IMPACT OF PUBLIC POLICIES ON THE IRON DEFICIENCY IN THE BRAZILIAN POPULATION: FORTIFICATION OF WHEAT AND CORN FLOUR AND THE NATIONAL IRON SUPPLEMENTATION PROGRAM

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Introduction: Anemia is a public health issue that affects nearly 24.8% of the world population, according to WHO. In order to reduce iron deficiency anemia prevalence, mandatory fortification of wheat and maize flour with iron and folic acid and National Program of Iron Supplementation (NPIS) were implemented in Brazil. Objectives: To verify the effectiveness of NPIS and flour fortification programs through a review. Methods: PubMed, SciELO and LILACS databases were searched. Original articles published between 2008-2017 were selected, including 14 in total, being 9 related to flour fortification and 5 related to NPIS. Results: Some studies show the adequacy of iron status and reduction of anemia prevalence after flour fortification, while other did not have achieved the expected results, mainly in children under 24 months of age and pregnant and reproductive age women. A low adherence to the NPIS was observed for mother and health professionals, and there were problems in the distribution and monitoring of the program, as well as in the training of the health professionals. Conclusion: Our study shows the need for monitoring nationally the flour fortification program, assessing the amount of fortified food consumed, iron nutritional status of Brazilian population and quality and iron...
bioavailability of the fortified food. Federal institutions need to improve the NPIS operationalization and to encourage health professionals to be conscious about the importance of this program to reduce anemia prevalence.

**Key words:** Iron, Iron Deficiency Anemia, Food Supplements, Iron Deficiency, Public Policy.
INTRODUCTION

The World Health Organization (WHO) classifies anemia when hemoglobin concentration levels are below those recommended according life stages, gender and age, and it may result from the lack of one or more nutrients. Iron deficiency is the most common cause of anemia, which mainly affects women of childbearing age/pregnant women and children aged under two years, with higher prevalence in developing countries.

Anemia, the most severe phase of iron deficiency, is considered a public health problem worldwide, because according to the WHO, it affects approximately 24.8% of the population and, depending on the degree, there may be loss of cognitive ability, reduced performance at work, learning difficulties, susceptibility to infections, increased risk of adverse complications in pregnancy, in addition to perinatal and parturient’s mortality.

In 1992, Brazil assumed a commitment to the United Nations to reduce, until 2003 the prevalence of iron-deficiency anemia in 1/3 of the levels found for pregnant women in 1990. This commitment resulted in the deployment of the intervention program of national scope for the entire Brazilian population of childbearing age/pregnant women.

Despite these actions, data from the Demographic and Health National Survey (PNDS - Pesquisa Nacional de Demografia e Saúde) of 2006 showed high prevalence of anemia in the country, being 20.9% in children and 29.4% in women. Frota, 2013, in the assessment of the prevalence of anemia in women and children enrolled in the Family Health Strategy program, in a representative sample of the population of Maranhão, found that 51.6% of children aged between 6 and 59 months were anemic, which increased to 64.5% among infants. Among mothers, anemia occurred in 39% of them.

The objective of this study was to verify, through an integrative review, the effectiveness of the programs: “Iron fortification of flour” and the “National Program of Iron Supplementation (NPIS)” in the compliance with need for the mineral and reduction of the prevalence of anemia in Brazil.

METHOD

This integrative review was performed with original articles published between 2008 and 2017, using articles, from the electronic databases PUBMED (National Library of Medicine and The National Institute of Health), SciELO (Scientific Eletronics Library Online) and LILACS (Latin American and Caribbean Health Sciences Literature) published in Portuguese and English. In the search strategy, the descriptors used were “Iron”, “Policies”, “Supplementation”, “Iron Deficiency,” “Fortification of flour” and “Brazil” (alone or combined).

The studies were considered eligible for inclusion when corresponding to the following criteria: evaluation of the impact of flour fortification with iron in the compliance with the need for the mineral and control of iron deficiency and anemia frequency to decrease the prevalence in children or women of childbearing age/pregnant women.

The selection of evidence was restricted to original studies, excluding review studies, experimental studies with animals, duplicate articles and case reports.

RESULTS AND DISCUSSION

The initial search returned 651 articles, but, after applying the inclusion and exclusion criteria, only 14 articles were considered for analysis in this review, with nine addressing the analysis of flour fortification and five, the national program of iron supplementation. Figure 1 shows the process of selection of articles in its different stages and the respective number of articles retrieved.

![Flowchart of the selection process of the analyzed articles](image-url)
Fortification of wheat and maize flour with iron and folic acid

The mandatory fortification of wheat and maize flour was implemented in Brazil in June 2004, after the publication of the Resolution of the Collegial Board (RCB) 344, on 13th of December of 2002, of the National Health Surveillance Agency (ANVISA). Aiming at reducing the prevalence of anemia, as well as the risk of neural tube defects, it determined that wheat and maize flours should be fortified with at least 4.2 mg of iron and 150 µg of folic acid every 100 g of flour. In addition, this resolution recommended the use of iron compounds in the fortification, namely: dehydrated ferrous sulfate, ferrous fumarate, reduced iron, electrolytic iron, iron and sodium EDTA and chelate iron bisglycine. It added that other compounds could be used insofar as they had their bioavailability proven.

On 13th of April of 2017, the ANVISA published RCB 150, updating RCB 344/2002. This resolution determines, in summarized form, lower and upper limits of iron fortification (4 - 9 mg) and folic acid (140 - 220 µg) every 100 g of flour, in addition to restricting the iron compounds used in the fortification (ferrous sulfate, encapsulated ferrous sulfate, ferrous fumarate or encapsulated ferrous fumarate)

RCB 150/2017 shall have validity in April 2019, not currently in force.

Vieira et al., comparing the data pre and post-fortification of two population-based studies of the state of São Paulo (ISA-Capital 2003, pre-fortification; and ISA-Capital 2008, post-fortification), observed that, after fortification, the average intake of iron increased in all age ranges, and the prevalence of inadequacy of nutrient intake decreased 99% in men and more than 63% in women. The authors emphasize that, even with the incorporation of bread and biscuits between the food sources of iron, the prevalence of inadequacy of consumption of mineral remained high among women of childbearing age, which means that they remained as a vulnerable group to anemia, which, in turn, brings the risk of deleterious complications in pregnancy.

Assunção et al. found similar results in their study, in which, despite the high prevalence of adequacy of iron intake (88.5%), the bioavailability of iron ingested was low (around 5%) in a population of children aged less than six years in the urban area of the city of Pelotas, Rio Grande do Sul, evaluated in the post-fortification period (2008). In this study, in addition to the iron intake, they also assessed the prevalence of anemia in three post-fortification studies (2005, 2006 and 2008) compared to the pre-fortification period (2004). The four studies presented a high prevalence of anemia. Furthermore, the prevalence of anemia increased over time, especially for children aged under 24 months.

A post-fortification study conducted by Santos et al. with individuals aged over 10 years participating in the Household Budget Survey (HBS) 2008-2009 - Brazilian national scale survey showed that the average iron intake and absorption from the fortification is low, regardless of age and gender, although the total iron intake was adequate.

The other six selected studies were performed in pregnant women treated in BHU by participants of the project entitled “Prospects for the fortification of wheat and maize flours with iron in the control of anemia 2006/2007”. They all had a common methodology of data collection in the medical records of pregnant women at Basic Health Units in two occasions: before June 2004 (pre-fortification) and date of the last menstrual period (LMP) at least 12 months after that date (post-fortification). For each group (pre- and post-fortification), at least 300 records were analyzed. The results obtained in this project, developed in 13 cities showed an increased iron consumption, as expected, and the concomitant increased hemoglobin concentration of 5.3% in the country as a whole and of 8.7, 7.3 and 3.5% among pregnant women of the Northeast, North and South, respectively. In these three regions, the average concentration of Hb also increased.

Silva et al., in Rio de Janeiro, observed that, as pregnancy evolved, the protective factor provided for fortification became clearer and decreased the prevalence of anemia. Souza Filho et al., in Teresina, Piauí, observed a significant increase in hemoglobin concentration among pregnant women belonging to the group after fortification: 11.7 g/dl through 12.4 g/dl. The authors reported in oral presentation the differentiated feeding practice of the population of Teresina, where there is daily consumption of noodles, whose price is low due to local production. The researchers, however, were not able to verify the adherence of pregnant women to iron supplementation.

In the city of São Paulo there were anemia prevalences similar before (9.2%) and after fortification (8.6%). As highlighted by the authors, the low prevalence of anemia did not allow observing the effect of fortification.

A similar result was found in Maringá, where the prevalence of anemia was 12.3% before the fortification and 9.4% after the intervention. Although there was not statistically difference, the mean hemoglobin level was higher in the group after, also showing an association between anemia and social determinants: occupation, marital status and obstetric history.

In Cuiabá, there was no difference between the prevalence of anemia before (22.2%) and after (27.8%) the fortification. The prevalence of anemia was associated with obstetric history; maternal malnutrition, higher gestational age and number of previous pregnancies.

Despite its non-inclusion for not complying with the requirements, it is important to highlight the article of the results found in Maringá and Cuiabá, both performed in health units with the Family Health Program, current the Family Health Strategy, which found that the existing social inequality among the municipalities was evident. Pregnant women attended to in Cuiabá-MT showed sociodemographic characteristics significantly more precarious. The prevalence of anemia was significantly higher and smaller mean hemoglobin values in Cuiabá-MT, regardless of gestational age. There was an association of hemoglobin levels with age, marital status, number of previous pregnancies, nutritional status and gestational trimester. This study emphasizes that regional differences in the occurrence of gestational anemia are socially determined, which should be considered in proposals for intervention in collective health.

Although some studies demonstrate adequacy of nutritional status of iron and reduced prevalence of anemia after flour fortification with iron and folic acid in certain people and places, others have demonstrated a failure to achieve these outcomes, especially when considering some risk populations, such as pregnant women, women of childbearing...
age and children aged under 24 months. Various causes have been proposed for the ineffectiveness of the fortification.

One of the hypotheses for failure in the prevention of iron deficiency is the insufficient consumption of wheat and maize flour fortified with iron and folic acid, as observed by Santos et al., although the study of Asuncion et al. shows that the increased prevalence of anemia after fortification cannot be explained by insufficient iron intake from fortified flour. There is still a gap in the scientific literature regarding the consumption of wheat and maize flour fortified with iron and folic acid, being necessary more studies of national scope to verify the consumption of iron from fortified flour.

Another point highlighted by some studies is the use of reduced iron in most fortified flours. The use of reduced iron in fortification is interesting because it does not interfere in the flavor of the food and it presents a low cost. However, this form presents low availability, and may be associated with the failure of fortification in order to prevent iron deficiency.

RCB 150/2017 of the ANVISA determines the restriction of iron compounds to be used in the fortification of flour to ferrous sulfate and fumarate, which, although they may interfere with the shelf life of the product by interacting with the array of food and interfere with the flavor, are compounds of high bioavailability when compared to reduced iron, and their implementation can contribute to a better effectiveness of the policy of flour fortification.

Another important finding of ANVISA showed that approximately 87% of the samples of maize flour had iron content in an amount smaller than that recommended by the mandatory fortification, which indicates that many food industries may not be following the recommendations of fortification, leading to a lower effectiveness of this policy. The supervision of the food industry and control of fortified products are necessary to ensure the appropriate content of iron proposed.

National Program of Iron Supplementation (NPIS)

As one of the strategies of the National Policy on Food and Nutrition for the combat of iron deficiency in Brazil, the National Program of Iron Supplementation (NPIS) was established by Decree 730 on 13th of May of 2005, and updated by Decree 1,555 of 30th of July of 2013. The goal of the program is to reduce the prevalence of anemia by iron supplementation, as prophylaxis for children aged from six months to two years and pregnant women by the third month postpartum or post-abortion freely distributed in all units of the Unified Health System (UHS) in all Brazilian cities. Table 1 shows the amounts for administration of prophylactic supplementation of ferrous sulfate according to the risk group.

In the literature, there are few studies that analyzed the impact of the National Program of Iron Supplementation in combating anemia. Among those available, five complied with the inclusion criteria of this survey and there is a lack of studies evaluating the NPIS at national level.

The study of Cembranel et al. had as objective to identify possible inadequacies in the treatment of iron-deficiency anemia among children enrolled in the NPIS in Florianópolis-SC. The authors verified the neglect treatment given to the NPIS in the city. Of all 13197 children that should be registered to receive the iron supplement, only 834 were enrolled in the program. Less than half of children that received indication to perform laboratory examination had the hemoglobin value recorded in the medical records, which generates doubts on whether it was performed. Among children whose result indicated the presence of anemia, only 85.3% had a record of the medical recommendation for use of iron supplementation salts for treatment of the disease. Finally, the authors point out the inadequacy of the prescribed dosage of ferrous sulfate, which is the main object of study.

An intervention study performed in the city of Víncosa, Minas Gerais, highlighted the low adherence to the NPIS, in which children aged from 6 six to 18 months, attended to by the Family Health Strategy (FHS). They received prophylactic

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Amount</th>
<th>Periodicity</th>
<th>RENAME</th>
</tr>
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<tbody>
<tr>
<td>Children 6-24 months</td>
<td>1 mg iron kg/weight</td>
<td>Daily up to 2 years of age</td>
<td>Oral Solution 25mg/ml Fe++</td>
</tr>
<tr>
<td>Pregnant Women</td>
<td>40 mg of elemental iron</td>
<td>Daily up to the end of pregnancy</td>
<td>Pill 40mg FE++</td>
</tr>
<tr>
<td>Women in postpartum or post-abortion</td>
<td>40 mg of elemental iron</td>
<td>Daily up to the third postpartum/post-abortion trimester</td>
<td>Pill 40mg FE++</td>
</tr>
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ferrous sulfate syrup supplementation, at a concentration of 25 mg/week during six months. Of the 1030 children aged between 6 and 18 months, 560 were attended to by the FHS. Of the 327 who agreed to participate in the study, 133 who did not have anemia were selected as the intervention group, but, of these, only 69 children (51.9%) completed the study and 18 had low adherence to treatment, i.e., used less than 75% of the sulfate dose prescribed for the period.

A cross-sectional study conducted by Motta et al. showed that, despite the existence of the NPIS for combating anemia, there is a high prevalence of gestational anemia and small children in the city of Santa Marian, from the Rio Grande do Sul state. The study also shows that only 27.8% of BHU/FHS deployed the NPIS, recommending more effective monitoring of the program by the responsible institutions, especially to risk groups, for an increased adherence and consequent reduction in the prevalence of anemia in the country.

Stulbach et al., in an intervention study with children aged from 6 to 24 months from educational centers in the city of Guarujá - São Paulo, observed that, when providing the amount of 25 ml of ferrous sulfate (5 mg of elemental iron) per week for 24 weeks, the prevalence of severe anemia decreased, but there was no significant change in the prevalence of moderate anemia. They also reinforce that the effectiveness of the program depends on political, administrative factors, organization and management of resources, and motivation of health professionals so that they reinforce the importance of preventive supplementation to mothers.

In this context, a qualitative study with dieticians who work in the FHS and consequently in the National Program of Iron Supplementation, in the City of Cabedelo, Paraíba, showed that they have satisfactory knowledge to act in the NPIS, but, due to some differences, they emphasize the lack of training and qualification and also reported that, despite the deployment in 2005, there are still problems with respect to the operation of the program.

These problems about the operationalization and lack of training of professionals who work in the national health services were also reported in a study that evaluated the NPIS in the municipality of São Sebastião do Paraíso, Minas Gerais. Intervention studies related to the NPIS showed that the supplementation was carried out on a weekly basis for children up to 24 months, but, subsequently, given the low adherence, the recommendation of the supplement began to be daily, hindering the comparison to studies with different behaviors. Nevertheless, the few studies carried emphasize the lack of effective results in the control of iron deficiency.

The program of flour fortification as the NPIS aim at increasing the amount of iron intake of the population since the greatest cause of iron deficiency is insufficient consumption and/or improper use of the nutrient. The specificity of the iron to be absorbed has an important role in the utilization of mineral being ingested.

The recommendation of ingestion of ferrous sulfate between meals intends to prevent the inhibitory effect of nutrient utilization especially when considering the milk, the infant’s main food.

In turn, breads, cakes and biscuits, major derivatives of fortified flour are consumed in the meals often without activators of iron absorption. Moreover, the quality of the source of the mineral compound that has been used in the fortification has poor utilization potential. The update of the ANVISA restricting the compounds to be used in the fortification increases the limitation of the use of supplementary iron transported by wheat and maize flours.

Certainly, the use of both fortified products as martial supplements, which, in controlled studies, show high efficacy, will increase the iron content ingested and, thus, possibly increase the opportunity to control the deficiency. Nevertheless, certainly, with so many obstacles, the control of iron deficiency will hardly achieve the population level.

**FINAL CONSIDERATIONS**

Iron-deficiency anemia has a high prevalence in the world and in Brazil, being considered a public health problem. Therefore, the country has implemented some actions to combat iron deficiency and anemia, including mandatory fortification of wheat and maize flours and the national program of iron supplementation. Nonetheless, according to the results presented in this review, these programs are not showing the effectiveness necessary for significantly reducing the prevalence of anemia.

Although controlled clinical studies conducted in Brazil and other countries have demonstrated the effectiveness of consumption of fortified foods on iron deficiency, the literature shows that the Brazilian policy of fortification of wheat and maize flours is not presenting the desired efficacy in the prevention of this outcome. This demonstrates the need for monitoring and evaluation of this program at national level, evaluating, among other factors, the amount of fortified food consumed (if the food consumption is adequate to comply with the population iron needs), the nutritional status of iron in the Brazilian population (including the assessment of biomarkers of the state of this mineral, such as serum iron, total iron-binding capacity and ferritin), as well as the quality and bioavailability of iron from fortified foods.

Regarding the NPIS and the program of flour fortification, existing studies only evaluated the program in regional scope, not allowing its evaluation at national level. Intervention studies used weekly supplementation, not complying with the NPIS, which recommends daily supplementation, which could be one of the factors that are compromising the effectiveness of the program. In addition, administration of ferrous sulfate and adverse effects have been hindering factors mentioned in studies, mainly by mothers and health professionals with respect to supplemented amount, which requires further studies to assess the adequacy and effectiveness of supplementation.

The studies that assessed the NPIS emphasize the need for regular training and qualification of professionals who work in public health services, especially in those that are part of the FHS, since these are responsible for deploying the program. Furthermore, the supervision of the program by federal institutions needs to be deployed to ensure the efficiency of the program.
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