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Folate inadequacy in the diet of pregnant women[1]

Inadequação de folato na dieta de gestantes

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ABSTRACT

Objective

To estimate food and dietary folate inadequacies in the diets of adult pregnant women.

Methods

A prospective study was conducted with 103 healthy pregnant adult users of the Public Health Care System of *Ribeirão Preto*, *São Paulo,* Brazil. The present study included the 82 women with complete food intake data during pregnancy, which were collected by three 24-hour dietary recalls. Food folate (folate naturally present in foods) and dietary folate (food folate plus folate from fortified wheat flour and cornmeal) inadequacies were determined, using the Estimated Average Requirement as cutoff.

Results

The diets of 100% and 94% of the pregnant women were inadequate in food folate and dietary folate, respectively. However, fortified foods increased the medium availability of the nutrient by 87%.

Conclusion

The large number of pregnant women consuming low-folate diets was alarming. Nationwide population studies are needed to confirm the hypothesized high prevalence of low-folate diets among pregnant women.

Indexing terms: Folic acid. Food consumption. Pregnancy.

[1] Article based on the master's thesis of LC CRIVELLENTI intitled "*Estimativa de folato na dieta de gestantes*: *o papel da fortificação de farinhas e do suplemento dietético*". Universidade de São Paulo; 2013.

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RESUMO

Objetivo

Estimar a inadequação de folato alimentar e folato dietético na dieta de gestantes adultas.

Métodos

Um estudo prospectivo foi conduzido entre 103 gestantes adultas e saudáveis, usuárias do Sistema Único de Saúde do município de Ribeirão Preto, São Paulo, Brasil. Foram incluídas no presente estudo 82 mulheres com dados de consumo alimentar ao longo da gestação. Os dados dietéticos foram obtidos por meio de três inquéritos recordatórios de 24 horas, durante a gravidez. Para estimar a inadequação do folato alimentar (naturalmente presente nos alimentos) e do folato dietético (folato dos alimentos adicionado ao proveniente da fortificação das farinhas), empregou-se o método do requerimento médio estimado - Estimated Average Requirement *como ponto de corte.*

Resultados

Verificou-se que 100% das gestantes apresentaram dietas com ingestão inadequada de folato alimentar. Considerando-se o folato dietético, 94% das gestantes reportaram dietas com ingestão inadequada do nutriente. Entretanto, houve um aumento de 87% na disponibilidade do valor mediano do nutriente após se considerar o ácido fólico proveniente da fortificação das farinhas.

Conclusão

A inadequação de folato na dieta das gestantes avaliadas foi alarmante. Estudos populacionais de abrangência nacional são necessários para a confirmação da hipótese de uma elevada inadequação de folato na dieta de gestantes.

Termos de indexação: *Ácido fólico. Consumo alimentar. Gravidez.*

INTRODUCTION

Folate is one of the micronutrients with important roles during pregnancy. Low dietary intake of this vitamin may compromise the mother's and child's health, making them more susceptible to preeclampsia, megaloblastic anemia, low birth weight, preterm birth, chromosomal changes, and fetal malformations due to Neural Tube Defects (NTD)[1-4].

High prevalences of folate inadequacy in pregnant women have been found in developing and developed countries. In rural China[5] and India[6], the prevalences of folate inadequacy were 97% and 99%, respectively. In Portugal, a prospective study found that 91% of the pregnant women had low dietary folate intake[7]. In southern Spain, the prevalence of folate inadequacy in pregnant women was 98%[8].

In the Brazilian context, studies that estimated folate adequacy in the diet of pregnant women are scarce[9-11]. Additionally, these studies were conducted before the Institute of Medicine (IoM) published recommendations for specific populations, namely the Estimated Average Requirement (EAR), established to assess nutrient adequacy[12].

The recommended folate intake during pregnancy is challenging to meet through diet alone[13]. Some strategies have been implemented to increase access to this nutrient, such as folic acid supplementation and fortification of wheat flour and cornmeal[14].

Like other countries, the *Agência Nacional de Vigilância Sanitária* (Anvisa, National Sanitary Surveillance Agency) in Brazil regulated the compulsory fortification of wheat flour and cornmeal, and their derivatives, with iron and folic acid. The legislation requires the addition of 150 µg of folic acid per 100 g of wheat flour or cornmeal[15].

A cross-sectional population study conducted in the municipal urban area of *São Paulo* analyzed folate intake before and after food fortification and found a significant decrease in the prevalence of folate inadequacy in all study

strata/groups (adolescents, adults, and older adults). However, the prevalence of folate inadequacy in adult women remained high (38%)[16].

The *Pesquisa Orçamento Familiares* (Family Budget Survey)[17] analyzed Brazilian food intake and found that folate inadequacy in adult women remains high (38.1%) regardless of added folate. However, information about the prevalence of folate inadequacy in pregnant women was not available.

Brazilian studies that estimate folate inadequacy in the diet of pregnant women according to the current recommendations have not been found[12]. Given the importance of adequate dietary folate intake during pregnancy, the present study aimed to estimate food and dietary folate inadequacies in the diet of pregnant women.

METHODS

The present study consisted of the secondary analysis of data from a prospective study on pregnant users of the municipal Public Health Care System of *Ribeirão Preto* (SP), Brazil.

Data from a convenience sample were collected at four primary care units located in the southern, eastern, and western regions of the municipality. The inclusion criteria were: age between 18 and 35 years; normal weight before pregnancy (18.5 kg/m² <BMI <24.9 kg/m²)[18]; and no reported conditions that impacted habitual food intake. An on-call scheme was implemented on the prenatal follow-up days in the selected health care units. All women who visited these units for prenatal care and met the study inclusion criteria were invited to join the study.

The study consisted of three assessments, one on each trimester of pregnancy, and collection of sociodemographic, asset, lifestyle, and food intake data. The first assessment was performed during the user's first prenatal care visit, from September 2009 to May 2010. The other two assessments were done during other prenatal care visits or at the patient's home.

In all, 247 women were approached; 103 met the inclusion criteria and accepted to enter the study. Eighty-two of the 103 participants provided complete food intake data during pregnancy, so they were included in the present study.

The present study included all pregnant women with complete food intake data during pregnancy, totaling 82 women.

A structured questionnaire collected age, marital status, skin color, education level of the family head, education level of the pregnant woman, and asset data. The *Associação Brasileira de Estudos Populacionais* (Brazilian Association of Market Research Companies')[19] questionnaire determined the socioeconomic classes of the pregnant women.

Estimate of dietary folate intake by the pregnant women was three 24-Hour Recalls (24HR), one on each assessment, collected dietary data of nonconsecutive days. A 24HR was administered by telephone to a subsample of pregnant women seven to fifteen days after the in-person interviews.

The 24-hour were filled using the multiple-pass method[20], and the standard weights of the cooking units in grams were provided by the "Brazilian Manual of Home Cooking Recipes and Cooking Units"[21,22].

The United States Department of Agriculture food composition table served as reference for estimating dietary folate intake. This table lists Dietary Folate Equivalents (DFE), which differentiates between the bioavailability of food folate and the folic acid in fortified foods[23]. The amount of DFE was given by the formula: DFE= folate + 1.7x folic acid[24].

The folic acid values were also corrected from 140 µg/100 g of wheat flour or cornmeal, the amount added in the United States of America[25], to 150 µg/100 g of wheat flour or cornmeal, the amount added compulsorily in Brazil[15].

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The contribution of a particular food to the dietary folate ingested by the pregnant women was given by multiplying the total amount of folate present in the food (naturally and added) by 100 and dividing by total dietary folate[26]. The foods were then ordered in decreasing percent contribution.

The mean and standard deviation of continuous variables and frequency of categorical values were calculated.

Folate inadequacy was estimated in two stages using the same method: the first considered only the folate naturally present in foods (food folate); the second considered food folate plus the folate added to flour wheat and cornmeal (dietary folate).

Once Analysis of Variance (Anova) adjusted the distribution of dietary folate intake, the proportion of pregnant women with inadequate folate intakes was calculated, using the EAR as cutoff, as recommended by the IoM[12].

All statistical analyses were performed by the software Statistical Package for the Social Sciences (SPSS) (version 17.0)

The study was approved the by Research Ethics Committee of the Health Center of the School of Medicine of *Ribeirão Preto* under protocol number CEP/CSE-FMRP-USP-150/2012. The pregnant women who met the inclusion criteria were informed of the study objectives in writing and filled out an Informed Consent Form.

RESULTS

Being married, socioeconomic class C, and at least eight years of formal education prevailed among the study women (Table 1).

The pregnant women had a mean (Standard Deviation) food folate intake of 183 (54) DFE/day and a median of 179 DFE/day, varying from 61 to 350 DFE/day. The mean dietary folate intake was 342 (109) DFE/day, and the median was 335 DFE/day, varying from 116 to 752 DFE/day. Therefore, food fortification increased folate availability by 87%.

Table 1. Sociodemographic characteristics of the 82 pregnant women. *Ribeirão Preto* (SP), Brazil, 2009.

Characteristics		
Age (years)	M=25	SD=5
	n	%
Marital status		
Married/lives with partner	57	69.5
Single	22	26.8
Separated	3	3.7
Skin color		
White	43	53.0
Brown/Red	28	34.6
Black	8	9.9
Yellow	2	2.5
Education level (formal education)		
<4 years	2	2.4
4 a 8 years	25	30.5
>8 years	55	67.1
*Socioeconomic class**		
A + B	7	8.5
C	59	72.0
D + E	16	19.5

Note: **Critério de Classicação Econômica Brasil*[19].

M: Mean; SD: Standard Deviation.

A total of 346 foods were listed in the 24HR. The foods that contributed most to food folate intake were: cooked beans, bread rolls, whole milk, orange juice, and loose-leaf lettuce. The greatest contributors to dietary folate intake were bread rolls, cooked beans, crackers, and whole milk (Table 2).

Figure 1 shows that the food folate intake of 100% of the study women fell short of the amount recommended by the EAR (520 µg DFE/day), and 94% of the women had inadequate dietary folate intake (Figure 2).

DISCUSSION

This is the first Brazilian study to estimate the food and dietary folate inadequacies in the diet of pregnant women according to the current recommended intake[12].

Although food fortification increased the nutrient's availability, the proportion of women with inadequate dietary folate intake according

Table 2. Contribution of different foods to the food and dietary folate intakes of pregnant women. *Ribeirão Preto* (SP), Brazil, 2009.

Classification	Foods	Contribution* (%)	Folate in 100 g of food**
	Dietary folate		
1	Bread roll	21.7	243.8
2	Cooked beans	9.9	48.6
3	Crackers	4.6	199.3
4	Whole milk	2.5	5.0
5	Hamburger bun	2.5	156.4
6	Natural orange juice	2.2	30.0
7	Breakfast cereal	2.1	845.3
8	Pasta	1.9	47.0
9	Cake	1.9	156.5
10	Cornmeal couscous	1.9	286.7
	Food folate		
1	Cooked beans	18.7	48.6
2	Bread roll	5.2	31.0
3	Whole milk	4.8	5.0
4	Natural orange juice	4.3	30.0
5	Loose-leaf lettuce	3.4	38.0
6	*Feijoada*	2.9	100.2
7	Papaya	2.6	38.0
8	Banana	2.2	20.0
9	Liver	2.2	260.0
10	Rice	2.1	2.00

Note: *Percent folate contribution of the food to the total dietary folate intake; **Shown as Dietary Folate Equivalent (DFE).
1 DFE = 1 µg of naturally occurring folate = 0.6 µg of synthetic folic acid present in fortified foods and vitamin supplements.

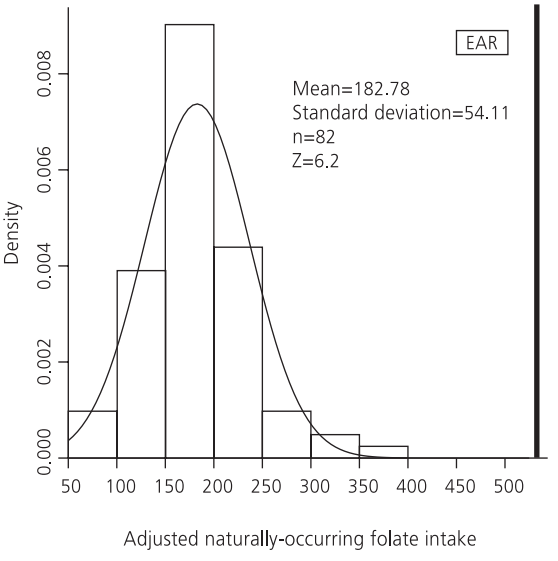

Figure 1. Distribution of the adjusted food folate intake Dietary Folate Equivalent of the 82 pregnant women. *Ribeirão Preto* (SP) Brazil, 2009.

Note: EAR: Estimated Average Requirement.

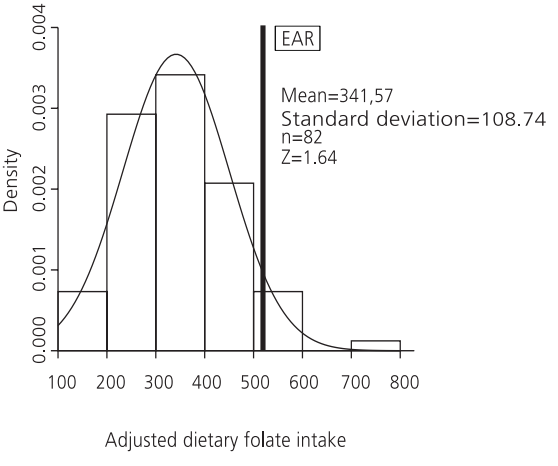

Figure 2. Distribution of the adjusted dietary folate intake Dietary Folate Equivalent of the 82 pregnant women. *Ribeirão Preto* (SP), Brazil, 2009.

Note: EAR: Estimated Average Requirement.

to the EAR was very high at 94%. This finding suggests a serious public health problem since folate deficiency during pregnancy may have some negative effects on the mother's and child's health[1,2,8].

Studies from other countries have also found high proportions of women with inadequate dietary folate intake, corroborating the present findings. A study in the state of Ohio, United States of America, with pregnant adolescents and adults found that less than 10% of the sample had adequate folate intake according to the reference standard[27]. In Spain a study found that folate was the second most prevalent dietary micronutrient inadequacy in pregnant women, affecting 99.6% of the study sample[28].

The foods that contributed most to dietary folate intake were bread rolls and beans. However, these were not the foods with the highest folate levels. Steluti *et al.*[29] reported a similar finding for Brazilian adolescents. A plausible explanation for this fact is that the foods preferred by the two groups are not the best sources of the nutrient.

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Another Brazilian study with adolescents, adults, and older adults found that breads and beans contribute most to dietary folate, and breads provided the highest contribution regardless of the subject's age[16]. The established folate requirement of pregnant women exceeds that of nonpregnant women, and it is challenging to meet the requirement without fortified foods and/or supplementation[30].

One limitation of the present study is the use of a convenience sample, which prevents extrapolation of the results. Additionally, biochemical tests were not performed. However, this original study in Brazil points out the high proportion of pregnant women with inadequate dietary folate intake.

CONCLUSION

The proportion of pregnant women with inadequate dietary folate intake was alarming. The food folate in the diets of all study pregnant women was short of the EAR, and 94% of the women still presented inadequate dietary folate intake, which included the folate added to wheat flour and cornmeal. Brazilian population studies are recommended to confirm the hypothesis that inadequate dietary folate intake by pregnant women is a serious public health problem.

CONTRIBUTORS

LC CRIVELLENTI participated to the collected data, analyzed and interpreted the data, and wrote the manuscript. P BARBIERI participated to the designed the prospective study, supervised data collection, and reviewed and approved the final version of the manuscript. DS SARTORELLI performed the general coordination of the study and reviewed and approved the final version of the manuscript.

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