Hemoglobin levels and prevalence of anemia in pregnant women assisted in primary health care services, before and after fortification of flour*

Níveis de hemoglobina e prevalência de anemia em gestantes atendidas em unidades básicas de saúde, antes e após a fortificação das farinhas com ferro

Abstract

We evaluated hemoglobin-Hb levels and prevalence of anemia in pregnant women before and after fortification of flour. It was developed a study to evaluate intervention, of the type before and after, with independent population samples. Study was conducted in primary health care services in Maringá, PR. We assessed 366 and 419 medical records, Before and After implementation of fortification. Pregnant women with Hb < 11g/dL were considered anemic. Data were submitted to multiple linear regression analysis. There was low prevalence of anemia affecting 12.3% and 9.4% pregnant women Before and After fortification ($p > 0.05$), but the Group After the fortification had higher Hb levels ($p < 0.05$). Hb levels associated with Group, gestational age, previous pregnancy number, employment and marital status ($p < 0.05$). Although the fortification of flour may have had role in increasing the mean hemoglobin, we need consider the contribution of other variables not investigated.

Keywords: Anemia. Hemoglobins. Iron deficiency. Pregnant women. Food Fortified. Prenatal Care.

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Resumo

Avaliaram-se níveis de hemoglobina-Hb e prevalência de anemia em gestantes, antes e após a fortificação das farinhas. Estudo de avaliação do tipo antes e depois, com amostras populacionais independentes, realizado em unidades básicas de saúde de Maringá, PR. Foram avaliados 366 prontuários de gestantes Antes da fortificação obrigatória das farinhas, e 419 Após a fortificação. Gestantes com Hb < 11g/dL foram consideradas anêmicas. Realizou-se análise de regressão linear múltipla. Verificou-se baixa prevalência de anemia que afetava 12,3% e 9,4% das gestantes, Antes e Após a fortificação (p > 0,05), porém o Grupo Após a fortificação obrigatória apresentou média de Hb mais elevada (p < 0,05). Evidenciou-se associação entre Hb e Grupo, idade gestacional, gestação anterior, ocupação e situação conjugal (p < 0,05). Embora a fortificação de farinhas possa ter um papel no aumento da média de hemoglobina, é preciso considerar a contribuição de outras variáveis não investigadas.

Palavras-chave: Anemia. Hemoglobinas. Deficiência de ferro. Gestantes. Alimentos fortificados. Cuidado Pré-Natal.

Introduction

Iron-deficiency anemia is still a global problem and the most frequent and alarming nutritional deficiency in terms of collective health. Unlike the decreasing trend of other nutritional deficits, anemia continues to be present in all continents and social groups, although its occurrence remains associated with negative socio-environmental conditions[1-2].

Pregnant women represent one of the most vulnerable groups, due to the high iron requirement to meet both the mother's and the fetus' needs[3]. It is estimated that 52% of pregnant women in developing countries have anemia, whereas this proportion is 23% in developed countries[1]. Although national data are not available, a review of studies that have been published in the last 40 years showed that the prevalence of anemia during pregnancy is high, despite the policies implemented to fight this disease[4]. Recent data from the *Pesquisa Nacional de Demografia e Saúde da Criança e da Mulher* (PNDS – National Demographic and Health Survey of Children and Women)[5] showed a reduction in the prevalence of anemia in children aged between six and 59 months, although the same was not observed among non-pregnant women of childbearing age, who had a high rate of anemia, with a prevalence of 29.4% in Brazil and relevant regional differences. This is an alarming fact, as nearly one third of women of childbearing age already have anemia before becoming pregnant, in addition to the gestational period being the most critical in terms of body iron requirement.

Prematurity, low birth weight, and higher maternal and perinatal mortality rate stand out as harmful consequences of anemia during the gestational period[1,6-8]. Recognizing the negative effects of anemia on health and survival of the mother and child, the Brazilian Ministry of Health implemented drug iron supplementation in the *Programa de Atenção à Gestante* (Health Care Program for Pregnant Women) in 1982[9] and subsequently in the *Programa Nacional*

de Suplementação de Ferro (National Iron Supplementation Program) in 2005[10].

Among the set of strategies aimed at iron-deficiency anemia control and reduction implemented in Brazil, the regulation of wheat and corn flour fortification with iron and folic acid of December 2002 should be emphasized[11]. However, this resolution established an 18-month period for companies to meet the regulation, so that fortification only became mandatory in June 2004.

Although the results of fortification are expected in the long term, positive effects can be observed more quickly as physiological needs increase[1]. Thus, the present study aimed to assess hemoglobin levels and the prevalence of anemia in pregnant women, before and after flour fortification with iron, with the purpose of understanding more about the impact of this intervention and enabling a point of reference for the evolution of this problem in the city of Maringá, PR, Southern Brazil. Researchers expect that the results of this study will help to improve local anemia prevention and control programs for pregnant women, including nursing interventions during prenatal care[12].

Methods

The present subproject, approved by the State University of Maringá Research Ethics Committee (Official Opinion number 095/2006), was part of a broader research project*. This study was designed to assess a before-and-after intervention in independent population samples and it was developed in 22 of the 23 primary health units of the city of Maringá, state of Paraná.

Data were obtained from the medical records of pregnant women cared for during prenatal follow-up in two periods: Before mandatory flour fortification, including pregnant women who had given birth between June 2003 and May 2004 and others who had given birth at least one year after the effective implementation of the strategy, including pregnant women whose last menstruation occurred between June 2005 and May 2006. In 2004, before fortification, the public prenatal care service in Maringá covered approximately 45% of births; in 2006, after mandatory flour fortification with iron, nearly 56% of pregnant women received prenatal care in the city's public service (Data from the SISPRENATAL and SINASC).

The minimum sample size of each group was calculated according to the following formula: $n=Z_{\alpha}^{2}PQ./d^{2}$, where n=minimum sample size; Z=confidence coefficient, whose value adopted was 1.96 for an alpha of 0.05; P=prevalence; Q=prevalence complement (Q=1-P); and d=maximum error in absolute value. Considering the fact that there are no national studies in Brazil that have estimated the dimension of the problem in pregnant women, a value of P=0.50 was adopted, which corresponds to a greater relationship between P and Q and expected accuracy d=5%. Thus, the following was obtained: $n=1.96^{2}x0.50x0.50/0.05^{2} = 384$.

The sample was selected using the City's Department of Primary Care Information System in two stages: first, a selection was performed using proportional stratification per primary health unit, so that the number of pregnant women to be studied per primary health unit was calculated, proportional to the number of pregnant women cared for in the Before mandatory flour fortification group between June 2003 and May 2004 and those in the After fortification group between June 2005 and May 2006; second, a selection was performed with the calculation of random numbers from the *Statística* 7.1 software program, which identified the pregnant women to be included in this study. A total of 10% was added to the sample for possible losses, although the medical records that were not found and those that did not include data on hemoglobin (Hb) were replaced by sequence listing numbers, maintaining the same randomness so that the percentage of stratification and the sample representativeness were not lost. Data on Hb from the After fortification group not found in the medical records were obtained from the Central Laboratory, despite its not including data prior to 2005, so that such

records were replaced for this group.

The medical records of pregnant women who had problems associated with blood loss or hemoglobinopathies that justified the continuing reduction in Hb were excluded. The final sample was comprised of 785 pregnant women: 366 in the Before mandatory flour fortification group and 419 in the After fortification group.

Data collection occurred between 2006 and 2007 and only included low-risk pregnant women, whose medical records had at least the following information: date of the first consultation, date of the last menstruation, date of the blood test and Hb test result. In addition, socioeconomic-demographic data (age, level of education, employment and marital status) and gynecological--obstetric and prenatal history (gestational age, weight and height in the first prenatal consultation, number of previous pregnancies and number of prenatal consultations).

Maternal age was categorized as less than 20 years and equal to or more than 20 years; level of education as less than 8 years of education and equal to or more than 8 years of education; employment as having a paid job and unpaid job; marital status as with and without a partner; gestational age in the beginning of prenatal care as first trimester (1 to 13 weeks), second trimester (14 to 27 weeks) and third trimester (28 weeks and more)[13]; number of prenatal consultations as less than 7 consultations and equal to or more than 7 consultations; and number of previous pregnancies as none and one or more previous pregnancies. Nutritional status was categorized according to the Brazilian Ministry of Health recommendations[14]: low weight; adequate weight; and overweight/obesity.

Data on Hb referred to the first test requested in the first prenatal consultation and, consequently, researchers considered that pregnant women were not receiving iron supplementation. Pregnant women with iron supplementation at the time of blood collection were not included in the sample. This was possible because the city has a reflective tool attached to the medical records, which is completed with data from the prenatal card, thus enabling information about the beginning of prenatal care and laboratory test results to be obtained, even when performed in other services. All tests were performed in the city's Central Laboratory, which uses a Cell-Dyn 3000 (Abbott) automated cell counter to analyze Hb. Gestational age at the time of Hb assessment was calculated, considering the date of the last menstruation and the date of blood test. Pregnant women with an Hb count lower than 11.0g/dL[1] were considered to be anemic. Data on Hb were analyzed according to the gestational trimester when the test was performed[13].

Data analysis was performed with Epi-Info 6.0, *Statistica* 7.1 and Statistical Package for Social Sciences – SPSS, version 11.0. Chi-square test, Student's t-test and variance analysis were used to analyze the data. Aiming to investigate the possible influence of the variables studied on Hb levels, these data were submitted to multiple linear regression analysis. Hb level was considered as the dependent variable and the Non-fortified and Fortified groups and prenatal, obstetric, socioeconomic and demographic characteristics were considered as predictive variables. Variables that showed an association in the bivariate analysis, with a significance level of 20% ($p<0.20$), were included in the model to prevent the exclusion of potentially important variables. A significance level of 5% ($p<0.05$) was used to identify associations.

Results

Table 1 shows the characteristics of pregnant women according to Groups, which differed in terms of marital status and beginning of prenatal care. A significantly higher proportion of pregnant women in the After mandatory flour fortification group did not have a partner (8% and higher) and began prenatal care in the first trimester (10% and higher).

The Before mandatory flour fortification group had a gestational age of 14.6±7.1

weeks in the beginning of prenatal care, while that of the After fortification group was 12.8±6.5 weeks (p<0.0001). Groups were homogeneous in terms of the other variables analyzed: a similar proportion of adolescents (<20 years); more than two thirds had completed primary school and more than half had a paid job; almost one third of both groups were overweight/obese and one fifth had low weight; the great majority had already had at least one previous pregnancy; and approximately half had had at least seven prenatal consultations (Table 1).

Mean Hb values differed significantly between Groups (p=0.03), although this difference referred to the third gestational trimester (p=0.02). Despite the frequency of anemia having been slightly lower in the After mandatory flour fortification group (9.3%), when compared to

Table 1 - Characteristics of pregnant second group before and after the mandatory fortification of flour. Maringá, PR, 2007.
***Tabela 1** - Características das gestantes segundo Grupos Antes e Após a fortificação obrigatória das farinhas. Maringá, PR, 2007.*

Variables	Before fortification n (%)	After fortification n (%)	p*
Age			
< 20 years	64 (17.5)	80 (19.2)	0.60
≥ 20 years	302 (82.5)	337 (80.8)	
Level of education			
< 8 years	100 (29.0)	88 (23.6)	0.12
≥ 8 years	245 (71.0)	285 (76.4)	
Employment			
Unpaid job	156 (44.4)	158 (45.1)	0.91
Paid job	195 (55.5)	192 (54.8)	
Marital status			
Without a partner	94 (26.4)	136 (34.4)	**0.02**
With a partner	262 (73.6)	259 (65.6)	
Beginning of prenatal care			
1st trimester	202 (55.2)	273 (65.2)	**0.02**
2nd trimester	140 (38.2)	125 (29.8)	
3rd trimester	24 (6.6)	21 (5.0)	
Prenatal consultations			
< 7 consultations	187 (51.9)	197 (47.2)	0.22
≥ 7 consultations	173 (48.1)	220 (52.8)	
Nutritional status			
Low weight	65 (21.0)	81 (22.9)	0.82
Adequate weight	152 (49.0)	167 (47.2)	
Overweight/Obesity	93 (31.0)	106 (29.9)	
Previous pregnancies			
None	156 (43.5)	160 (41.0)	0.39
1 or more	203 (56.5)	239 (59.0)	

* The p value refers to Chi-square test / ** O valor de p se refere ao teste Qui-quadrado*

Table 2 - Mean of Hb and the proportion of pregnant women with anemia (Hb < 11.0 g / dL) second gestational trimesters and Groups Before and After the mandatory fortification of flour. Maringá, PR, 2007.
***Tabela 2** - Médias de Hb e proporção de gestantes anêmicas (Hb < 11,0g/dL) segundo trimestres gestacionais e Grupos Antes e Após a fortificação obrigatória das farinhas. Maringá, PR, 2007.*

Trimester	Before fortification			After fortification			p*	p**
	n	x ± SD	n (%) <11.0 g/dL	n	x ± SD	n (%) <11.0 g/dL		
I	202	12.5±1.1	19 (9.4)	273	12.6±1.0	13 (4.8)	0.14	
II	140	11.9±1.0	21 (15.0)	125	11.9±1.1	26 (20.8)	0.68	
III	24	11.8±0.9	5 (20.8)	21	12.4±0.9	-	**0.02**	
Total	366	12.2±1.1	45 (12.3)	419	12.4±1.1	39 (9.3)	**0.03**	0.22

* The p value refers to the t-Student test / **O valor de p refere-se ao teste t-Student*
** The p value refers to Chi-square test / *** O valor de p se refere ao teste Qui-quadrado*

the Before fortification group (12.3%), this difference was not statistically significant. Nonetheless, high frequencies of anemia (20.8%) stood out in the second and third gestational trimesters of the After and Before mandatory flour fortification groups, respectively (Table 2).

Table 3 shows the results of the multiple linear regression analysis. After adjusting for confounding variables, researchers observed that pregnant women of the After mandatory flour fortification group had a mean Hb concentration that was 0.17g/dL higher than that of the Before fortification group. Pregnant women with a paid job and a partner also showed higher Hb levels. Negative coefficients were identified for the "gestational age in the first consultation" and "number of previous pregnancies" variables, with significant decreases in Hb levels as the gestational age in the first prenatal consultation and the number of previous pregnancies increased.

Discussion

The assessment of the effect of programs and interventions must be performed according to pre-established goals, although such aspect is not usually included in the planning stage. Thus, an alternative to assess interventions is to compare results of prevalence surveys based on baseline data, when such are present in the beginning of the program, to subsequent findings[15]. Considering the fact that studies on the prevalence of anemia among pregnant women in Brazil are restricted to specific populations, thus preventing the generalization of findings[4], and that the city of Maringá, PR, does not have reference data, a before-and--after study was designed, including two independent groups of pregnant women.

The selection of pregnant women to

Table 3 - Parameters of multiple linear regression for mean hemoglobin levels and studied variables. Maringá, PR, 2007.
***Tabela 3** - Parâmetros da regressão linear múltipla para níveis médios de hemoglobina e as variáveis estudadas. Maringá, PR, 2007.*

Variables	β	Standard Error	p-value
After fortification group *	0,172	0,081	0,034
Employment (has a paid job)*	0,231	0,080	0,004
Marital status (with a partner)*	0,306	0,089	0,001
Gestational age in the first prenatal consultation	-0,034	0,006	<0,001
Number of previous pregnancies	-0,103	0,033	0,002

* Categorical variable / **Variável categórica*

assess the effect of fortification considered two aspects: the first, already mentioned in the present study, is that the group analyzed is one of the most vulnerable to anemia; and the second, which enabled this study to be developed, is the fact that the prenatal care provided by public health services guarantees that a Hb test will be performed for all pregnant women having their first prenatal consultation[14]. However, the difficulty in establishing the diagnosis of anemia during pregnancy should be considered, as hemoglobin concentration changes with the hemodilution that occurs at this time in a woman's life[16]. Based on such difficulty, hemoglobin levels were analyzed according to gestational trimester.

Although data was obtained from medical records, an aspect that should be taken into consideration due to quality of information, this method enabled the assessment of a great number of pregnant women. Consequently, the present study stands out because it provides a reference diagnosis of anemia in women cared for in public services of the city of Maringá, PR, and because it shows an evolution of this problem.

Data analysis showed that the two Groups of pregnant women studied were significantly different in terms of marital status and beginning of prenatal care. The proportion of pregnant women without a partner increased from one fourth in the Before mandatory flour fortification group to one third in the After fortification group. As the occurrence of anemia is dependent on negative socioeconomic-environmental conditions[2,17] and women without a partner usually tend to have greater financial difficulties, this difference could cause the After fortification group to have a higher prevalence of anemia and lower Hb levels, although this was not observed here. The effect of flour fortification remained, despite pregnant women with a partner having a mean Hb concentration that was 0.30g/dL higher than that of pregnant women without a partner in the multiple analysis, which controlled confounding variables.

With regard to the beginning of prenatal care, it was observed that two thirds of pregnant women in the After fortification group started it in the first trimester, compared to half of the Before fortification group. This fact can partly explain the lower prevalence of anemia found in the After fortification group, considering the influence of gestational age on hemoglobin levels[3]. However, mean Hb levels did not differ in the first and second gestational trimesters. Only in the third trimester were the means higher in the After fortification group. With the adjustment of confounding variables, the higher the gestational age in the first prenatal consultation, the lower the mean Hb concentration, which decreased 0.03g/dL per week of gestation in the beginning of prenatal care. Thus, the higher proportion of pregnant women who began prenatal care in the first trimester significantly affected the results of this study, whether these were higher mean Hb levels or lower prevalence of anemia in the After flour fortification group. Despite the maintenance of the positive effect of fortification after controlling for confounding variables, it is important to consider the fact that other social policies implemented apart from flour fortification, such as the income transfer programs which enabled an increase in the power of purchase of poorer families and greater access to food, health and sanitation, and that other variables not analyzed in this study could have contributed to the more positive Hb levels observed in the results. These levels had a statistically significant variation, although slight and of low clinical relevance.

The total prevalences of anemia found in the city of Maringá-PR both before (12.3%) and after (9.3%) flour fortification were lower than the prevalences of 30 to 40% estimated for pregnant women in Brazil[2] and the data established by a review of articles published in the last 40 years[4]. With regard to categories of epidemiological importance, they are classified as mild, a level defined by prevalences of anemia in pre-school children and pregnant women

ranging between 5% and 20%, according to the classification proposed by the World Health Organization (WHO)[1]. A recent study developed in the semi-arid region of the state of Alagoas found a prevalence of 50% of anemia in pregnant women[18], while the prevalence observed in primary health units in the city of Cuiabá was 25.5%[19], revealing a result that was very different from that found in Maringá. Thus, researchers confirmed the alarming results of anemia found by the PNDS[5] in women of childbearing age, which affects 39% of this population in the Northeast region. In Mexico, although a reduction has been observed, the prevalence of anemia in pregnant women remains at 20%[20], indicating that this public health problem has not been resolved[21].

The social determination of anemia in our environment has been well documented in children[22,23,24]. In pregnant women, in the 1980s, this nutritional deficiency was associated with socioeconomic conditions that were characteristic of class situations[25]. Considering the fact that the South region shows the best social indicators when compared to the other regions[26], the low prevalences of anemia found in this study confirm the influence of such variables on the development of iron deficiency.

The possibility of these low prevalences of anemia preventing the effect of fortification from being observed should be taken into consideration, similarly to another study that also found a low prevalence of anemia in pregnant women cared for in a primary health unit of the city of São Paulo, before (9.2%) and after (8.6%) flour fortification, without a significant difference[27].

However, a study conducted with a population of pregnant women with a high prevalence of anemia observed a significant reduction in the rate of this disease, which decreased from 28.9% to 7.9%. According to the author, although the variables not investigated could have contributed to this result, mandatory fortification was essential as there was a significant increase in mean iron intake by the pregnant women studied during the period immediately before and one year after the implementation of mandatory flour fortification with iron[28]. It should be emphasized that, although the Brazilian government regulated flour fortification in December 2002, it is possible that companies used the deadline of 18 months to regularize their status, so that fortification actually became effective in July 2004, when it became mandatory[11] .

However, this result was not observed in a study that assessed the effect of flour fortification in children, even in a group with high prevalence of anemia, as this prevalence varied from 30.2% to

41.5% and subsequently to 37.1% in the three stages of the study: baseline, one year after the implementation of fortification, and two years after this implementation, respectively[24].

It should be emphasized that aspects associated with the pregnant women's diet were not analyzed in the present study. Nonetheless, a study that assessed the intake of foods subject to mandatory fortification with iron by pregnant women cared for in prenatal consultations showed that the iron intake did not meet the recommendation for this population[30]. Likewise, a study that assessed eating habits and the intake of food sources of iron, whether natural or fortified, by women of childbearing age found that non-pregnant women met the iron requirement with the additional flour fortification recommended, whereas pregnant women did not[31]. Thus, authors emphasized the need to promote other anemia prevention and control actions with flour fortification.

Considering the hematological changes during pregnancy and the fact that groups were not homogeneous in terms of the "gestational age in the beginning of prenatal care" variable (Table 1), the frequency of anemia and hemoglobin levels stratified by gestational trimester were analyzed. The results confirmed the increase in the occurrence of anemia with the advance in the gestational period, as observed in several studies, where the prevalences of anemia varied from 3.6% to 23.9% in the

first trimester; from 9.2% to 43.9% in the second trimester; and from 10.9% to 52.3% in the third trimester[4].

However, mean Hb concentrations differed significantly between Groups, decreasing with the development of the pregnancy in the Before mandatory flour fortification group, but increasing in the last trimester of the After fortification group. The fact that the mean Hb concentration of the After fortification group was significantly higher in the third gestational trimester could suggest that this concentration was more influenced by gestational aspects inherent in the second trimester than by external factors, so that the positive effect of flour fortification can only be observed in the last trimester.

Although there were no differences in the prevalence of anemia after adjustment for confounding variables, the results showed the positive effect of flour fortification on Hb levels, indicating an increase of 0.17g/dL in the After fortification group, compared to the Before fortification group. This result was not observed in a similar study conducted in the city of São Paulo[22].

An association between Hb levels and the "employment" variable was observed, so that the mean Hb concentration of pregnant women with a paid job was 0.23g/dL higher than that of women who did not work. This variable did not differ between groups; however, this result suggests an association between anemia and social conditions[2]. In addition, the number of previous pregnancies had a significant negative effect on Hb, which was 0.10g/dL lower per additional previous pregnancy. This result corroborates those of other studies, which found lower Hb concentrations in pregnant women with a higher number of previous pregnancies[32] and an association between anemia and a number of pregnancies higher than three[33].

The results of the present study must be interpreted with caution, as many other variables may interfere with the occurrence of anemia, in addition to fortification. Thus, it is recommended that other studies be developed.

Conclusions

Considering the fact that, in our environment, data on anemia in pregnant women are accurate and show a great variation in different places, the present study stands out as it provides an important point of reference for the city of Maringá-PR in particular and for the country in general. The reason for this is that it assessed a representative sample of pregnant women cared for in all primary health units of this city.

The fact that this study analyzed hemoglobin levels and the occurrence of anemia, before and after the regulation of flour fortification, enables a baseline or reference diagnosis and the evolution of the problem at least one year after the effective implementation of the strategy. There were no differences in the low prevalences of anemia, both before and after flour fortification. These results are important and serve as positive feedback for the city's public health services and health professionals who work there.

Despite the small variation in Hb levels found, which seems to have little meaning from a clinical perspective as the values were above the cut-off point for anemia, this difference was statistically significant and the Hb levels were higher in the After fortification group. Consequently, even with the differences observed between groups, it is possible to assume that the flour fortification strategy has contributed to this result, although one should not ignore the contribution of other aspects not analyzed that were associated with different social policies implemented during this period. However, this result does not reject the importance of prenatal care and drug supplementation with ferrous sulfate during pregnancy.

Due to the use of secondary data, it was not possible to assess food intake to observe whether the amount of fortified foods in the diet was sufficient to increase Hb levels in the pregnant women studied, nor was the composition of flours analyzed. Thus, it is very important that other studies be

conducted, using more extensive methodologies and aiming to effectively assess the impact of flour fortification on anemia control.

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