

Growth and hematological studies on Brazilian children of low socioeconomic level

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SUMMARY. Anemia and undernutrition are common all over the world, especially in less developed countries. The relationship between low weight, short stature and iron deficiency should be better understood so that appropriate measures might be taken to prevent these problems. A total of 115 institutionalized children aged 12 to 72 months were studied in day-care institutions in the town of Pontal, Southeastern Brazil, during the second semester of 1999. Personal data, weight, height and hematological profile were obtained from all subjects. Food intake was evaluated in 20 children by a direct food-weighing method. The prevalence of low weight for age (2.6%), low weight for height (1.7%) and low height for age (4.3%) was considered low. Anemia was observed in 68.7% of the children. Diet was found to be adequate in terms of the major nutrients evaluated, but food iron supply was of low bioavailability. In conclusion, the population studied revealed a peculiar behavior i.e., the coexistence of fairly good anthropometric nutritional status along with iron-deficiency anemia. The prevention of this kind of malnutrition cannot be limited to an adequate calorie/protein supply but should also be based on the correction of the severe iron deficiency present in this low socioeconomic level preschool children in Brazil.

Key words: Anemia, malnutrition, children, alimentation, nutritional status, iron deficiency.

RESUMO. Crescimento e estado nutricional de ferro em crianças brasileiras de baixo nível sócio-econômico. Anemia e Subnutrição são problemas comuns em todo o mundo, especialmente nos países menos desenvolvidos. A relação entre baixo peso e baixa estatura e a deficiência de ferro precisam ser melhor compreendidas para que se possam instituir medidas de combate adequadas. Foram avaliadas 115 crianças institucionalizadas, com idades entre 12 e 72 meses, no segundo semestre de 1999, na cidade de Pontal, Sudeste do Brasil. Obtiveram-se Dados Pessoais, Peso, Estatura e dados Hematológicos. A partir de uma amostra de 20 crianças, foi realizada avaliação da alimentação através do método de Pesagem Direta dos Alimentos. As Prevalências de Baixo Peso para Idade (2,6%), Baixo Peso para Estatura (1,7%) e Baixa Estatura para Idade (4,3%) foram consideradas baixas. Observou-se Anemia em 68,7% das crianças. A alimentação revelou-se em geral adequada para os nutrientes avaliados mas observou-se que o ferro oferecido era de baixa biodisponibilidade. Em conclusão, a população estudada revelou um aspecto bastante peculiar isto é, a coexistência de bom estado nutricional antropométrico e anemia ferropriva. A prevenção desse tipo de subnutrição não pode se limitar ao adequado fornecimento de calorias e proteínas mas deve levar em conta, também, a presença marcante da deficiência de ferro nessa população carente do Brasil.

Palavras chave: Anemia, desnutrição, criança, alimentação, estado nutricional, deficiência de ferro.

INTRODUCTION

Undernutrition and anemia are detected in many developing countries, especially among children of lower socioeconomic condition. Inadequate food intake, parasitic infestations, poor hygiene, low educational level and low acquisitive power are some of the main causes of these high prevalences. The presence and relationship of these factors in different areas and countries is of great importance for a better understanding of the physiopathology, prevalence and prevention of these conditions

Undernutrition of different degrees is still a highly prevalent problem in many countries and regions, especially among children under five years of age. UNICEF (1) data

show that from 1990 to 1998, the prevalence of moderate and severe forms of low weight for age was 40% in underdeveloped countries, 31% in developing countries, 10% in Latin America and the Caribbean, and 30% in the World as a whole. In Brazil, data from Health Authorities (2) showed that in 1996, 5.7% of the children had severe weight deficiency for age. Regional differences are found in our country, with a prevalence of 8.3% in less developed regions and a prevalence of 2 to 4.7% in the more developed South and Southeast areas (2).

Iron deficiency is known to be the most frequent nutritional disorder world over, affecting large number of persons in all countries. More than two billion people are estimated to be affected, with anemia occurring in half of

them (3). In Brazil, the prevalence of anemia has been shown to be high and to be on the rise in some regions. In 1974, 22% of children aged 6 to 60 months living in the City of São Paulo were anemic (4). Monteiro and Szarfac (5) reported that, in 1984-1985, the prevalence of anemia in the State of São Paulo was 35.6% among children aged 6 to 60 months. Torres et al. (6) reported in 1993 a 59.1% prevalence of anemia among children aged 6 to 23 months attending 160 health units in 63 counties of the State of São Paulo.

Simultaneous presence of children undernutrition and anemia has been shown in Brazil and other parts of the world where malnutrition is severe (1, 7, 8). On the other hand, the presence of anemia with normal growth is not so common and requires further investigation in terms of physiopathology and prevention. In Brazil, Dutra-de-Oliveira reported the presence of this situation in a small sample of children attending day-care centers in the State of São Paulo, Southern part of the country (9).

Considering all these factors, the present investigation was carried out on a group of children of low socioeconomic level attending day-care centers in a small town in Southeast Brazil in order to characterize the nutritional status of these children, mainly through anthropometric data, and to relate it to their hematological status. Information on the food offered to the children was also obtained in to discuss its possible relationship to the iron status. The importance of these findings for current complementary nutrition programs for Brazilian children is emphasized.

MATERIAL AND METHODS

The study was carried out at 2 public day-care centers in a small town called Pontal, State of S. Paulo, with a large underprivileged population, including rural workers. According to the 1996 census of the Brazilian Institute of Geography and Statistics, the town has about 26,916 inhabitants, 4,378 of whom are rural workers. A total of 27,177 of the 31,947 hectares of the county area are used for agricultural activities, mainly sugar-cane production (10). The day-care centers studied are the only public ones operating in the town, providing care for most of the children from poorer families, whose parents work outside their homes.

At first 228 children, aged 12 to 72 months, were included in the study and their parents authorized them to participate. Of these, 115 completed the study while the remaining ones were excluded because of febrile diseases, impossibility to perform anthropometry or incomplete laboratory tests. Data were collected from July 1 to December 31, 1999. The study was approved by the local Health Ethics Committee.

Three types of data were collected: clinical nutritional/ anthropometric values, hematological laboratory evaluation and food intake. The nutritional study included clinical and

anthropometric data such as age, sex, weight, and height. The ASP software (11) was used to calculate the z scores for weight for age (W/I), weight for height (W/H) and height for age (H/A). Children with a z score higher than -2 were considered to be eutrophic, and children with a z score lower than -2 were considered to be anthropometrically deficient. The mean (M), standard deviation (SD) and the median (MD) were also calculated for the three indices used. The anthropometric measurements were made by a nurse trained for this task, using research type scales and anthropometers, controlled and calibrated against standard parameters.

The material for the hematology studies was collected in the morning when the children arrived at the day-care center, under fasting conditions. Seven ml of blood was obtained from the cubital vein and divided into two tubes, with and without anticoagulant. The samples were sent to two laboratories of recognized competence, linked to the University, where the following determinations were carried out:

- Hemoglobin, hematocrit and mean corpuscular volume (MCV) using a T-890^R Coulter counter.
- Serum iron and total iron binding capacity (TIBC) using the ferrozine method and the Cobas Mira Plus kit (Roche^R), with calculation of the transferrin saturation index (TSI) as the ratio of serum iron to TIBC.
- Ferritin, by the Enzyme Linked Fluorescent Assay, using the Mimividas kit (Bio-Mérieux^R).
- Transferrin receptor: determined by immunoenzymatic assay using the Spectro-Ferritin kit of Ramco Laboratories^R.
- Test of red blood cell sickling.

The following cut-off points were used to determine anemia and iron-deficiency (12-15): hemoglobin (lower than 11 mg/dl for children younger than 4 years and lower than 11.5 mg/dl for children older than 4 years), MCV (lower than 72 fl for children younger than 4 years and lower than 75 fl for children older than 4 years), TSI (lower than 12%), ferritin (lower than 12 ng/ml), transferrin receptor (higher than 28 nmol/l).

For the diet study, a random sample of their daily food intake was obtained from 20 children, including all meals and using the method of direct individual food weighing (16). The data for individual consumption of each meal was obtained on two different days during the week. The meals were monitored from breakfast to supper, for a total of four meals a day. The ingested foods were weighed on an electronic scale with 0.01 g sensitivity; leftover food and repeated intake were also determined, when present. When parents of the 20 children who had their food intake measured came to the institution to pick up their children, they were

instructed to record any food offered to the children that night and the record was delivered to us on the following day. The total food intake were recorded and analyzed with a computer software (17).

Intake of calories, macro and micro nutrients was calculated and compared to the recommended dietary allowances (18). To guarantee that the results obtained from the food intake survey could be extrapolated to the study population, the 20 children were divided into two groups of 10, which were compared with the parcel of the population of the same age range in terms of 3 variables: z score for weight for age, hemoglobin value and MCV value. Data were analyzed by the Student *t*-test, with the level of significance set at 5% using the estimate of the confidence intervals. The groups were considered to be similar when the population mean was within the confidence interval estimated on the basis of the sample mean for the three variables evaluated (19).

RESULTS AND DISCUSSION

Table 1 summarizes the results obtained for the anthropometric and laboratory studies. It can be seen that the children were distributed over all the age ranges proposed, with a slight predominance of older children. Sex distribution was practically identical. With respect to anthropometry, 8.7% presented deficiency of at least one of the indices studied, the most frequent deficit being height/age (4.3%). The mean and median z scores for weight/age (-0.2 and -0.1) and for weight/height (0 and 0) were always close or equal to 0. The z score for height/age tended to show lower values (-0.2 and -0.3), with a mean and median lower than zero associated with a higher standard deviation (SD -1.2).

When these anthropometric values were compared with data for the United States and the Brazilian population (20), the mean z score for weight/height (-0.2) was above the Brazilian mean (-0.71) and comparable to the mean for white American children (0.11). The mean z score for the height/age index (-0.2) was higher than the Brazilian mean (-1.32) and similar to the American mean (-0.23). These facts, show the anthropometric index for the population studied to be quite satisfactory, a characteristic of the more developed areas of Brazil, especially the Southeast. Anthropometric evaluation of nutritional status yields results similar to those obtained in developed countries, with a low prevalence of anthropometric deficits. Comparing data for the reference population of Brazil, the Southeast Region (21), with NCHS (22), a high agreement is found between the two populations in terms of weight and height with Brazilian medians actually almost always higher than American ones (23).

TABLE 1
Data from the 115 children of the two institutions studied

Variable	Description	Total	%
AGE	12 to 24 months	13	11.3
	25 to 36 months	18	15.7
	37 to 48 months	29	25.2
	49 to 60 months	28	24.3
	61 to 72 months	27	23.5
SEX	Male	58	50.4
	Female	57	49.6
ANEMIA	Hb < 11 (12 - 48 months)	79	68.7
	Hb < 11.5 (> 48 months)		
Iron deficiency anemia	Low Hb and Low MCV and/or Low TSI and/or Low Ferritin and/or High Transferrin receptor	59	51.3
Iron nutritional status	MCV < 72 fl (12 - 47 months)	24	20.9
	< 75 fl (> 48 months)		
	TSI < 12%	48	41.7
	Ferritin < 12 ng/ml	27	23.5
	Transferrin receptor >28 nmol/ml	71	61.7
Nutritional status determined by anthropometry (Z Score of less than -2)	Deficient W/A, W/H or H/A	10	8.7
	Deficient W/A	3	2.6
	Deficient W/H	2	1.7
	Deficient H/A	5	4.3

The hematologic data showed 68.7% of the children to be anemic (low Hb level), with at least one abnormal iron test (MCV, Transferrin Saturation, Ferritin and Transferrin Receptor). These results indicate the presence of Iron-Deficiency Anemia, which was observed in 51.3% of them. In contrast to the model often used to explain iron-deficiency anemia, which points out successive and consecutive depletion of iron stores (evaluated on the basis of ferritin), followed by low iron available for erythropoiesis (evaluated on the basis of MCV, transferrin receptor and TSI) and later on by hemoglobin, the present study showed that among the 68.7% anemic children only 20.9%, 23.5% and 41.7% presented low MCV, ferritin and TSI, respectively. The transferrin receptor proved to be a sensitive method for the detection of iron-deficient children, with an observed 61.7% prevalence of values above the cut-off point, confirming previous experience of our group with this parameter (24). The red blood cell sickling test was negative in 100% of the children.

Table 2 summarizes the analysis of food intake by the 20 children studied. It can be seen that mean calorie intake was about $\frac{3}{4}$ of recommended levels. In addition, the diet was found to contain high protein levels, but low intake of proteins of high biological value. Iron and vitamin A intake was adequate and vitamin C intake was 70.8% of the recommended levels. Fibers were well below recommended levels. No tannins were considered to be present in the diet over the two days studied.

TABLE 2
Dietary nutrient intake of the 20 children and their adequacy in relation to the RDA

Nutrient	Pontal	RDA	% Adequacy
Energy (Kcal)	995.7	1300	76.6%
Proteins (g)	39.8	20	199%
Protein of high biological value (%)	36.5	50	70%
Iron (mg)	9.8	10	98%
Vitamin C (mg)	30.1	42.5	70.8%
Vitamin A (IU)	1168	911	128%
Fibers (g)	1.3	9.9	13%

It is of interest to point out that the sample used for the study of food intake was found to be similar to that of the population from which it was derived in terms of the three variables studied, with the mean z scores for weight/age, hemoglobin and MCV for the 115 children studied being

within the 95% confidence interval for the sample mean. Thus, it was concluded that the evaluation performed on the sample of 20 children could be considered representative of the food intake of the study group as a whole (Table 3).

The evaluation of diet considering RDA and correcting for the Brazilian mean weight in relation to calorie intake, the nutrient intake of the study population is around 75% of its requirements, an amount that could represent a sufficient energy supply to promote adequate growth for most of the children. Protein intake was practically double that proposed by the RDA, rich in plant protein sources, especially rice and beans, and combined with small amounts of meat and milk (25). The iron supply covering 98% of the requirements, associated with a reasonable supply of factors which facilitate its absorption, such as vitamin C and a low fiber and tannin sources, could also be considered adequate. In addition, if we consider that the presence of low iron reserves increases iron absorption from 15 to 35% (26), ferritin analysis showed that only 23% of the children (ferritin < 12ng/ml) benefited from this fact. The low intake of meat in the diet may have contributed to the higher prevalence of iron-deficiency anemia in these children in two ways: low iron supply and reduced presence of foods of animal origin. Indeed, results obtained in dietary surveys, even when the latter are carried out according to a rigorous methodology as in our case, cannot always be used as single parameter for the evaluation of nutrition in pediatric populations. On the other hand, they may offer important information on the risk of specific nutritional deficiencies, such as anemia (27).

TABLE 3
Z score for weight for age, hemoglobin values and MCV values obtained for 2 dietary intake samples of the population of the 2 institutions studied

Groups	Mean Z score for weight for age			Mean hemoglobin levels			MCV		
	Sample Mean \pm SD	Confidence interval	Population: Mean \pm SD	Sample Mean \pm SD	Confidence interval	Population: Mean \pm SD	Sample Mean \pm SD	Confidence Interval	Population: Mean \pm SD
12 to 36 months	0.12 \pm 0.7	-0.42 to 0.67	-0.17 \pm 1.05	10.1 \pm 1.7	8.78 to 11.31	10.2 \pm 1.4	70.9 \pm 9.8	63.9 to 77.9	71.3 \pm 7.3
37 to 72 months	-0.26 \pm 1.3	-1.21 to 0.69	-0.22 \pm 1.46	10.7 \pm 1.6	9.55 to 11.80	11.0 \pm 1.0	75.8 \pm 8.2	69.9 to 81.7	78.8 \pm 5.4

Despite efforts of international organizations and the proposals for drastic reduction of iron deficiency anemia in the world by the year 2000 (7), small advances have been made in the development and implementation of strategies that will reach this aim. Indeed, the fight against iron-deficiency anemia should be linked to overall nutritional interventions as well as specific actions, that certainly are

not limited to therapeutical treatment of clinical disease (28).

The present study including clinical, hematological and food intake data shows that the available large food distribution program to preschool and school feeding programs in the State of São Paulo is apparently able to guarantee desirable growth of our low socioeconomic children but the prevalence of iron deficiency is high and

sometimes increasing (4, 5, 6). Our findings show this peculiar situation of the children studied: the group of children has an adequate physical development with a high prevalence of anemia, in spite of a reasonable good diet.

The explanation for the presence of iron deficiency and iron deficiency anemia in regions with a high prevalence of severe undernutrition is certainly linked to an all over deficient diet, including energy, iron and other macro and micro nutrients. This situation is found in the Northeast part of Brazil, the poorest part of our country, where it has been reported a high prevalence of 48.3% energy protein malnutrition along with the presence of 54% of iron deficiency anemia. A similar situation is also found in Southern Asia (51% of iron deficiency anemia and 51% of weight for age deficiency) and in other parts of the world, such as Southeast Asia or Pakistan (1, 7, 8).

The situation found in our children of the Southern part of Brazil, where the socioeconomic situation is the best of our country, is different on the way that the amount of protein energy undernutrition is quite low and anemia is quite high.

These findings are important for the implementation and follow up of nutritional programs to fight children malnutrition. They should be understood not only as cases of growth failure and/or deficits, criteria normally used for the users screening of these feeding programs in Brazil. Other nutrients, and in our cases, the supply of iron is a *si ne qua non* element. Walker (29), in a recent review on this topic stated that supplementation with medications or food fortification are always needed to control iron deficiency, especially in poor countries. An interesting study conducted in England also shows that not even the most rigorous dietary education can prevent iron deficiency in children, it needs extra supplies of iron for this (30). Considering the severe damage to the physical and mental development of children that caused by iron deficiency and iron anemia, children nutrition policies and feeding programs should definitely be revised to include not only energy and protein as has been used in several countries. Iron is sometimes so or more important than protein/energy. This component will allow the children to grow and gain weight, but iron is a key factor for them to develop at their full potential.

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