status in preeclamptic women. Adv Biomed Res. 2015;31(4):183. http://dx.doi.org/10.4103/2277-9175.164003

10. Associação Brasileira de Empresas de Pesquisa. Critério de classificação econômica: Brasil 2016. São Paulo: Associação Brasileira de Empresas de Pesquisa; 2016 [acesso 2017 mar 20]. Disponível em: www.abep.org/criterio-brasil.

11. Atalah Samur E, Castillo LC, Castro Santoro R, Aldea PA. Propuesta de um nuevo estándar de evaluación nutricional em embarazadas. Rev Méd. 1997;125(12):1429-36.

12. Rasmussen KM, Yaktine AL. Committee to reexamine IOM pregnancy weight guidelines; Institute of medicine; National Research Council. Weight gain during pregnancy: Reexamining the Guidelines. Whashington (DC): National Academies Press; 2009. [cited 2017 Mar 20]. Available from: www.ncbi.nlm.nih.gov/pubmed/20669500

13. Vasconcelos SML, Silva JVL, Vasconcelos PN, Costa VS. Manual de uso e interpretação das DRIS na análise quantitativa de inquéritos dietéticos. Alagoas: EDUFAL; 2011.

14. Institute of Medicine. Dietary reference intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc. Washington (DC): National Academy Press; 2002 [cited 2017 Mar 20]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK222310/

15. Sulistyowati S. The role of oxidative stress in the pathogenesis of pre-eclampsia. Pregnancy Hypertens. 2014;4(3):244. http://dx.doi.org/10.1016/j.preghy.2014.04.014

16. Daher S, Mattar R. Gestação: um fenômeno imunológico? Rev Bras Alerg Imunopatol. 2009;32(2):63-7.

17. Neves C, Medina JL, Delgado JL. Alterações endócrinas e imuno-modulação na gravidez. Arq Med. 2007;21(5/6):175-82.

18. Facchini LA, Nunes BP, Motta JVS, Tomasi T, Silva SM, Thumé E, *et al*. Insegurança alimentar no Nordeste e Sul do Brasil: magnitude, fatores associados e padrões de renda per capita para redução das iniquidades. Cad Saúde Pública. 2014;30(1):161-74. http://dx.doi.org/10.1590/0102-311X00036013

19. Morais DC, Dutra LV, Franceschini SCCF, Priore SE. Insegurança alimentar e indicadores antropométricos, dietéticos e sociais em estudos. Ciênc Saúde Coletiva. 2014;19(5):1475-88. http://dx.doi.org/10.1590/1413-81232014195.13012013

20. Lins APM, Sichieri R, Coutinho WF, Ramos EG, Peixoto MVM, Fonseca VM. Alimentação saudável, escolaridade e excesso de peso entre mulheres de baixa renda. Ciênc Saúde Coletiva. 2013;18(2):357-66. http://dx.doi.org/10.1590/S1413-81232013000200007

21. Hirata BK, Banin RM, Dornellas AP, Andrade IS, Zemdegs JC, Caperuto LC, *et al*. Ginkgo biloba extract improves insulin signaling and attenuates inflammation in retroperitoneal adipose tissue depot of obese rats. Mediators Inflamm. 2015;2015:e419106. http://dx.doi.org/10.1155/2015/419106

22. Rocha VS, Della Rosa FB, Ruano R, Zugaib M, Colli C. Association between magnesium status, oxidative stress and inflammation in preeclampsia: A case-control study. Clin Nutr. 2015;34(6):1166-71. http://dx.doi.org/10.1016/j.clnu.2014.12.001

23. Ikpen MA, Eigbefoh J, Eifediyi RA, Isabu PA, Okogbenin S, Okogbo FO, *et al*. Determination of antioxidant status of pre-eclamptic and normotensive sub-rural Nigerian pregnant women at the Irrua Specialist Teaching Hospital, Irrua, Edo State. J Matern Fetal Neonatal Med. 2012;25(10):2046-50. http://dx.doi.org/10.3109/14767058.2011.599458

24. Ugwa E, Gwarzo M, Ashimi A. Oxidative stress and antioxidant status of pregnant rural women in north-west Nigeria: Prospective cohort study. J Matern Fetal Neonatal Med. 2015;28(5):544-7. http://dx.doi.org/10.3109/14767058.2014.924102

25. Mezouar D, Merzouk H, Merzouk AS, Merzouk SA, Belarbi B, Narce M. In vitro effects of vitamins C and E, n-3 and n-6 PUFA and n-9 MUFA on placental cell function and redox status in type 1 diabetic pregnant women. Placenta. 2016;42:114-21. http://dx.doi.org/10.1016/j.placenta.2016.04.013

26. Rumbold A, Ota E, Hori H, Miyazaki C, Crowther CA. Vitamin E supplementation in pregnancy.

Cochrane Database Syst Rev. 2015;7(9):1-127. http://dx.doi.org/10.1002/14651858.CD004069.pub3

27. Barbosa KBF, Costa NMB, Alfenas RCG, Paula SO, Minim VPR, Bressan J. Estresse oxidativo: conceito, implicações e fatores modulatórios. Rev Nutr. 2010;23(4):629-43. http://dx.doi.org/10.1590/S1415-52732010000400013
28. Coelho NLP, Cunha DB, Esteves APP, Lacerda EMA, Theme Filha MM. Padrão de consumo alimentar gestacional e peso ao nascer. Rev Saúde Pública. 2015;49(62):1-10. http://dx.doi.org/10.1590/S0034-8910.2015049005403
29. International Life Science Institute Brasil. Uso e aplicações das "Dietary reference intakes" DRIs. São Paulo: International Life Science Institute do Brasil; 2001.
30. Schoenaker DA, Soedamah-Muthu SS, Mishra GD. The association between dietary factors and gestational hypertension and pre-eclampsia: A systematic review and meta-analysis of observational studies. BMC Med. 2014;12:157. http://dx.doi.org/10.1186/s12916-014-0157-7

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