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The impact of systematic dietary counseling during the first year of life on prevalence rates of anemia and iron deficiency at 12-16 months

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Abstract

Objective: To evaluate the impact that a program based on maternal dietary counseling covering breastfeeding and healthy complementary feeding had on the prevalence of iron deficiency, anemia and iron deficiency anemia in children aged 12 to 16 months.

Methods: Newborn infants were randomized at birth to an intervention or a control group. Mothers in the intervention group received home visits during the children's first year of life on a monthly basis up to 6 months, and at 8, 10 and 12 months. The mothers in the control group received visits for data collection when children reached 6 and 12 months. All children were visited at ages between 12 and 16 months and 24-hour dietary recalls and hemoglobin and ferritin tests were conducted.

Results: There was no evidence that the intervention had an effect on anemia incidence, which was 66.5% in the intervention group and 61.8% in the control group. There was also no evidence of any difference between the groups in the prevalence of iron deficiency anemia or of iron deficiency. However, a higher percentage of children in the intervention group were exclusively breastfed at 4 and 6 months, and breastfed at 6 and 12 months. Intervention group children also consumed more meat and were fed diets with better iron bioavailability and consumed less cow's milk and calcium than children from the control group.

Conclusion: This intervention had no effect on the prevalence of anemia, iron deficiency or iron deficiency anemia.

Clinical trial registry identification number: NCT00629629.

J Pediatr (Rio J). 2012;88(1):33-9: Intervention studies, anemia, public policies, infant nutrition.

Introduction

Anemia is considered one of the largest public health problems in both developing countries and developed countries.[1] In Brazil, the National Demographic and Health Survey (Pesquisa Nacional sobre Demografia e Saúde, PNDS)[2] found that approximately 3 million children had anemia in 2006. A systematic review[3] showed that the median prevalence of anemia among children under 5 years old was 53% and that the highest prevalence rates are observed among children less than 24 months old. The principal cause of anemia among children less than 2 years old is iron deficiency (ID).[1,4-5]

ID causes delays in central nervous system development and children aged 6 to 12 months are the most susceptible to these effects, which appear to last into adulthood.[6] In developing countries, 200 million children under 5 years old do not achieve their development potential. It is estimated

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that this delayed development is responsible for more than 20% of the causes of low income among adults, which in turn has implications for the development of the countries they live in.[7] Prevention of anemia is based on three intervention strategies: iron supplementation, fortification of foods and education about food and nutrition.[4]

The recommendations for feeding Brazilian children under 2 are summarized in a publication entitled "Ten Steps for Healthy Feeding of Children Younger Than Two Years" (Dez Passos para Alimentação Saudável de Crianças Menores de Dois Anos). The basic principles are as follows: contribute to increasing the duration of both exclusive and overall breastfeeding; provide an adequate quality of complementary feeding to children under 2; and develop healthy dietary habits.[8] Against this background, the objectives of this study were to evaluate the impact that an intervention based on the dietary guidelines contained in the Ten Steps publication had on the prevalence rates of anemia, of ID and of iron deficiency anemia (IDA) in children aged 12-16 months and to investigate certain feeding practices that are related to anemia.

Methods

This is a randomized field study that recruited children at birth at the Hospital Centenário, which is the only hospital in the city of São Leopoldo, state of Rio Grande do Sul, Brazil. Only children in Brazilian National Health Service (Sistema Único de Saúde, SUS) wards were enrolled. Newborn infants were eligible for the study if they had birth weight ≥ 2,500 g and gestational age ≥ 37 weeks. Mothers were invited to take part in the study between October 2001 and June 2002 and were provided with information on how the study would work, i.e., that there would be differences between a control group and an intervention group. More detail on the methodology is provided in a previous publication.[9] The sample size used in this study had 92% power within a 95% confidence interval (95%CI) to detect a 30% reduction in the occurrence of anemia on the basis of an estimated 60% prevalence of the condition in the control group.

Intervention group

The intervention consisted of providing the mothers with dietary counseling based on the guidance provided in the Ten Steps for Healthy Feeding of Children Younger Than Two Years.[8] Counseling took place during 10 home visits: during the first 10 days after their children's births, monthly up to 6 months and then at 8, 10 and 12 months. The dietary recommendations that the mothers were given prioritized exclusive breastfeeding up to 6 months and introduction of complementary foods at the age of 6 months. Mothers were advised not to give their children bottles or pacifiers. They were encouraged to provide complementary feeding with fruit snacks and meals made from cereals or roots, meat, pulses and greens, vegetables or fruit, with emphasis on leaving enough time between meals to guarantee that the children would eat a sufficient quantity of these foods. Mothers were given a simplified illustrated folder on the Ten Steps and a printed sheet with four recipes providing examples of food groups and meal preparation. They were instructed not to give the infants fried foods, sweets, honey, sugared drinks, porridge or savory snacks. Twelve undergraduate students of nutrition conducted the home visits in pairs. The entire team was trained in the dietary guidelines and in techniques for counseling mothers about the Ten Steps for Healthy Feeding of Children Younger Than Two Years. Each dietary counseling session lasted 30 to 40 minutes.

Control group

Members of the control group were visited at 6 and 12 months for collection of anthropometric, dietary and sociodemographic data and to collect data on the infants' health status. Interviewers informed mothers about the anthropometric results and instructed them to attend the nearest health service if nutritional problems were detected.

Assessment of nutritional iron status

Interviewers who were not involved in the intervention process and who were blind to which group children belonged to conducted home visits at 6 and 12 months in order to collect data on the study variables. A total of 397 children were evaluated at ages of 12-16 months. Their mothers were instructed to take them to the Municipal Clinical Analysis Laboratory for blood tests. A total of 369 blood samples were collected and 369 hemoglobin (Hb) results and 289 serum ferritin (SF) results were obtained. Hb was measured with a Coulter meter and SF was measured using a commercial ELISA kit. The outcome variables investigated were anemia, ID and IDA. Anemia was defined as Hb < 11 g/dL; ID as SF < 15.0 µg/L and IDA as the combination of both Hb < 11 g/dL and SF < 15 µg/L in the same child. Mean cell volume results of < 74 fL[4,10] were defined as microcytosis.

Assessment of feeding habits related to nutritional iron status

The study analyzed the following variables at 6 months of age for both groups: exclusive breastfeeding, defined as breastfeeding as the only food offered to the child, with no infusions or water; breastfeeding, defined as breastmilk as part of the child's feeding, irrespective of whether other foods were also given. A 24-hour dietary recall was used to record each child's dietary intake on the day before the last home visit, providing specific details of portions as reported by the mother or guardian. Commercial products mentioned were researched by brand, because of the high frequency of products fortified with micronutrients. For

breastfed children, an estimated volume of 448 mL/day for 12-month old infants was adopted.[11]

The nutritional content of the children's diets was calculated using UNIFESP's NutWin software and tables of the chemical composition of foods, in addition to information provided by food manufacturers about products not listed in the tables. A total of 343 24-hour dietary recalls were analyzed and 26 were discarded because of the following reasons: seven were not filled out correctly, two related to children who were sick, 13 provided information in the form of non-specific household measures, four of the children's carers did not know the information requested.

The bioavailability of the children's iron intake was assessed using an adapted method that has been described in an earlier publication.[12] The current recommendation is to employ the estimated average requirement (EAR), which, for the age group in question, is 3 mg of iron per day.[13] Nutrient and food intake results are presented as means and standard deviations.

Statistical analysis

The chi-square test was used to verify homogeneity of the sample in terms of distribution of socioeconomic and demographic variables across the intervention and control groups after randomization. The chi-square test was also used to evaluate the differences in the prevalence rates of the primary study outcomes: anemia, ID and IDA. Relative risks and their respective 95%CI were calculated in order to quantify the effect of the intervention on breastfeeding and feeding habits. The sample size changed for different analyses, depending on the availability of data. Student's *t* test and the Mann-Whitney nonparametric test were used for intake variables, Hb and SF and the Kolmogorov-Smirnov test was used to check they were applicable. The cutoff for rejection of the null hypothesis was set at 5% for all tests.

Research ethics

The research protocol was approved by the Ethics Committee at the Universidade Federal do Rio Grande do Sul (UFRGS). At the start of the home visits, each child's guardian was given a free and informed consent form containing information about all of the procedures involved in the research, a guarantee of confidentiality and a statement about the right to refuse to take part in the investigation. The interview was only started if agreement was forthcoming and the informed consent form was signed.

Results

The distributions of the socioeconomic and family variables and the children's sex were similar for the control and intervention groups, confirming that the randomization process conducted at the start of the study had been adequate (Table 1). At the point at which the study outcomes were assessed, mean age was 12.95±1.15 months (range: 11.84 to 16.25 months). As is shown in Table 2, there was no statistically significant difference in anemia between the groups, with a prevalence of 66.5% in the intervention group and prevalence of 61.8% in the control group ($p = 0.21$). The groups were also not different in terms of ID, IDA or microcytosis. Mean Hb concentrations were 10.35±1.09 g/dL and 10.52±1.19 g/dL in the intervention and control groups respectively, with no statistically significant difference. Mean SF also did not differ between groups and was 5.87±7.51 µg/L in the intervention group and 7.29±9.66 µg/L in the control group.

The results related to dietary outcomes are listed in Table 3 and show that the proportion of children who were exclusively breastfed for less than 1 month was statistically higher in the control group and that the children in the intervention group had a 40% greater likelihood of receiving exclusive breastfeeding for 4 months or more. The children in the intervention group were more than twice as likely to be on exclusive breastfeeding at 6 months of age. The proportion of children receiving breastfeeding at 6 and at 12 months was also greater in the intervention group. Cow's milk was introduced earlier in the control group ($p = 0.004$).

The prevalence of supplementation with iron was similar for the two groups, at around 20%. More than 40% of both groups were fed with fortified flour ($p = 0.85$) and approximately 80% of the children had iron intakes that were above their EAR. Notwithstanding, a higher percentage (18.1%) of the intervention group had diets with a high level of iron bioavailability when compared with the control group (9.8%) (Table 3).

Table 4 lists the results for intakes of micronutrients and foods. Mean iron intake was approximately 5 mg/day in both groups. It will be observed that 29.2% of dietary iron in the intervention group was not heme, whereas, in the control group this proportion was 23% ($p < 0.001$). The intervention group had a higher meat intake ($p = 0.02$). According to the dietary recall, cow's milk and calcium intakes were higher in the control group, whereas vitamin C intake, iron intake from fortified foods and intake of beans did not differ between the groups.

Discussion

Previous studies have shown that the intervention described in this article promoted a reduction in the prevalence of caries[14] and respiratory morbidities.[15] However, this study has demonstrated that the intervention was not effective for the prevention of anemia or ID. High prevalence rates of anemia, ID and IDA were observed among the children studied.

Table 1 - Sex of children and maternal and socioeconomic variables in the intervention and control groups

Variables	Intervention		Control		
	n	(%)	n	(%)	p*
Sex of child					
Male	93	(57.1)	130	(55.5)	
Female	70	(42.9)	104	(44.5)	0.42
Maternal educational level					
< 8 years	99	(61.1)	131	(56.0)	
≥ 8 years	63	(38.9)	103	(44.0)	0.18
Maternal age					
≤ 19 years	29	(17.8)	46	(19.7)	
20 to 35 years	116	(71.2)	168	(71.8)	
> 35 years	18	(11.0)	20	(8.5)	0.41
Maternal marital status					
Married	139	(85.3)	193	(83.2)	
Not married	24	(14.7)	39	(16.8)	0.34
Maternal occupation					
Paid	58	(35.8)	76	(33.2)	
Unpaid	104	(64.2)	153	(66.8)	0.33
Family income					
≤ 1 x minimum wage	17	(10.7)	25	(11.1)	
> 1 to 2.9 x minimum wage	101	(63.5)	132	(58.7)	
≥ 3 x minimum wage	41	(25.8)	68	(30.2)	0.52
Paternal educational level					
< 8 years	93	(61.6)	115	(53.1)	
≥ 8 years	58	(38.4)	98	(46.0)	0.09
Paternal occupation					
Paid	130	(88.4)	195	(91.1)	
Unpaid	17	(11.6)	19	(8.9)	0.25
Type of construction (home)					
Wooden	51	(32.3)	84	(36.2)	
Masonry	84	(53.2)	106	(45.7)	
Mixture	23	(14.5)	42	(18.1)	0.33
Waste disposal					
Sewage/septic tank	147	(94.8)	214	(96.0)	
Open air	8	(5.2)	9	(4.0)	0.39

* Chi-square test.

A study conducted in Mexico with low socioeconomic status women and neonates showed that iron reserves are lower at birth if maternal stocks are deficient, which is a reflection of the limited capacity of the fetus to acquire iron and the restriction imposed by gestational ID on building up fetal stocks.[16] A study conducted in Indonesia supported this hypothesis, demonstrating that infants born with normal weight (≥ 2,500 grams), but to anemic mothers (Hb < 12 g/dL) had twice the likelihood of low Hb when compared with normal weight children whose mothers were not anemic.[17] The majority of women eat diets with low iron bioavailability and may begin pregnancy with reduced iron

reserves.[18] A national survey conducted in Brazil[2] showed that the prevalence of anemia among women of fertile age is approximately 20%.

Another factor that could explain the high prevalence rates of anemia and the absence of any impact from the intervention on outcomes related to nutritional iron status is the time between delivery of the child and clamping of the umbilical cord. In Brazil, the cord tends to be clamped early; however, this variable was not analyzed in the present study.[19] There is sufficient evidence to show that later umbilical cord clamping has the effect of reducing the incidence of anemia, ID and IDA in the child at later ages. A systematic review showed that late clamping of the umbilical cord (2-3 minutes) increases Hb concentration by an average of 2.17 g/dL.[20]

It is also interesting to note that, although the intervention group had a higher intake of heme iron, this nutrient still accounted for less than 30% of the total iron intake. Mean iron intake was greater than the EAR, but it is important to take into consideration the fact that this recommendation was based on an 18% absorption level,[13] which does not reflect the true dietary situation of the children investigated.

The intervention led to increased consumption of meat and better quality iron intake. Evidence has been published showing that introducing meat during the first year of life is a protective factor against anemia.[12,21] The effect of reducing cow's milk intake may reduce the risk of anemia, since this has been associated with a reduced incidence of anemia.[12,22] Therefore, this intervention led to an improvement in the dietary profile of the children in the intervention group, but had no impact on the children's nutritional iron status.

Table 2 - Prevalence of anemia, iron deficiency, iron deficiency anemia and microcytosis in intervention and control groups

	Intervention group		Control group		
Variables	**n**	**(%)**	**n**	**(%)**	**p‡**
Anemia*	105	(66.5)	131	(61.8)	0.21
ID	118	(90.1)	143	(90.5)	0.53
IDA	79	(57.2)	91	(51.7)	0.19
Microcytosis†	82	(52.6)	105	(50.0)	0.35

ID = iron deficiency (serum ferritin < 15 µg/L); IDA = iron deficiency anemia.
* Hemoglobin < 11 g/dL.
† Mean cell volume < 74 fL.
‡ Chi-square test.

Table 3 - Simple frequencies and percentages, relative risks and 95% confidence intervals for dietary habits, by intervention or control group

	Intervention		Control				
Variables	**n**	**(%)**	**n**	**%**	**RR**	**95%CI**	**p***
Dietary habits							
Exclusive breastfeeding							
< 1 month	54	(33.3)	111	(48.0)	0.69	(0.54-0.90)	0.004
≥ 4 months	73	(45.1)	66	(28.6)	1.58	(1.21-2.06)	0.001
≥ 6 months	31	(19.1)	19	(8.2)	2.34	(1.37-3.99)	0.001
Breastfeeding							
At 6 months	114	(66.3)	134	(55.6)	1.19	(1.02-1.39)	0.04
At 12 months	86	(52.8)	98	(41.9)	1.26	(1.02-1.55)	0.04
Introduction of cow's milk							
≥ 6 months	83	(50.9)	85	(36.6)	1.28	(1.07-1.53)	0.004
Use of fortified flour	70	(45.2)	95	(44.2)	1.02	(0.84-1.30)	0.85
Iron supplement at 0-6 months	32	(18.2)	20	(19.6)	1.03	(0.81-1.31)	0.77
Iron supplement at 6-12 months	54	(23.0)	29	(21.8)	0.97	(0.81-1.16)	0.77
Dietary iron highly bioavailable	28	(18.1)	21	(9.8)	1.44	(1.09-1.91)	0.06
Iron intake ≥ 3 mg/day (EAR)	129	(83.2)	178	(82.8)	1.01	(0.80-1.27)	0.91

95%CI = 95% confidence interval; EAR = estimated average requirement; RR = relative risk.
* Chi-square test.

Table 4 - Daily intakes of nutrients and foods, by intervention or control group

Variables	Intervention			Control			p
	n	Mean	SD	n	Mean	SD	
Iron (mg)*	155	5.1	2.4	215	5.4	2.7	0.22
Heme iron (mg)†	133	1.5	1.1	160	1.2	1.0	0.003
Non-heme iron (mg) †	155	3.8	1.9	215	4.5	2.5	0.002
Calcium (mg)*	155	658.4	388.1	215	745.5	443.8	0.05
Vitamin C (mg)*	155	45.6	33.1	215	49.9	41.2	0.29
Cow's milk (mL)*	126	501.6	317.3	169	588.1	344.9	0.03
Beans (g)*	73	71.5	41.4	115	68.6	54.8	0.70
Meat (g)*	131	54.3	28.5	159	47.3	23.9	0.024

SD = standard deviation.
* Student's *t* test.
† Mann-Whitney nonparametric test.

In this study, dietary intake was assessed on the basis of just a single 24-hour dietary recall, which may have limited the results. It is recognized that a given individual's dietary intake includes a wide range of variation and so in order to acquire more trustworthy data it is necessary to conduct more than one dietary recall per person. Notwithstanding, this limitation should not have had a significant effect on the results, since mean intakes of two groups were compared meaning that possible sources of bias would have occurred at similar rates in both groups.

Adherence to healthy dietary habits may have been limited by cultural and socioeconomic features of the study population, which is a function of the multiple causes of anemia that are not restricted to the health sector. Interventions involving nutritional guidance for mothers and/or guardians during the first year of infants' lives did not have an effect on reducing anemia or on increasing the quantity of dietary iron when the children reached 18 months of age.[23] Another two studies showed that dietary education led to an increase in mean SF and Hb, but that levels remained below the cutoff points for normality.[24-25]

The high prevalence rates of anemia, ID and IDA observed in both groups of full term normal birth weight infants from families who use the SUS emphasize the magnitude of the problem in the 12-to-16-month age group. The research team did not recommend the use of iron supplements. Use of iron supplements was not a limitation to the results observed in this study, since approximately 20% of the children in both groups were given these products. In many parts of Brazil, complementary feeding does not appear to meet the high iron requirements of children under 2 years old.[12,26-27] It is therefore necessary, in addition to healthy dietary intake, to supplement with iron and/or fortified foods. Current research is revisiting the effectiveness of isolated iron supplementation for children and suggesting the use of multiple micronutrients.[28-30] It is therefore accepted that a given population that is deficient in one nutrient is undoubtedly also deficient in other micronutrients. The PNDS survey in Brazil also found that 17.4% of children from 6 to 59 months had vitamin A deficiency.[2] Fishman et al.[29] have stated that for certain populations prevention and control of nutritional anemia demands the use of supplementation with several micronutrients. Another meta-analysis showed that combined supplementation with vitamins and minerals is better than supplementation with one or two micronutrients in isolation.[30] A recent World Health Organization publication recommends the use of multiple micronutrients for prevention of anemia on a public health scale.[28]

The results of this study show that the intervention resulted in a better dietary intake profile. The children in the intervention group were breastfed for longer, had non-human milk introduced later, consumed significantly greater quantities of heme iron and meat and had diets with better iron bioavailability in relation to the children in the control group. However, the intervention was not sufficient to prevent occurrence of anemia, ID or IDA in children aged 12 to 16 months. Therefore, in our country, prevention of ID in children less than 2 years old from low socioeconomic conditions must involve a variety of strategies, such as iron supplementation during pregnancy, later clamping of the umbilical cord, promotion of exclusive breastfeeding up to 6 months, recommendations for the introduction of good-quality complementary feeding and supplementation with iron and other micronutrients for infants aged 6 to 24 months.

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