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# Magnitude, time trends and factors associate with anemia in children in the state of Paraíba, Brazil

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## ABSTRACT

**OBJECTIVE:** To estimate the magnitude of the anemia, to analyze the time trends and investigate the factors associated with this disturbance in children in the state of Paraíba, Brazil.

**METHODS:** A cross-sectional survey, of population-based, with 1108 children, aged 6 to 59 months, both sexes in the state of Paraíba. Hemoglobin (Hb) in venous blood was analyzed with an automatic counter. The social-economic and demographic characteristics of children were obtained by questionnaire. Proportions were compared by Pearson's chi-squared test, and the association between hemoglobin concentrations and potential risk factors was tested by regression model Poisson. The time trend of anemia was assessed by the increase/decreased in the prevalence of anemia, using as comparison the prevalence observed in the years 1982, 1992 and 2007.

**RESULTS:** The prevalence of anemia (Hb < 11.0 g/dl) in the state of Paraíba was 36.5% (95%CI 33.7 to 39.3). It was observed that 1.3% (95%CI 0.7 to 1.8) were in severe form (Hb < 7.0 g/dl), 11% (95%CI 9.4 to 13.5) in a moderate form and 87.6% (95%CI 79.1 to 91.2) in the mild form. There was an increase 88.5% in cases of anemia between the years 1982-1992 and stabilization in the prevalence between the years 1992-2007. The analysis adjusted Poisson model showed a greater susceptibility to anemia in children 6 to 24 months of age, those breastfed for six months or more, who co-inhabited with more than four people in the same household and lived in houses with less than five rooms.

**CONCLUSIONS:** The results revealed that anemia remains an important public health problem in the state of Paraíba and despite having been shown an stabilization in the prevalence of anemia between 1992-2007, differently the prevalence observed between 1982-1992, this deficiency presents in high level, witch requires more effective measures of prevention and control.

**DESCRIPTORS:** Child. Anemia, epidemiology. Socioeconomic Factors. Risk Factors. Cross-Sectional Studies.

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## INTRODUCTION

Micronutrient deficiencies affect approximately one third of the world's population, damaging the health of individuals and the development of nations. The most common and widely distributed nutritional deficiency in the world is iron deficiency, the main cause of anemia in childhood. Despite the high prevalence and although its etiology is well known, it is a problem that persists even in developed countries.<sup>14</sup>

Iron deficiency is caused by an imbalance between the amount of iron that is biologically available and its organic need.<sup>20</sup> It can be considered as the final result of a long period of negative iron balance. In the initial phase of iron

deficiency (ID), the reserves in the form of ferritin and hemosiderin are adequate to maintain the iron serum levels at normal values, and only a reduction in the mineral in the organic deposits occurs. In the second phase, a reduction occurs in the plasma iron concentration, together with an increase in the total iron fixation capacity and the consequent decrease in the transferrin saturation percentage, as well as an increase in the concentration of free erythrocyte protoporphyrin, without significant modifications in the hemoglobin levels. In the third and last stage, iron deficiency anemia is produced, which is characterized by a sharp decrease in the concentration of hemoglobin, hematocrit and plasma iron.<sup>7</sup>

This nutritional disorder can cause important harmful effects in the individual. Even in the form of moderate iron deficiency, it has been associated with reduction in the productive capacity, cognitive development disorders and psychomotor development.<sup>5</sup> ID has been generally associated with risk of low birth weight<sup>19</sup> and reduction in the immunologic capacity, leading to greater susceptibility and to the occurrence of infections and high morbidity and mortality.<sup>a</sup> In a more comprehensive way, there are the economic consequences, which are directly related to the costs of the treatment of prevailing cases: approximately 5% of the gross domestic product of developing countries is wasted on health expenses deriving from ID anemia.<sup>21</sup>

It is estimated that more than two billion people in the world are affected by ID. Infants, preschoolers, pregnant women and non-pregnant women of childbearing age are the main risk groups.<sup>b</sup> Studies have shown a correlation between iron nutritional status and a series of determinants, such as: age,<sup>2,12,19,24</sup> gender,<sup>6</sup> maternal age, housing conditions and birth weight,<sup>20</sup> number of co-inhabitants in the household,<sup>14</sup> mother's level of schooling and *per capita* income,<sup>13</sup> father's level of schooling,<sup>18</sup> breastfeeding,<sup>15</sup> among others.

In spite of all knowledge about the etiology and treatment of iron deficiency anemia, its high prevalence and spatial distribution in Brazil are well known. In the last ten years, the magnitude of the deficiency in infants ranged between 51.9% and 65.4%,<sup>2,6,9,18,20</sup> and in preschoolers, it varied between 31.6% and 62.5%.<sup>1,12,19,24</sup> Secular trends in anemia data in the State of São Paulo between 1984 and 1996 show a significant increase in the prevalence of the disease (from 35.6% to 46.5%).<sup>13</sup>

The Northeast region of Brazil, which is potentially vulnerable to nutritional deficiencies, presents high prevalence of anemia.<sup>2,12,20,24</sup> In the State of Paraíba two important population-based epidemiological studies were carried out with preschoolers. The first one was conducted between 1981 and 1982 by Dricot D'Ans et al<sup>c</sup> and revealed a prevalence of 19.3% of anemia; the second, carried out in 1992 by Oliveira et al,<sup>17</sup> revealed a prevalence of 36.4%.

Knowing the evolution of anemia after the implementation of intervention actions – especially the iron supplementation program and the program of wheat flour and corn flour fortification with iron and folic acid – is fundamental to control this nutritional disorder in childhood in the primary care services. Understanding the risk factors of each population enables to take efficient measures to prevent and control anemia.

This paper aimed to estimate the prevalence of anemia in children, its temporal trend, and to identify associated factors.

## METHODS

A cross-sectional, cohort, population-based household survey was carried out between January and April 2007, with children aged six to fifty-nine months, of both sexes, living in the urban area of the State of Paraíba (Northeastern Brazil). The eligible subjects were children with these characteristics who did not present diarrhea, neurological problems or infectious diseases at the moment of the screening.

The sample was calculated by estimating a prevalence (*p*) of anemia of 36%.<sup>20</sup> The basis for sample definition was the equation described in the formula  $N = [E^2 \cdot p \cdot (1-p) \cdot c] / A^2$ , in which *E* is the confidence limit (*E* = 1.96) for a margin of error of 5%; *c* is the cluster sample correction coefficient (*c* = 2.1); and *A*, the accepted precision for the estimated prevalence (*A* = 4.5%). The minimum sample size that was obtained (*N*) was of 919 children. Sample size was corrected by a proportional factor of 1.25 (100/100-80) to correct possible losses and allow for a better disaggregation of the independent variables, resulting in a final sample of 1,149 children.

The children were selected by multistage sampling. The population data of the State's municipalities were

<sup>a</sup> United Nations Children's Fund. Preventing iron deficiency in women and children technical consensus on key issues. New York: International Nutrition Foundation; 1999 [cited 2007 Aug 25]. Available from: [http://www.inffoundation.org/pdf/prevent\\_iron\\_def.pdf](http://www.inffoundation.org/pdf/prevent_iron_def.pdf)

<sup>b</sup> Pan American Health Organization. Gender, health and development in the America 2003. Washington (DC); 2003 [cited 2007 Jul 25]. Available from: <http://www.paho.org/english/ad/ge/GenderBrochure.pdf>

<sup>c</sup> Dricot D'ans C, Dricot JME, Santos LMP, Ascitti LS. Estudo epidemiológico preliminar da desnutrição no Estado da Paraíba [relatório técnico]. João Pessoa; 1985. Apud: Arruda BKG, editor. A política alimentar e nutricional brasileira. In: Anais do 7º Congresso Latinoamericano de Nutrición; 1984; Brasília (DF). Jaboticabal: Fundação de Estudos e Pesquisas em Agronomia Medicina Veterinária e Zootecnia; 1984. p.7-56.

estimated for the year of 2006 according to the data of *Instituto Brasileiro de Geografia e Estatística* (IBGE – Brazilian Institute of Geography and Statistics),<sup>d</sup> and the number of children aged six to 59 months that lived in the urban zone was surveyed (15% of the population), with the respective accumulated populations.

After the calculation of the sample interval, the randomization of the municipalities was performed. The municipalities of João Pessoa and Campina Grande, located respectively in the mid-regions of Zona da Mata and Agreste, were intentionally selected because they are the municipalities that have the largest populations of the State. The municipalities of Patos, Belém do Brejo do Cruz, Boa Ventura, Conceição, Malta, Pedra Branca and São José de Espinharas, located in the mid-region of Sertão, were selected in a random, systematic way.

Then, the census tracts were drawn, followed by the number of households per tract, with maximum limit of 40 units, and finally, the sample unit. It was decided to assess all children residing in the household that met the eligibility criteria.

In the household the interviewer explained about the research and asked for the guardian's authorization for the child to participate in the research through the signature of a consent document. After the participation was authorized, the collection of the child's blood was scheduled at the Primary Family Health Units. After this, a socioeconomic and demographic questionnaire was administered.

The sample of 4 ml of blood was collected by means of the peripheral venipuncture technique. Of this amount, 2 ml were deposited in tubes without anticoagulant (serum obtention) to determine C-reactive protein (CRP) and 2 ml were deposited in tubes with the anticoagulant K<sub>3</sub>EDTA to analyze the hemoglobin concentrations.

The blood and serum samples that were obtained were adequately packaged and transported to the analysis laboratories, maintaining an unbroken cold chain.

The analyzes were performed at the Clinical Analyses Laboratory of *Hospital Universitário Lauro Wanderley, Universidade Federal da Paraíba*, in the city of João Pessoa. The hemoglobin (Hb) concentrations were determined by an automatic counter (Sysmex SF – 3000, Roche Diagnóstica). The children who presented Hb levels below 11.0 g/dL were considered anemic, taking into account the study's age group, according to the World Health Organization (WHO).<sup>e</sup> To define the degrees of anemia, the following categories were considered: mild anemia (Hb  $\geq$  9.0 to  $<$  11.0 g/dL);

moderate anemia (Hb  $\geq$  7.0 to  $<$  9.0 g/dL); and severe anemia (Hb  $<$  7.0 g/dL).

CRP concentrations were analyzed through the latex agglutination technique (SYMSMEX SF-3000, Roche Diagnóstica). CRP concentrations  $\geq$  6 mg/L were considered significant subclinical infection.<sup>22</sup>

A semi-structured questionnaire was used, with variables related to the mother (level of schooling, age), to the child (gender, age, breastfeeding duration, *per capita* income), and to the household (type of house, number of co-inhabitants, number of rooms, garbage collection, type of sewage, water availability).

The database was constructed through the program EpiInfo version 6.04 (WHO/CDC, Atlanta, GE, EUA), in double entry; then, the *validate* module was used to check for possible inconsistencies. The statistical analyzes were performed in the statistical programs SPSS version for Windows 13.0 and Stata version 9.0.

The variables presented normal distribution according to the Kolmogorov-Smirnov test. In the description of the proportions, the binomial distribution was approximated to the normal distribution by the 95% confidence interval. The proportions were compared by Pearson's chi-square test, and the strength of the association among proportions, by the prevalence ratio with the respective confidence interval.

The association between hemoglobin concentrations and potential risk factors was tested by Poisson's regression model.

The temporal trend of anemia was evaluated by the increase/decrease in the prevalence of anemia, and the following formula was employed: [prevalence A x Prevalence B / Prevalence A x 100]. The prevalences observed in the years of 1982,<sup>e</sup> 1992<sup>17</sup> and 2007 were used for the comparison.

The investigation project was approved by the Ethics Committee of *Universidade Estadual da Paraíba* (protocol n° 11280133000-05/2006). The diagnosed cases of anemia were referred to the Primary Care Units for specific treatment.

## RESULTS

Of the total of 1,149 children that should participate in the study, 1,108 were evaluated, due to a 3.6% sample loss that was caused by problems related to the collection, processing and analysis of the biological material. The median of the children's age was 34.5 months ( $P_{25} = 19.0$  and  $P_{75} = 46.0$ ); 90.2% were children of

<sup>d</sup> Instituto Brasileiro de Geografia e Estatística. Censo Demográfico 2000 [cited 2006 Sep 20]. Available from: <http://www.sidra.ibge.gov.br/cd/defaultcd2000.asp?o=11&i=P>

<sup>e</sup> World Health Organization. Iron deficiency anemia assessment, prevention, and control: a guide for programme managers. Geneva; 2001.

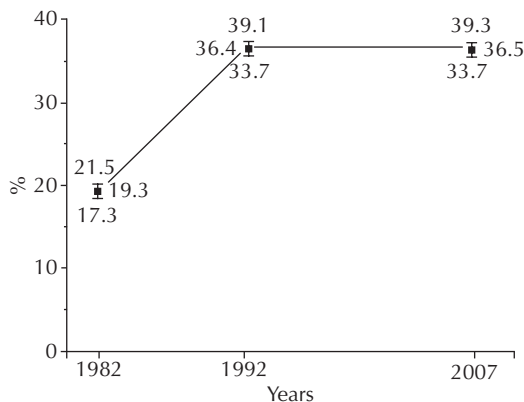
mothers who had four or more years of schooling; 47.1% were children of mothers aged between 20 and 28 years; 80.2% of the children came from families with *per capita* income below 0.5 minimum salary; 86.3% lived in brick houses and 66.2% lived in houses with five or more rooms. The mean hemoglobin concentration was 11.2 g/dL (SD 1.2), with minimum concentration of 6.1 g/dL and maximum concentration of 15.6 g/dL.

The prevalence of anemia (Hb < 11g/dL) was 36.5 % (95%CI 33.7;39.3); 87.6% (95%CI 79.1;91.2) was of the mild form, 11.1% (95%CI 9.4;13.5) moderate and 1.3% (95%CI 0.7;1.8) severe.

There was a sharp increase in the number of cases of anemia (88.5%) in the period between 1982 and 1992, and stabilization in the period from 1992 to 2007, but in a high level (Figure).

In the univariate analysis, the following children presented greater vulnerability to anemia: children aged six to 24 months, children who were breastfed for six months or more, children of mothers younger than 20 years and belonging to families with *per capita* income below 0.5 minimum salary. Concerning housing conditions, the following children were more susceptible to anemia: those who lived in unfinished brick houses, in houses which had more than eight co-inhabitants, less than five rooms and no sewage system (Table 1).

The variables that represented potential confounding factors with association at the level of  $p < 0.20$  in relation to anemia and that participated in Poisson's regression model were: child's age, breastfeeding duration, mother's age, *per capita* income, mother's level of schooling, type of construction of the house, number of co-inhabitants in the household, number of rooms of the house, public garbage collection, sewage system and public water supply. After the analysis of the adjusted model, the following variables remained associated with anemia: child's age, breastfeeding period, number



**Figure.** Temporal trend of anemia in children aged six to 59 months. State of Paraíba, 1982-2007.

**Table 1.** Prevalence of anemia in children aged six to 59 months, according to demographic, biological and socioeconomic characteristics. State of Paraíba, 2007.

Variable	N	Anemia		p <sup>a</sup>
		Yes n %	No n %	
<b>Age (months)</b>				
6 - 12	115	73 63.5	42 36.5	<0.001
12 - 24	249	150 60.2	99 39.8	
24 - 36	219	66 30.1	153 69.9	
36 - 48	265	69 26.0	196 74.0	
≥ 48	260	46 17.7	214 82.3	
<b>Sex</b>				
Male	571	206 36.0	365 64.0	0.933
Female	537	196 36.5	341 63.5	
<b>Duration of breastfeeding (Months)</b>				
< 3	52	14 26.9	38 73.1	0.012
3 - 6	414	135 32.6	279 67.4	
≥ 6	569	231 40.6	338 59.4	
<b>Mother's age (years)</b>				
< 20	101	52 51.5	49 48.5	<0.001
20 - 28	514	198 38.5	316 61.5	
≥ 28 anos	478	145 30.3	333 69.7	
<b>Per capita income (Minimum salary)<sup>b</sup></b>				
≤ 0,25	482	203 42.1	279 57.9	0.001
> 0,25 e ≤ 0,50	407	135 43.6	272 56.4	
> 0,50	219	64 29.2	155 70.8	
<b>Mother's level of schooling (years of schooling)</b>				
< 4	103	46 44.7	57 55.3	0.085
≥ 4	949	337 35.5	612 64.5	
<b>Type of construction of the house</b>				
Brick house	955	333 34.9	622 65.1	0.016
Unfinished brick house	152	69 45.4	83 54.6	
<b>Number of co-inhabitants in the household</b>				
1-4	471	147 31.2	324 68.8	0.001
5-8	486	183 37.7	303 62.3	
> 8	151	72 47.7	79 52.3	
<b>Number of rooms in the house</b>				
1-4	374	160 42.8	214 57.2	0.002
≥ 5	731	241 33.0	490 67.0	
<b>Public garbage collection</b>				
Yes	1052	375 35.6	677 64.4	0.109
No	55	26 47.3	29 52.7	

Continue

**Table 1.** continuation

Variável	N	Anemia				p <sup>a</sup>
		Yes		No		
		n	%	n	%	
Sewage system						
Yes	721	225	32.4	466	67.4	0.001
No	417	177	42.4	240	57.6	
Public water supply						
Yes	961	341	35.5	620	64.5	0.187
No	147	61	41.5	86	58.5	
Subclinical infection (CRP ≥ 6 mg/L)						
Yes	125	55	44.0	70	56.0	0.071
No	983	347	35.3	636	64.7	

<sup>a</sup> Chi-square test<sup>b</sup> R\$ 350.00

CRP: C-Reactive Protein

**Table 2.** Poisson's regression model adjusted for prevalence of anemia in children aged six to 59 months. State of Paraíba, 2007.

Variable	RP	95%CI	p-value
Child's age (months)			
6 † 12	3.84	2.79;5.29	0.000
12 † 24	3.56	2.62;4.83	0.000
24 † 36	1.89	1.34;2.67	0.000
36 † 48	1.58	1.11;2.25	0.012
≥ 48	1	-	-
Duration of breastfeeding (months)			
< 3	0.74	0.48;1.13	0.165
3 † 6	0.81	0.69;0.95	0.011
≥ 6	1	-	-
Number of co-inhabitants in the household			
1-4	1	-	-
5-8	1.28	1.09;1.51	0,003
> 8	1.55	1.28;1.89	0.000
Number of rooms in the house			
1-4	1.29	1.11;1.49	0,001
≥ 5	1	-	-

of co-inhabitants in the house and number of rooms in the house (Table 2).

## DISCUSSION

The results found in the present study indicate that iron deficiency anemia is a nutritional deficiency of great magnitude which continues to represent a public health problem of the moderate type (10% to 40%) in the State of Paraíba. The prevalence of anemia observed in the State of Paraíba (36.5%) was similar to the prevalences described in studies conducted in States of the Northeast region of Brazil.<sup>10,16</sup>

Analyzing the temporal trend of anemia in the studied ecological context, the stabilization in the prevalence of anemia in the period from 1992 to 2007 shows a trend profile that is significantly different from that of the period between 1982 and 1992, when there was a sharp increase in the problem, which has also been reported by Oliveira et al.<sup>17</sup> This trend was somewhat unexpected, as its prevalence was expected to decrease, in consonance with what has been observed in temporal trend studies of other nutritional deficiencies, like protein-energy malnutrition. A possible explanation for this unexpected behavior would be the fact that, although sufficiently adequate in quantitative and energetic terms, these children's nutrition is deficient in iron, mainly that of high bioavailability, to meet their physiological needs. This high prevalence, although the mild form of anemia prevails, suggests that the measures to combat iron deficiency and anemia in children, like food fortification, oral iron supplementation and promotion of nutritional education, recommended by the WHO,<sup>c</sup> need to be implemented, monitored, and evaluated, so that the real impact of this interventions on the combat of nutritional anemia can be known.

The genesis of anemia seems to be associated with conjunctural and structural elements. Although iron deficiency is characteristically an organic problem, its occurrence is not reduced to this dimension, that is, to the processes generated by deficiencies in the consumption and absorption of foods and/or spoliation of this mineral. In order to know the totality of the causes of this disorder, it is necessary to consider the reality outside the human organism, like specific social processes which also determine iron deficiency.

The greater susceptibility to anemia in children younger than 24 months strengthens the hypothesis that the disease is significantly more prevalent among younger children, which has been ratified by other studies.<sup>3,9,10,19,24</sup> This greater vulnerability might be attributed, mainly, to the accelerated growth and consequent increase in the iron needs in the first years of life.<sup>9</sup> After the sixth month of age, with the end of the iron reserves that were acquired in the uterus, nutrition becomes fundamental to supply the mineral. Therefore, children younger than two years constitute a group of higher risk for anemia, as they present factors such as: early abandonment of exclusive breastfeeding, inadequate transition diet, as well as greater exposure to the contagion of infectious and parasitic diseases, due to greater contact with the external environment.

The greater vulnerability to anemia in the children who were breastfed during a larger period might be explained by the short duration of exclusive breastfeeding and the complementation with an iron-deficient nutrition. This process occurs simultaneously with the organism's greater requirement of an increased consumption of



this mineral for an adequate erythropoiesis, due to the accelerated growth. Low iron reserves at birth can also represent an important factor in the triggering of anemia, since iron storage during intrauterine life and exclusive breastfeeding meet the needs of the infant in the first six months of life.<sup>15</sup> In this sense, it should be emphasized that the duration of exclusive breastfeeding in Paraíba has been of only 22.4% of children younger than four months of age and 16.6% of children younger than six months,<sup>23</sup> a prevalence that is well below what is recommended by the WHO.<sup>f</sup> Kitoko et al,<sup>8</sup> in a study carried out in the municipality of João Pessoa, found a prevalence of exclusive breastfeeding of 23.9% in children younger than four months, and revealed that only 24.8% of children aged six to nine months received what the WHO<sup>g</sup> considers to be timely complementary feeding. Furthermore, of this total, 40.5% did not include in the diet beans and meat, two important sources of iron.

Studies have verified the beneficial effect of exclusive breastfeeding in the first six months of life, as it increases the hemoglobin levels.<sup>11,15,16</sup> In addition, the association of breastfeeding with the use of cow's milk has caused a decline in children's hemoglobin levels due to occurrences of intestinal microhemorrhages.<sup>11,15,16</sup> As a preventive measure, combined with other interventions, it is necessary to implement actions to promote exclusive breastfeeding up to the sixth month of life and nutritional guidance about adequate complementation to breast milk up to two years, aiming to reduce the consumption of cow's milk and to stimulate the ingestion of foods with high density of heme iron.<sup>16</sup>

The greater risk of anemia in children with unfavorable housing conditions (number of co-inhabitants and number of rooms in the house) might be explained by the reduction in these families' economic accessibility, which leads to a *per capita* reduction in foods and to the consequent reduction in iron intake.<sup>10</sup> The fact that anemia is more prevalent in households with lower number of rooms might be associated with factors that contribute to a greater dissemination of infectious diseases and intestinal parasitosis.<sup>13</sup> This is a consequence of confinement and overpopulation, which, in turn, contribute to the increase in insalubrity. It is known that this process of iron spoliation occurs due to the microhemorrhages that are caused by the parasitosis,

and by the reduction in iron absorption and the decrease in hemoglobin production as a result of infections.<sup>9</sup>

The non-association of anemia in the adjusted model with other variables that translate the socioeconomic status might be explained by the fact that it was represented in the adjusted model by other proxy variables, like housing condition. However, the distribution of anemia in the majority of the studied geographical spaces shows that iron deficiency exceeds the socioeconomic limits, since it occurs in countries that are considered developed. Many studies<sup>3,13</sup> have shown that, the larger the child's family income, the more he/she is protected from anemia, due to the influence in the very quality of nutrition. To these authors, although individuals from any stratum are not immune to anemia, families of lower socioeconomic level are subject to a higher risk of developing the disease, and its prevalence tends to be lower in the strata of better socioeconomic level. The relevance of income level in the determination of anemia seems to derive from its effect on the quantity and quality of food, on the consumption of foods that are sources of heme iron, on the access to healthcare services and on the quality of housing and sanitation.<sup>4</sup>

Although the variable maternal age lost its strength of association in the regression analysis, children whose mothers were younger than 20 years were more susceptible to anemia. Similar findings from other studies<sup>10,13,20</sup> lead us to suppose that these mothers' lack of maturity and knowledge influence the inadequate choice of complementary foods. Furthermore, adolescent mothers have higher probability of having preterm children, with low birth weight and, consequently, lower hemoglobin reserves.<sup>6</sup>

The results that were found in this study reiterate that anemia in the State of Paraíba continues to be an important public health problem and that little advance has been obtained regarding the reduction in this nutritional disorder, probably due to the fact that this deficiency is the final result of a series of biological, social, economic and cultural factors in which the child is included. As a measure to prevent and control this nutritional deficiency, it is necessary that the public health polices implement effective and urgent actions, mainly in the risk population; otherwise, irreversible damages may affect the population.

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