0021-7557/07/83-01/39
Jornal de Pediatria

ORIGINAL ARTICLE

Socioeconomic and dietary risk factors for anemia in children aged 6 to 59 months

Maria A. A. Oliveira,[1] Mônica M. Osório,[2] Maria C. F. Raposo[3]

Abstract

Objective: The objective of this study was to use statistical modeling to identify risk factors for anemia in children aged 6 to 59 months in the state of Pernambuco, covering socioeconomic and dietary aspects.

Methods: The sample comprised 746 children aged between 6 and 59 months from the state of Pernambuco. Their hemoglobin was assayed and a 24-hour dietary recall performed. Risk of anemia was analyzed with relation to socioeconomic variables and to dietary intakes, using multivariate analysis models.

Results: The risk factors for anemia were: a high proportion of calories from cow's milk, low density of nonheme iron, low age and low maternal educational level; age was the most prominent factor, with children under 24 months exhibiting 3.61 times greater risk of being anemic than the older children.

Conclusions: This study confirms the need for a clear picture of the dietary intake of children in Brazil, in order that associations with anemia can be better understood. Our results revealed that the dietary factors which were most responsible for risk of anemia were a greater proportion of calories from cow's milk and lower density of nonheme iron, in addition to age below 24 months and low maternal educational level.

J Pediatr (Rio J). 2007;83(1):39-46: Iron deficiency anemia, epidemiology, risk factors, food intake, child nutrition.

Introduction

Iron deficiency anemia is the result of the interaction of multiple etiological factors which lead to an imbalance between requirements of the organism and the quantity of iron absorbed. The anemia risk factors most often cited in the literature are low family income and low maternal level of education, lack of access to healthcare services, inadequate sanitary conditions and a diet with insufficient quantities of iron.[1-4] among the factors associated with the diet, research has identified low iron intake and low consumption of foods that aid its absorption, deficiencies of other nutrients involved in iron metabolism, such as vitamin A, and the presence of iron absorption inhibitors.[5-7] Among smaller children the determinants of this problem that most stand out are intense growth velocity, low birth weight and early weaning and complementary feeding based on cow's milk with late introduction of heme iron-rich foods (meat).[8]

the results of studies undertaken in metropolitan São Paulo and the state of Paraíba, demonstrate that over the last three decades the prevalence of anemia in children under five years has increased, without any significant deterioration in these populations' socioeconomic indicators.[1,9]

This being so, recent research emphasizes an ever growing need to analyze dietary habits of children, identifying possible indicators or dietary components that could be associated with anemia.[4,10,11] Monteiro et al.[1] found that the density of iron in the diet, was a decisive

1. Doutora, Universidade Federal de Pernambuco (UFPE), Recife, PE, Brasil. Professora adjunta, Departamento de Nutrição, Universidade Federal de Alagoas (UFAL), Maceió, AL, Brasil.
2. Doutora, UFPE, Recife, PE, Brasil. Professora adjunta, Departamento de Nutrição, UFPE, Recife, PE, Brasil.
3. Doutora, UFPE, Recife, PE, Brasil. Professora adjunta, Departamento de Estatística, UFPE, Recife, PE, Brasil.

Manuscript received Jan 05 2006, accepted for publication Nov 01 2006.

Suggested citation: Oliveira MA, Osório MM, Raposo MC. Socioeconomic and dietary risk factors for anemia in children aged 6 to 59 months. J Pediatr (Rio J). 2007;83:39-46.

doi 10.2223/JPED.1579

factor in increasing or reducing the risk of anemia in children from 0 to 59 months in the city of São Paulo. In the same city, Levy-Costa & Monteiro[12] found an association between the proportion of dietary calories supplied by cow's milk and anemia in children from six to 59 months, i.e., as the fraction of the diet accounted for by cow's milk increased, hemoglobin concentration reduced and the risk of anemia increased.

In the city of Goiânia, Hadler et al.[13] also observed that consumption of liquid cow's milk was positively associated with anemia prevalence among children aged 6 to 12 months. Male et al.,[14] studied children from the same age group and demonstrated that the most important dietary risk factor for anemia is premature introduction of cow's milk and that longer periods of feeding on cow's milk had a strong, and consistent, negative effect of hemoglobin concentration.

Bearing in mind the importance of identifying the determinants of childhood anemia, in order to better plan preventative actions, this study was proposed with the objective of identifying the socioeconomic and dietary risk factors for anemia in children from 6 to 59 months of age, in Pernambuco state, Brazil, by means of statistical modeling.

Methods

This study is based on a database that was compiled as part of the II Statewide Health and Nutrition Survey,[15] carried out in Pernambuco, Brazil between February and May in 1997. The random sample was selected in three stages: administrative regions (municipalities), census sectors and homes. In order to allow for comparison with the I Statewide Health and Nutrition Survey,[16] the same 18 municipalities that had been chosen for the first survey by simple randomization were used once more here. Also in common with the previous survey, it was defined in advance that a total of 46 children would be investigated from each census sector chosen. Starting from this definition a simple randomization by lots was employed to choose census sectors, respecting the proportionality of the population of each municipality, resulting in 45 census sectors chosen from the total number of 2,655. Finally, working from maps of the census sectors, the children under 5 years old were chosen by systematic randomization. A total of 2,078 children were studied and a subset of 1/3 of these, 992 children, were selected systematically for the dietary intake survey and hemoglobin assays. Twenty-four of this sample were excluded due to inconsistencies in answers given to dietary recall questionnaires, in addition to 222 infants under 6 months old who had not had blood samples taken for hemoglobin assay. The final study sample therefore comprised 746 children from 6 to 59 months old.

Data collection was performed in interviews during home visits, using a questionnaire covering data on age and sex of the child, family income per capita, maternal education and other information.

Hemoglobin was assayed in blood samples taken by venous puncture, using Hemocue direct reading equipment. The use of venous puncture was justifiable because a battery of other laboratory analyses, unrelated to this study, were also being carried out. Children were defined as anemic if their hemoglobin concentration was below 11 g/dL, in accordance with World Health Organization criteria.[17]

A 24-hour dietary recall questionnaire was used to obtain data on the dietary intake of children under 5. The biological or adoptive mother, or the adult responsible for the child, was interviewed and details recorded on meal times, foods eaten, preparation methods and brand names (for industrialized foods) in addition to the quantities prepared, offered to and consumed by the child, in both traditional measures (cups, spoons etc.) and measures of volume. Foods consumed at all daily meals were included (breakfast, snacks, lunch, dinner and supper), and when quantities were given in traditional measures these were later converted into net weight, thus allowing the data to be analyzed both qualitatively and quantitatively.

A database was compiled containing the dietary intake information using Virtual Nutri software[18] in order to analyze the nutritional composition of foods in terms of macronutrients and micronutrients. Breastmilk intake was estimated from the number of feeds given, scaling volume per feed according the age of child.[18]

Dietary iron density was calculated by summing the total quantity of iron (mg) consumed by the child, dividing this figure by the sum total of calories consumed during the day and multiplying the result by 1,000. For the purposes of this study, total, heme and nonheme dietary iron were expressed in mg of iron per 1,000 kcal in the diet.

Dietary heme iron was represented by the total daily quantity of iron originating from meat, poultry and fish, and nonheme iron was obtained by summing the iron from all other foods.

Daily milk consumption was determined in mL of liquid milk (*in natura*, pasteurized and UHT or commercially sterilized). When powdered milk was being used, the quantities reported (in g) were converted into liquid-milk equivalents (in mL). A dilution constant of 12.93% was adopted for this calculation, obtained from the mean dilution rate fed to a randomly-selected subset of 82 children, equivalent to 20% of those who were fed powdered milk. The proportion of dietary calories provided by milk was obtained by dividing dietary calories sourced from milk (kcal) by total dietary calories (kcal) consumed by the child in 1 day.

Initially a descriptive analysis was made of the variables related to diet: total iron, heme iron, nonheme iron and iron density (total, heme and nonheme) and proportion of cow's milk calories in the diet, by age and sex of the children. The medians of these variables were used as cutoffs in order to categorize them into dichotomous variables. Student's *t* test was used to compare mean hemoglobin concentrations when the variable presented two categories. For variables with more than two categories and which exhibited normal distribution, the ANOVA mean comparison test was used and, when significant differences were detected, the Tukey test was used to identify which categories differed. When variables exhibited an asymmetrical distribution, the Kruskal-Wallis nonparametric test was used. In order to deepen the analysis, risk of anemia was determined using logistic regression, with anemia as the dependent variable (present or absent) and as possible risk factors those variables which had demonstrated significant associations under bivariate analysis: the proportion of calories from cow's milk, iron density (heme and nonheme), age, maternal education and family income per capita. The final model was arrived at by the best choice regression equation procedure, leaving just those variables with statistical significance. As a function of the sample size, it was necessary to transform these variables into dichotomous ones, taking their medians as a basis for categorization, while the measure of their influence on the risk of anemia was expressed as odds ratios (OR). The OR of each variable was first analyzed separately (bivariate analysis) and then the logistic regression model was adjusted for all variables, with only those with $p < 0.05$ remaining in the final model.

This research meets the regulatory standards for research involving human beings, resolution 196/96 of the National Health Council (Conselho National de Saúde), and was approved by the Research Ethics Committee at the Instituto Materno Infantil de Pernambuco. Those children diagnosed as anemic received treatment with 3 mg of elemental iron (in the form of ferrous sulphate) per kg of weight per week for 6 months.

Results

The sample studied here comprised 746 children aged 6 to 49 months from the state of Pernambuco, Brazil. Mean age was around 28 months, and distribution by sex was homogeneous (50.9% male, 49.1% female). The children had a mean hemoglobin concentration of 10,9±1,6 g/dL and an anemia prevalence of 40.6%. Cow's milk consumption was highly predominant, with 88.9% of children consuming the food.

Table 1 shows the mean proportion of calories from cow's milk and the median density of total iron, heme iron and nonheme iron in the dietary intake of children aged 6 to 59 months in the state of Pernambuco, by age group. Note that there were no significant differences between sexes in the proportion of calories from cow's milk or in iron density (total, heme or nonheme). The mean proportion of calories from cow's milk exhibited statistically significant differences between age groups. The last two age categories are similar (≥36 months) and differ from the others (Tukey test $p < 0.05$). Total iron and heme iron densities increased significantly with age.

Table 2 contains the results of anemia risk factor analysis by bivariate analysis and logistic regression. Observe that in the bivariate analysis it was age that had greatest influence on anemia rates, since children less than 24 months old presented a 3.61 times greater risk of being anemic than children aged 24 months or more. The next most influential variable was the proportion of cow's milk calories in the diet, where the risk of anemia was more than doubled among children whose diets contained 27.6% or more of calories from cow's milk. Once the logistic regression model had been adjusted, using the best-fit regression equation procedure, the following variables remained: proportion of cow's milk calories, nonheme iron density, age and maternal education. All of these variables lost a proportion of their explanatory power, however, they remained significant, and age remained the variable with greatest influence over anemia rates.

Once the same procedure had been repeated, by age group, it was observed that the two groups had different models, with the model for children under 24 months containing the variables maternal education and heme iron density, which were maintained because they exhibited levels of significance very close to the preestablished cutoff, while the model for children aged ≥ 24 months retained the proportion of cow's milk calories in the diet and nonheme iron density as variables explanatory of the occurrence of anemia (Table 3).

Discussion

Identification of the risk factors for anemia is essential to enable actions aimed at solving the problem to be planned, especially in those regions where prevalence is elevated, as is the case with the population studied here.[19]

In line with the tendency for anemia prevalence to reduce as the age of children increases, which was observed by Osório et al.[19] in the same population and which is in agreement with other studies,[3,10,20] it is also observed that the proportion of dietary calories that come from cow's milk also reduces as age increases, at the same time as iron

Table 1 - Mean proportion of dietary calories provided by cow's milk and median iron density (total, heme and nonheme) in the diets of children aged 6 to 59 months, by age and sex (Pernambuco, 1997)

	Proportion of cow's milk calories (%)		Total Fe density (mg/1.000 kcal)				Heme Fe density (mg/1.000 kcal)				Non-heme density (mg/1.000 kcal)			
Variables	**Mean (SD)**	**p**	**P25**	**M**	**P75**	**P**	**P25**	**M**	**P75**	**p**	**P25**	**M**	**P75**	**p**
Sex														
Male	29.1 (19.1)	0.93*	3.5	5.3	7.5	0.50*	0	0	1.4	0.71*	2.6	4.2	6.3	0.75*
Female	29.2 (21.8)		3.2	5.0	7.4		0	0	1.1		2.5	4.2	6.2	
Age (months)														
06|—12	44.8† (21.5)	0.000‡	2.2	4.6	7.8	0.00§	0	0	0	0.000§	2.1	4.4	8.0	0.20§
12|—24	33.5† (18.6)		3.0	4.8	7.4		0	0	0.8		2.4	4.1	6.2	
24|—36	27.4† (18.3)		3.4	5.1	7.0		0	0.5	1.7		2.4	3.9	5.8	
36|—48	19.4|| (15.4)		4.3	6.3	8.1		0	0.5	2.2		3.1	4.5	6.2	
≥ 48	15.2|| (14.5)		3.6	5.6	7.4		0	0.8	2.5		2.7	3.4	5.2	
Total			5.2	3.3	7.4		0	0	1.2		2.6	4.3	6.2	

Fe = iron; M = mean; SD = standard deviation.
* *t* test; † Tukey < 0.05; ‡ ANOVA; § Kruskal Wallis (χ^2); || Tukey ≥ 0.05.

density, especially heme iron density, is increasing. These results are compatible with findings published by Levy-Costa & Monteiro,[12] for the city of São Paulo, and reflect the changes that occur to the dietary profile of children as they grow older, gradually developing from an essentially milk-based diet to a more varied diet that is closer to that of the rest of the family.[21,22]

Dietary iron density was very low at all ages, with special attention due to median heme iron which was zero up to 24 months of age, and negligible among the older children, reflecting the low level of consumption of foods rich in the nutrient. In the city of São Paulo, Levy-Costa & Monteiro[12] observed mean heme iron density of 0.6 mg/1,000 kcal among children under 12 months and 1.0 mg/1,000 kcal from 12 to 24 months. Studies undertaken in the Northeast demonstrate that it is only after 2 years that there is a progressive increase in the frequency and mean consumption per capita of foods such as beans, meat and subproducts.[21,22] Although it is not yet entirely clear through what mechanism meat stimulates iron absorption, there is evidence that it acts by reducing the suppressive effect of polyphenols and phytates on nonheme iron absorption and increases the bioavailability of heme iron.[23]

Since anemia is the result of a combination of several factors simultaneously, it was decided that multivariate analysis methods would be employed, raising the explanatory power of the variables. Logistic regression models were developed with the objective of better understanding the relationship between anemia and the explanatory variables.

The logistic regression analysis indicated a 3.14 times greater risk of anemia among children under 24 months. The first months of life are a critical period for growth and development, with weight tripling and body surface area doubling during the first year.[24] Therefore, in order to achieve this intense growth, children in this age group have increased iron requirements, which should be met by their diet. In practice, it is known that these requirements can only be met by the consumption of substantial quantities of animal products, especially meat and offal, or of fortified foods.[8] However, in the group studied here, the children's diets were based on cow's milk, cereals and sugar, lacking iron-rich foods.[22]

Among the socioeconomic variables, low maternal educational level (less than 4 years' schooling) increased the risk of anemia by 1.59 times, with the remaining variables in the model maintained constant. Taking children under 24 months as a subset, this risk increased to 2.21 times, providing evidence for the importance of maternal education, particularly to this age group. It is known that mothers who have spent longer in education are associated with better knowledge of healthcare, improved capacity to employ the family income rationally and better employment and remuneration prospects which in turn make better childcare and nutrition more likely.[1,25]

The fact that per capita family income did not survive to the final logistic regression model does not necessarily mean that it is unimportant, since it may influence other variables, such as the quality of the diet itself.[4] Other studies have detected associations between income and anemia, but, when analyzed simultaneously with other variables, explanatory power is reduced.[4,20] Monteiro et al.[1] found that socioeconomic variables could not be used to explain the tendency for anemia to increase in São Paulo city during the eighties and nineties.

Still on the subject of variables related to diet, only nonheme iron density, and not heme iron density, remained in the final logistic regression model for all children, with an estimated 1.5 times greater risk to those whose nonheme iron density was below 4.14 mg/1,000 kcal; in the model for the under-24 months subset, this risk was 1.78 times. When modeling was by age groups, it is observed that heme iron density begins to attain importance for children under 24 months, with an estimated 1.57 times greater risk of anemia to children whose density is below 0.04 mg/1,000 kcal. Among these children, despite the general level of

Table 2 - Risk of anemia by age, socioeconomic and intake variables in children aged 6-59 months (Pernambuco, 1997)

	Bivariate analysis		Logistic regression	
Variables	**OR**	**95%CI**	**OR**	**95%CI**
Age (months)				
≥ 24	1		1	
< 24	3.61	2.67-4.31	3.14	2.27-4.34
Maternal education (years)				
≥ 4	1		1	
< 4	1.73	1.29-2.32	1.59	1.16-2.17
Family income per capita (MW)				
≥ 0.50	1			
< 0.50	1.71	1.27-2.30		
Proportion of cow's milk calories (%)				
< 27.6	1		1	
≥ 27.6	2.27	1.69-3.04	1.57	1.14-2.16
Heme iron density (mg/1.000 kcal)				
≥ 0.04	1			
< 0.04	2.11	1.58-2.83		
Nonheme iron density (mg/1.000 kcal)				
≥ 4.14	1		1	
< 4.14	1.56	1.17-2.08	1.50	1.10-2.05

95%CI = 95% confidence interval; OR = odds ratio; MW = multiples of the minimum monthly wage.

heme iron-rich food consumption being low, any quantity consumed appears to have a positive influence on iron nutritional status.

The results demonstrate that cow's milk contributes approximately 45% of the total number of calories in the diets of children aged 6 to 12 months, reduced to 33.5% for the 12 to 24 months subset. Indeed, the diets of children aged 6 to 24 months were primarily made up of porridges (milk added to flour and sugar), which produces increased satiety and compromise intake of other foods rich in iron.[22] This situation appears to be common in Northeast Brazilian, where certain regional foods, including meat, offal, fish, fruit and vegetables are not given to children under 2 years, even when other family members eat them.[21,22,26]

Analyzing the entire sample as one, the logistic regression model indicated that the risk of anemia among children whose dietary calories were 27.6% or more from cow's milk was 1.57. When broken down by age, it was observed that proportion of cow's milk calories only remained in the final model for children aged 24 months or more. It could be thought that the explanatory power of the variable would lie in the quantity of cow's milk consumed, in detriment to foods that are richer in iron. In fact, both the proportion of cow's milk calories and iron density (heme and nonheme) were adjusted for in the logistic models, suggesting that there could be some factors intrinsic to cow's milk that could increase the risk of anemia.

Levy-Costa & Monteiro[12] also found evidence that the relative proportion of cow's milk in the diet was significantly associated with increased risk of anemia. The authors found that a mean reduction of 50% in the energy value of the cow's milk fraction of diet, with its substitution by a pool of habitual children's foods, raised the mean heme iron and nonheme iron densities by 25 and 14%, respectively, and increased mean hemoglobin concentration by 0.21 g/dL. In contrast, when consumption of meat was increased 50% and of beans by 100%, hemoglobin concentration increased by just 0.09 g/dL.

Works found in the literature describe the effects of cow's milk or its components (proteins and calcium) on relative iron nutritional status, whether by inhibiting the absorption of iron from other foods,[27,28] or by occult blood loss in feces.[29,30] There is, however, a need for more studies to elucidate these effects.

Table 3 - Risk of anemia, by socioeconomic and intake variables, split by age of child (Pernambuco, 2004)

Variables	OR (adjusted)	95%CI
Age < 24 months		
Heme iron density (mg/1.000 kcal)		
≥ 0.04	1	
< 0.04	1.57	0.99-2.49
Maternal education (years)		
≥ 4	1	
< 4	2.21	1.41-3.46
Age ≥ 24 months		
Proportion of cow's milk calories (%)		
< 27.6	1	
≥ 27.6	1.89	1.20-2.96
Nonheme iron density (mg/1.000 kcal)		
≥ 4.14	1	
< 4.14	1.78	1.14-2.76

95%CI = 95% confidence interval; OR = odds ratio.

It is worth pointing out that other variables related with food consumption that are not considered in this study, primarily with respect to factors that suppress (phytates and polyphenols) and facilitate (vitamin C) absorption of iron from the diet, could be of substantial help in the analysis of the problem.

In general, it can be concluded that, age under 24 months, low maternal educational level, high proportions of calories in the diet from cow's milk and low nonheme iron density were the determinant factors for risk of anemia.

The results of this study emphasize the importance of profiling the dietary intake of the children in Brazil in order that its association with anemia occurrence can be better established and, in this way, provide a foundation for healthcare and nutrition policies that aim to solve the problem. As a preventative measure, in conjunction with other strategies, it is necessary to implement nutritional education actions, aiming to promote exclusive breastfeeding up until 6 months of age and continued breastfeeding until 2 years, to provide guidance on appropriate complementary feeding, reducing cow's milk consumption and encouraging feeding with foods that have greater iron density.

References

1. Monteiro CA, Szarfarc SC, Mondini L. Tendência secular da anemia na infância na cidade de São Paulo, (1984 –1996). Rev Saude Publica. 2000;34(Supl 6):62-72.
2. Lima ACVMS, Lira PIC, Romani SAM, Eickmann SH, Piscoya MD, Lima MC. Fatores determinantes dos níveis de hemoglobina em crianças aos 12 meses de vida na Zona da Mata Meridional de Pernambuco. Rev Bras Saude Matern Infant. 2004;4:35-43.
3. Neuman NA, Tanaka OY, Szarfarc SC, Guimarães PR, Victora CG. Prevalência e fatores de risco para anemia no Sul do Brasil. Rev Saude Publica. 2000;34:56-63.
4. Osório MM, Lira PI, Ashworth A. Factors associated with Hb concentration in children aged 6-59 months in the state of Pernambuco, Brazil. Br J Nutr. 2004;91:307-15.
5. Cozzolino SMF. Biodisponibilidade de minerais. Rev Nutr PUCCAMP. 1997;10:87-98.
6. Semba RD, Bloem MW. The anemia of vitamin A deficiency: epidemiology and pathogenesis. Eur J Clin Nutr. 2002;56:271-81.
7. Hallberg L, Rossander-Hulten L, Brune M, Gleerup A. Bioavailability in man of iron in human milk and cow's milk in relation to their calcium contents. Pediatr Res. 1992;31:524-7.
8. World Health Organization. Complementary feeding of young children in developing countries: a review of current scientific knowledge. Geneva: WHO; 1998.
9. Oliveira RS, Diniz AS, Benigna MJ, Miranda-Silva SM, Lola MM, Gonçalves MC, et al. Magnitude, distribuição espacial e tendência da anemia em pré-escolares da Paraíba. Rev Saude Publica. 2002;36:26-32.
10. Assis AMO, Gaudenzi EN, Gomes G, Ribeiro RC, Szarfarc SC, Souza SB. Níveis de hemoglobina, aleitamento materno e regime alimentar no primeiro ano de vida. Rev Saude Publica. 2004;38:543-51.
11. Szarfarc SC, Souza SB, Furumoto RAV, Brunken GS, Assis AMO, Gaudenzi EM, et al. Concentração de hemoglobina em crianças do nascimento até um ano de vida. Cad Saude Publica. 2004;20:266-74.
12. Levy-Costa RB, Monteiro CA. Consumo de leite de vaca e anemia na infância no município de São Paulo. Rev Saude Publica. 2004;38:797-803.
13. Hadler MC, Colugnati FA, Sigulem DM. Risks of anemia in infants according to dietary iron density and weight gain rate. Prev Med. 2004;39:713-21.
14. Male C, Persson LA, Freeman V, Guerra A, van't Hof MA, Haschke F, et al. Prevalence of iron deficiency in 12-mo-old infants from 11 European areas and influence of dietary factors on iron status (Euro-Growth study). Acta Paediatr. 2001;90:492-8.
15. Brasil, Ministério da Saúde. II Pesquisa estadual de saúde e nutrição: saúde, nutrição, alimentação e condições sócio-econômicas no Estado de Pernambuco. Recife: INAN; 1998.
16. Brasil, Pernambuco, Governo do Estado. Crianças e adolescentes em Pernambuco: saúde, educação e trabalho. Recife: UNICEF; 1992.
17. World Health Organization. Iron deficiency anaemia assessment, prevention and control: a guide for programme managers. Geneva: WHO; 2001.
18. Philippi ST, Szarfarc FC, Latterza AR. Virtual Nutri. Versão 1.0 para Windows. São Paulo: Universidade de São Paulo; 1996.
19. Osório MM, Lira PI, Batista-Filho M, Ashworth A. Prevalence of anemia in children 6-59 months old in the state of Pernambuco, Brazil. Rev Panam Salud Publica. 2001;10:101-7.
20. Silva LSM, Giugliani ERJ, Aerts DRGC. Prevalência e determinantes de anemia em crianças de Porto Alegre, RS, Brasil. Rev Saude Publica. 2001;35:66-73.
21. Assis AMO, Barreto ML. Condições de vida, saúde e nutrição na infância em Salvador. Salvador: Bureau; 2000.
22. Farias Júnior G, Osório MM. Padrão alimentar de crianças menores de cinco anos. Rev Nutr. 2005;18:793-802.
23. Bianchi MLP, Silva HC, Oliveira JED de. Considerações sobre a biodisponibilidade de ferro dos alimentos. Arch Latinoam Nutr. 1992;42:94-100.
24. Stekel A. Iron requirements in infancy and childhood. In: Stekel A (org). Iron nutrition in infancy and childhood. New York: Raven Press; 1984. p. 1-10.
25. Osório MM. Fatores determinantes da anemia em crianças. J Pediatr (Rio J). 2002;78:269-78.
26. Monte CMG, Sá MLB. Guias alimentares para crianças de 6-23 meses no Nordeste do Brasil: da teoria à prática. Fortaleza: The British Council; 1998.
27. Hurrel RF, Lynch SR, Trinidad TP, Dassenko SA, Cook JD. Iron absorption in humans as influenced by bovine milk proteins. Am J Clin Nutr. 1989;49:546-52.
28. Hallberg L, Rossander-Hultén L, Brune M, Gleerup A. Calcium and iron absorption: mechanism of action and nutritional importance. Eur J Clin Nutr. 1992;46:317-27.

29. Ziegler EE, Jiang T, Romero E, Vinco A, Frantz JA, Nelson SE. Cow's milk and intestinal blood loss in late infancy. J Pediatr. 1999;135:720-6.

30. Jiang T, Jeter JM, Nelson SE, Ziegler EE. Intestinal blood loss during cow milk feeding in older infants: quantitative measurements. Arch Pediatr Adolesc Med. 2000;154:673-8.

Correspondence:
Maria Alice Araújo Oliveira
Rua do Sossego, 461, Casa 5, Farol
CEP 57057-420 – Maceió, AL – Brazil
Tel.: +55 (82) 3338.9817
E-mail: alicemcz@superig.com.br