Factors associated with anemia in Brazilian children living in a socially vulnerable area of northeast Brazil

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Abstract: Anemia is the main endemic deficiency affecting 273.2 million children worldwide; it has negative impacts on their physical-cognitive development and leads to other morbidities. Aim: To determine the prevalence and factors associated with anemia in 6-59-month-old children . Materials and methods: Cross-sectional study with 333 children 6-59-month-old living in a socially vulnerable area of Maceió County, Nortnortheast Brazil. Anemia was defined as hemoglobin concentration <11.0 g/dL. A study about the association between anemia and the factors of the anemia determination multivariate model was conducted. Descriptive (mean ± standard deviation) and bivariate (Pearson's $\chi 2$ test) analyses were used to assess categorical variables, whereas the Poisson regression analysis was used to assess the multivariate model. The results were presented as prevalence ratios at 95% IC. Anemia showed 44.9% prevalence. Ten out of the 33 variables in the model presented p <0.20 and were selected to the multiple logistic regression analysis. In the end, the up-to-date vaccination kept the protective effect against anemia, after adjustment (p = 0.002), thus evidencing the importance of taking prophylactic actions transversal to primary care programs aimed at preventing and controlling anemia. Conclusions: The high prevalence of anemia among children points out to the need of assessing and monitoring the issue in order to support the planning of effective and group-contextualized actions, as well as to consolidate the primary care model applied by the Brazilian Unified Health System.

Keywords: **anemia, preschool, child, risk factors, cross-sectional studies**

I. INTRODUCTION

Anemia is the main endemic deficiency affecting 273.2 million children worldwide; it has strong negative impacts on their physical-cognitive development and increases the frequency of other morbidities.(1,2) Despite the implementation of intervention measures, the control of anemia did not show considerable progress in recent decades.(3)

According to the National Demography and Health Survey conducted in Brazil, in 2006, 20.9% of the children younger than 5 years old had anemia. (4) The survey also highlighted that the Brazilian Northeastern region showed the highest prevalence of anemia (25.5%), although this health issue has been widely assessed and showed prevalence higher than 40% in the last decade. Consequently, it was classified as a serious public health issue in studies conducted in all Brazilian regions, besides being often associated with children younger than 24 months old, with vulnerable environmental conditions, with households inhabited by more than 4 people or with the lack of treated water or sanitation. (5-12)

Monitoring anemia and identifying its determinant and conditioning factors, mainly in first development-stage children considered as risk groups, are among the global-indicator targets of the Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition set by the World Health Organization (13); as well as among the principles and general guidelines of the National Primary Care Policy; the goals of the National Health Promotion Policy; and the guidelines of the Brazilian National Food and Nutrition Policy.(14-16) Studies able to explain the magnitude of anemia in children may contribute to the planning of effective strategies aiming at controlling impact of it. Thus, the aim of the current study was to determine the prevalence of and the factors associated with anemia in 6-59-month-old children living in Maceió County, Alagoas State.

II. METHODS

The herein presented cross-sectional study was based on the project entitled "*Projeto Situação Nutricional de Crianças em Creches Públicas e Ações de Alimentação e Nutrição na Atenção Básica: Um Enfoque Intersetorial (SINUCRI)*" (The Nutritional Condition of Children in Public Daycare Centers, and Dietary and Nutrition Actions in Primary Care: An Intersectoral Approach). The aforementioned project was carried out in Maceió County - the capital city of Alagoas State - and the data were collected and analyzed between 2014 and 2016. All children (N = 359) regularly enrolled in municipal public schools belonging to the 7th health district of Maceió County, which is the most socially vulnerable region in the city, were defined as study units. The current experimental design comprised 6-59-month-old children, who represented 92.8% of the original research and totaled 333 individuals. The data collection was carried out in the schools and comprised information about the children's features and dietary aspects, maternal history, health service-related factors, and socioeconomic and environmental aspects. The children's clinical and nutritional conditions were assessed after the data collection stage was finished.

A blood sample was collected through digital puncture in order to be tested for anemia. The hemoglobin concentration was analyzed in the portable Hemocue hemoglobinometer (Hemocue Limited, Sheffield - UK) and children showing hemoglobin values lower than 11 g/dL were considered anemic. The assessment of the children's nutritional condition was based on indices such as weight-for-age, height-for-age and BMI-for-age, according to criteria set by WHO (2006). These indices were expressed as Z score and converted in the Anthro software, version 3.2.2. The association between anemia and nutritional risk, which was defined according to Z scores lower than -1, was herein investigated. Children younger than 2 years old or weighing up to 15 kg were weighed in a baby-weighing scale (5-g graduations). The other children were weighed in a digital platform scale. The anthropometric ruler with

mobile cursor recommended by the Brazilian Society of Pediatrics (graduated every 0.5 cm up to 120 cm) was used to measure the children's height. An anthropometer with 0.1-cm precision scale was used to measure children older than 2 years. The children were featured according to sex, age and birth weight, which was recorded in their health cards and classified according to the criteria set by WHO 1995 ($\geq$3000 g = adequate weight, <3000 g = insufficient or low weight).(19,20)

The association between anemia in preschoolers and infant-feeding factors was investigated based on the recommendations of steps 1 and 3 in the Guide for Children Under Two Years Old,(21) which is a Brazilian food guide based on the recommendations of the Pan American and World Health Organizations. Thus, it was investigated whether children up to six months old fed on breast milk alone. The age when food containing heme (beef, chicken, beef broth, liver and fish) and non-heme iron (beans) was introduced in the complementary food - CF was presented as prevalence and categorized as introduction "at the recommended age" (6-month-old children) or "early or late" introduction (children younger or older than 6 months).

The child morbidity was assessed through the maternal account of previous hospitalization or not, as well as of congenital diseases, and blood and stool tests. Maternal factors were assessed according to the age of the mothers, who were categorized into three age groups, namely: [1] < 20 years old, [2] $\geq$ 20 and < 29 years old, or [3] $\geq$ 30 years old; as well as according to gestation and birth conditions: number of prenatal visits ($\leq$ 5 or $\geq$ 6 visits), delivery type (C-section or natural birth) and pregnancy period (< 37 or $\geq$ 37 weeks).

The primary health care was investigated through the maternal responses (yes or no) about their participation in interventions concerning feeding and nutritional orientations or about providing ferrous sulfate-based supplementation to their children, as well as through the maternal knowledge about the Brazilian policy of articulation between the school and the health network (School Health Program) and about the habit of taking their children to the community health service located in their neighborhood.

The socioeconomic profile was generated from information about the access to social programs (Bolsa Família Program) - yes or no; about the maternal schooling level - collected as study years and categorized as 0 to 4, 5 to 8 or $\geq$ 9 years; and about the per capita income, which was converted from the current Brazilian currency (Real R$) into US dollars (USD) - according to the mean value of 2014, when US $ 1.00 was worth R$ 2.35 - and categorized as tertiles (1st tertile: $\leq$ USD 59.57; 2nd tertile: USD 61.62 - USD 99.57; and 3rd tertile: USD 100.29 - USD 567.37). The environment was featured according to the sanitation and housing conditions (sanitary sewage type - open or closed); to the frequency of garbage collection (number of collections per week categorized as < 3 and $\geq$ 3); to the origin of the water in the household (cistern or public supply); and to the number of siblings in the household (categorized as no siblings, one sibling, or two or more siblings).

The database was built through the double entry of information. Next, inconsistencies were checked using the EpiInfo software version 6.04. Statistical analyses were performed in the SPSS software version 13.0 and in the Stata software version 9.0. The variables were subjected to descriptive analysis; bivariate analyses were performed through the chi-square test in order to study the association between anemia and the herein investigated associated factors, whereas the Yates correction was used in dichotomous variables. P-values < 0.05 were statistically significant, whereas p $\geq$ 0.05 and p < 0.10 tended to statistical significance. The variables presenting p < 0.20 were selected to compose the multivariate model; the Poisson regression analysis was used to estimate the adjusted prevalence ratios (PR) and the 95% confidence intervals (95% CI).

Four (4) determining-factor levels were defined from the adaptation of the hierarchical model of anemia-determining factors by Osório et al.(21) and jointly introduced in the analysis starting from the most distal causal level of anemia in the following order: level 1 = socioeconomic and environmental

factors; level 2 = maternal and health service-related factors; level 3 = biological factors; level 4 = dietary and nutritional factors, and morbidities (Figure 1).

The project was approved by the Institutional Review Board of the Federal University of Alagoas (Research Ethics Committee). Children diagnosed with nutritional disorders were referred to the reference health care units near the education center they were enrolled in to treat their condition.

Figure 1. Hierarchical model of the anemia determination process applied to 6-59-month-old children.
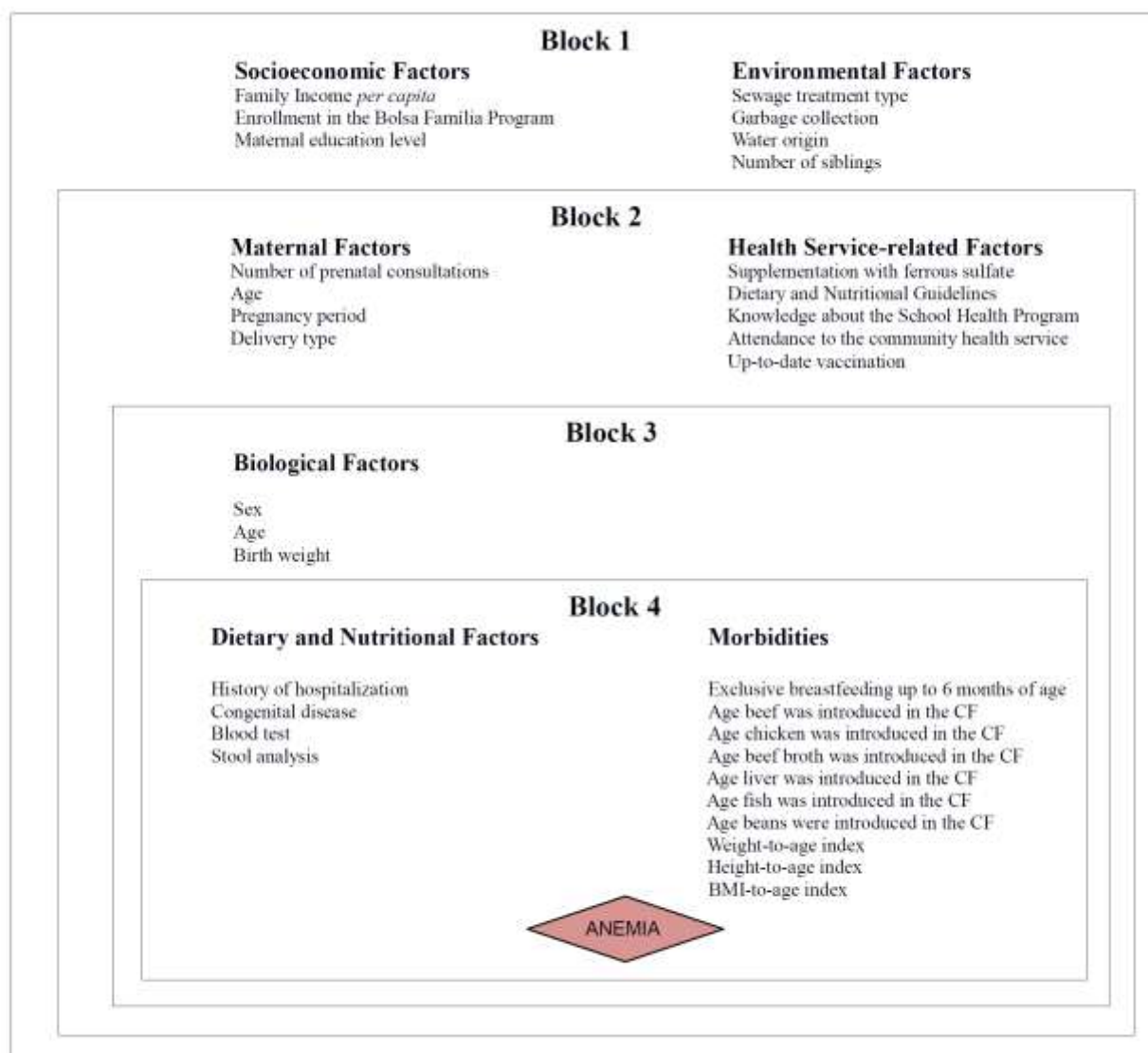
Source: Adapted from Osório (2002).

III. RESULTS

The anemia showed 44.9% prevalence and the mean hemoglobin value was 11.0 g/dL (standard deviation (SD) = 1.39). Sixty percent (60%) of the anemic children had mild anemia; 36.7% had moderate anemia; and 3.3% had severe anemia. The mean age of the children was 43.3 months (SD = 9.1); 50.3% of them were boys. Age and sex were not associated with anemia.

With respect to health service-related factors, it was possible seeing the protective effect from the access to the reference community health service, as well as from the updated immunization schedule on anemia. With respect to dietary factors, the median age beef, chicken, beef broth, beef liver, fish and beans were introduced to the children's diet remained between 8 and 12 months; the highest prevalence was at the age 10 months or older. However, the introduction of iron-rich food, which occurred later than the recommended age, did not show statistically significant association with anemia.

Ten (10) out of the 33 variables composing the 4 hierarchical anemia determination blocks showed p < 0.20 and were included in the multiple logistic regression model: 3 from block 1 - environmental factors (sanitary sewage type, garbage collection and water origin); 3 from block 2 – health service-related factors (maternal knowledge about the School Health Program, attendance to the community health service and up-to-date vaccination); 1 from block 3 (birth weight); and 3 from block 4 – dietary and nutritional factors (age when chicken and beans were introduced in the supplementary feeding - SF) and morbidities (stool analysis).

According to the multivariate model analysis, keeping the vaccination schedule updated (health service-related factor) maintained the protective effect against anemia after the adjustment (p = 0.002); it evidenced the importance of taking prophylactic actions transversal to the primary care programs and actions aimed at preventing and controlling anemia. Children attending the reference community health service, whose birth weight was ≥ 3000 g, showed anemia-association trend, if one takes into consideration the borderline values p = 0.08 and p = 0.06, which represent 92% and 94% anemia-protection probability, respectively.

Table 1. Prevalence Ratio, Adjusted Prevalence Ratio and respective 95% confidence intervals according to variables selected in the multiple logistic regression model used to determine anemia in 333 children (6 to 59 months old) living in a socially vulnerable area. Maceió County, Alagoas State, Brazil, 2014

Blocks/Variables	N[a]	PR$_{crude}$ (95%CI)	PR$_{adjusted}$ (95%CI)	p
Block 1	330			
Environmental factors				
Sewage treatment type				
Open		1,23 (0,97-1,57)	1,22(0,95-1,56)	0,12
Closed		1	1	
Garbage collection (times/week)				
< 3		1,31(0,97-1,76)	1,27(0,93-1,73)	0,13
≥ 3		1	1	
Water origin				
Cistern		1,27 (1,00-1,61)	1,22(0,96-156)	0,10
Public supply		1	1	
Block 2	327			
Health service-related factors				
Knowledge about the School Health Program				
No		1,29 (0,91-1,82)	1,15(0,82-1,61)	0,42
Yes		1	1	
Attendance to the Community Health Service				0,08
No		1,36 (1,04-1,79)	1,29(0,97-1,70)	
Yes		1	1	
Up-to-date vaccination				0,002
No		1,57 (1,20-2,04)	1,52 (1,17-1,99)	
Yes		1	1	
Block 3	308			
Biological factors				
Age (months)				
> 36		0,81 (0,58-1,12)	0,79(0,57-1,09)	0,16
≤ 36		1		
Birth weight (g)				0,06
< 3000		1,23 (0,96-1,58)	1,27(0,99-1,63)	
≥ 3000		1	1	
Block 4	306			
Dietary and nutritional factors				
Introduction of heme iron-rich food in the complementary food				
Chicken				
Early or late introduction		1,28 (0,90-1,84)	1,12(0,74-1,71)	0,57
Introduction at the recommended age		1	1	
Introduction of non-heme iron-rich food in the complementary food				
Beans				
Early or late introduction		1,34 (0,97-1,85)	1,13(0,77-1,66)	0,52
Introduction at the recommended age		1	1	
Morbidities				
Stool analysis				
No		1,20 (0,94-1,52)	1,10(0,86-1,41)	0,42
Yes		1	1	

[a] The differences in the absolute values of the frequencies correspond to losses.
[b] Number of individuals. [c] Prevalence ratio. [d] 95% Confidence Interval

IV. CONCLUSIONS

The reduction of anemia is a vital component in children's health. The prevalence of anemia in Maceió County is a serious public health issue; thus, the implementation of intervention actions, programs and policies must be prioritized.

It is necessary developing strategies to be incorporated to the primary health care system, as well as to the existing programs, in order to cause significant impacts on the control and prevention of anemia. Such strategies should be adapted to the local conditions in each scenario, as well as take into consideration the specific prevalence and etiology of the issue in each context and population.

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