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## Anemia in low-income exclusively breastfed infants

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### Abstract

**Objective:** To verify the behavior of hemoglobin levels and anemia prevalence in full term infants, aged 3 to 6 months and on exclusive breastfeeding.

**Methods:** A cross-sectional study of 242 infants aged 3 to 6 months with birth weights of more than 2,500 g, on exclusive breastfeeding and monitored by the Program for the Promotion of Infant Growth and Development, part of the Paraisópolis Einstein Community Program. Hemoglobin was assayed by finger prick between the third and sixth months of life. Anemia was defined as Hb < 10.3 g/dL (Saarinen) or Hb < 10 g/dL (Brault-Dubuc) for infants aged 3 to 5 months and as Hb < 11.0 g/dL (WHO) for infants aged 6 months.

**Results:** Mean hemoglobin concentration was 11.3 and 11.4 g/dL at 3 and 4 months and 11.2 and 11.1 g/dL at 5 and 6 months, respectively. The percentage of anemic infants varied depending on age and the cutoff adopted, being 11.8, 10.2 and 8.3% at 3, 4 and 5 months, respectively, according to the Brault-Dubuc criteria, and 20.6, 14.8 and 10.4% by the Saarinen criteria. Anemia prevalence at 6 months was 37.5%.

**Conclusions:** Anemia prevalence rates observed among infants aged between 3 and 6 months varied from 8.3 to 37.5%, justifying increased attention on the part of pediatricians to the hemoglobin levels of infants who are on exclusive breastfeeding, come from low-income families and present risk factors for iron deficiency.

*J Pediatr (Rio J). 2006;82(4):284-8: Anemia, breastfeeding, iron deficiency.*

### Introduction

During the first 6 months of life, exclusive breastfeeding is the ideal way to feed infants, guaranteeing their nutritional requirements and adequate growth and development and tightening the mother-child bonds. In our country it is all too frequent for children not to be

breastfed, to be weaned early or to have supplementary foods introduced to their diets, particularly before they reach 4 months of age. This situation has consequences for their health, such as challenges by foreign proteins, prejudiced digestion and nutrient assimilation and exposure to infectious agents – all of which are reflected in their growth and development.<sup>1-4</sup>

There is consensus among health professionals that exclusive breastfeeding up to the sixth month of life impedes the installation of iron deficiency and of iron deficiency anemia. Even though breastfeeding prevents iron deficiency anemia in infants, the duration of protection conferred by breastmilk remains controversial.<sup>5-8</sup>

Possibly the greatest difficulty in dealing with this issue is the absence of any standard for the behavior of hemoglobin in children on exclusive breastfeeding during the 6 first months of life.

The objective of this study was to investigate the behavior of hemoglobin and the incidence of anemia in full term infants exclusively breastfed up to the sixth month of life, according to two of the curves that have been published to aid in the identification of that nutritional deficiency.

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## Methods

A study of 242 infants aged 3 to 6 months, born with weights greater than 2,500 g, exclusively breastfed, successively enrolled on the Program for the Promotion of Infant Growth and Development (PPIGD), part of the Paraisópolis Einstein Community Program between January 2003 and March 2004 and assayed for hemoglobin levels at between 3 and 6 months of age. This sample size permits the estimation of prevalence rates of the order of 45% with precision and type I error of 0.10.

The favela of Paraisópolis is the second largest deprived community in the city of São Paulo. Located in the district of Morumbi, surrounded by high luxury apartment blocks and houses, it has an estimated population of 60,000 inhabitants. Within this community, the Hospital Albert Einstein has set up the Paraisópolis Einstein Community Program, which is based around a clinic for the care of children from 0 to 10 years and a center for healthcare and health promotion, where the PPIGD will be carried out.

The PPIGD is a program of educational activities for the mothers of newborn infants and of infants from 0 to 1 year of age, carried out by a multidisciplinary team, as a supplement to the mother and baby care provided by basic healthcare units. The activities are founded on three pillars: breastfeeding encouragement, recovery and strengthening of the mother-baby bond and educational activities on health and nutrition.

The project takes the form of activities in groups of an average of 20 mothers. Each educational meeting lasts 2 hours. During this time activities aimed at the age group of the children are carried out, such as question-answer sessions to clear up doubts, neuromotor development stimulation, auditory assessment, mother-baby bond reinforcement, discussion of the themes and practice of experimental cooking. Each of these activities is run by a certain type of professional, who use a period of time during the educational meetings and who are present or not depending on the requirements of the age group of the infants involved.<sup>9</sup>

At the point of enrollment of each mother a record sheet was filled out, containing socioeconomic details on the family nucleus, data on the pregnancy, delivery and birth of the child. At each return appointment, information was updated and nutritional information recorded. During the first 3 months of life, each infant was seen weekly, from 3 to 6 months they were seen fortnightly and from 6 to 12 months they attended monthly.

Breastfeeding encouragement is one of the primary objectives of the PPIGD, and the entire multidisciplinary team acts in an integrated manner to promote and maintain it and to resolve problems presented by breastfeeding mothers. They have frequent success with relactation, where feasible.

Iron-deficiency anemia screening was performed by blood sample, taken before each infant reached 6 months. Hemoglobin assay was performed on a finger prick blood sample by the colorimetric method using Hemocue portable equipment.<sup>10</sup> Anemia in children aged 3-5 months was doubly defined, first according to the standards published by Saarinen et al.,<sup>11</sup> which defines anemia as a hemoglobin level of less than 10.3 g/dL, and also according to the Brault-Dubuc et al. standard,<sup>12</sup> which sets the cutoff at 10.0 g/dL. Children aged 6 months or more were defined as anemic if their hemoglobin was below 11.0 g/dL, as defined by the World Health Organization (WHO).<sup>13</sup>

The calculation to obtain estimated hemoglobin levels for the ages studied was performed according to the equation proposed by Szarfarc et al.,<sup>14</sup> based on the following assumptions: newborn infants have 75 mg Fe/kg weight, 85% of which is in the form of hemoglobin; their blood volume corresponds to 85 mL/kg weight, and 1 gram of hemoglobin contains 3.4 mg of iron. Therefore:

Estimated Hb =  $(BW \times 75 \times 0.85 \times 100) / (3.4 \times 85 \times CW)$  g/dL, where BW and CW are birth weight and current weight in kilograms.

Data were analyzed using the software programs Epi-Info (Centers for Disease Control and Prevention, Atlanta, GA, USA) and Stata 8.0 (Stata Corporation, College Station, TX, USA). The chi-square test was used to perform statistical analysis of differences in proportions. ANOVA was used for the analysis of differences between means.<sup>15</sup> The level of significance adopted for all analyses was 0.05.

The research project was approved by the Ethics Committee at the Hospital Israelita Albert Einstein, São Paulo, SP, Brazil.

## Results

The results of the socioeconomic characterization are presented in Table 1. Data on family income show that 6.7% of the families had no monthly income whatsoever and that 38.3% have a *per capita* income of less than one half of a monthly minimum wage, i.e. 45.0% of the families studied here live below the poverty line.

Twenty-one point three percent (21.3%) of the mothers interviewed had employment away from home, 25.4% were aged less than 20 years and 48.5% had not completed their elementary education.

Thirty-three point five percent (33.5%) of the infants were born weighing less than 3,000 g. When hemoglobin was assayed, the ages of the 242 infants analyzed were as follows: 34 at 3 months, 88 at 4 months, 48 at 5 months and 72 at 6 months.

Figure 1 represents the behavior of the mean hemoglobin levels for each age together with the standard curve published by Saarinen et al.<sup>11</sup>

**Table 1** - Socioeconomic and biological characteristics of the study population

| Variables                  | Sample | Observed (%)                          |
|----------------------------|--------|---------------------------------------|
| <b>Mother</b>              |        |                                       |
| Per capita income          | 231    | None - 6.7%<br>1/2 MW or less - 38.3% |
| Age                        | 240    | Adolescent - 25.4%                    |
| Education                  | 200    | DNF - 48.55%                          |
| Employment away from home? | 240    | Yes - 21.3%                           |
| Has a partner?             | 240    | Yes - 87.9%                           |
| Number of children         | 240    | 1 - 58.3%                             |
| Wanted pregnancy?          | 237    | No - 46.4%                            |
| Prenatal consultations     | 236    | Six or more - 82.2%                   |
| Maternal anemia            | 196    | No - 100.0%                           |
| <b>Infant</b>              |        |                                       |
| Delivery                   | 238    | Caesarian - 39.0%                     |
| Sex                        | 242    | Males - 53.8%                         |
| Birth weight               | 242    | Underweight* - 33.5%                  |

DNF = did not finish elementary school; MW = minimum wage.

\* Between 2,500 and 2,999 g.

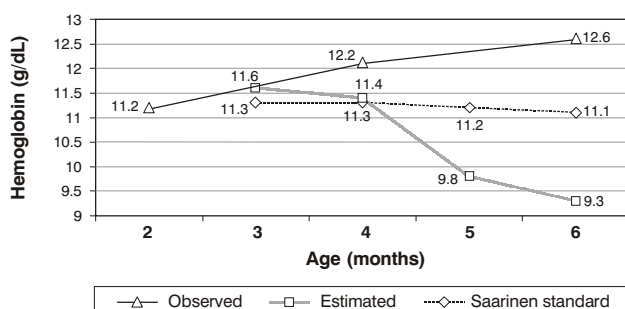
The observed values were lower than those on the Saarinen et al.<sup>11</sup> standard at all ages, with the difference increasing in line with the ages of the infants. In contrast, the observed values were similar to the estimated ones for 3 and 4 months and superior to them at 5 and 6 months.

Anemia prevalence data, by age group and according to the Saarinen et al. and Brault-Dubuc et al.,<sup>11,12</sup> standards, are presented in Table 2. According to the Brault-Dubuc standard, 18.2% of the total sample of infants between 3 and 6 months of age on exclusive breastfeeding were anemic and, according to the Saarinen standard, this figure was 21.5%.

Fifty-five infants in the sample were born underweight (below 3,000 g) and 155 were born weighing more than 3,000 g. The prevalence rates of anemia in these two groups were 16.4 and 13.9%, respectively ( $\chi^2 = 0.15$ , nonsignificant). The relationship between the presence of anemia and the mother's age, split into older and younger than 20 years, was also investigated. Infants born to mothers over 20 years exhibited an anemia prevalence of 14.5% and, while those born to mothers under 20 had a prevalence of 19.0% ( $\chi^2 = 0.72$ , nonsignificant).

## Discussion

Iron deficiency anemia has an elevated prevalence among infants in Brazil; countless consequences of this are described in the literature, such as increased risk of infections, growth restriction and neurocognitive abnormalities. Therefore, prevention and early treatment are essential. It is known that infants who suffer certain events during the prenatal and perinatal phases of life present increased risk for iron deficiency. Low iron reserves at birth can be caused by maternal diabetes mellitus, intrauterine growth restriction and conditions that change the mass of erythrocytes in the concept, such as fetal-maternal hemorrhage, *placenta abruptio*, *placenta previa*, velamentous umbilical cord insertion, fetofetal transfusion and early umbilical cord clamping.<sup>16-19</sup> Some authors

**Figure 1** - Observed and expected mean hemoglobin levels (g/dL), according to age of infant

**Table 2 -** Percentage of children with anemia, by age and according to three different standards

| Age (months)        | Sample | Anemia                |                   |
|---------------------|--------|-----------------------|-------------------|
|                     |        | Brault-Dubuc standard | Saارينen standard |
| 3                   | 34     | 4 (11.8%)             | 7 (20.6%)         |
| 4                   | 88     | 9 (10.2%)             | 13 (14.8%)        |
| 5                   | 48     | 4 ( 8.3%)             | 5 (10.4%)         |
| <b>WHO standard</b> |        |                       |                   |
| 6                   | 72     | 27 (37.5%)            | 27 (37.5%)        |
| Total               | 242    | 44 (18.2%)            | 52 (21.5%)        |

WHO = World Health Organization.

accept that expectant mothers who exhibit low iron reserves (Hb < 8.5 g/dL) may be an important cause of iron deficiency in childhood, although this is controversial.<sup>16</sup>

Accelerated growth during the first months of life can lead to increased iron requirements, which could cause endogenous iron stocks to be used up early and increases the risk of anemia.

In this study, only infants born weighing more than 2,500 g and fed exclusively at their mothers' breasts. These infants' rate of weight gain was very much accentuated in both sexes, from the second month of life onwards, with mean weight above the 50th percentile of the NCHS curves by the sixth month of life, despite having been below this at 2 months of age.<sup>20</sup>

When the behavior of the mean hemoglobin level curve is compared with the standard published by Saarinen et al.,<sup>11</sup> it becomes evident that the mean hemoglobin levels of the children from Paraisópolis, even those born to term and with weights greater than 2,500 g, lagged behind from 4 months (-1.1 g/dL) to 6 months (-1.5 g/dL). A plausible explanation for this observation could be the accelerated weight gain from 2 to 6 months of age.

In contrast, when the observed and estimated hemoglobin levels were compared, it was found that these exclusively breastfed infants exhibited an average that was well above that expected at 5 and 6 months of age, despite their elevated growth velocity, which adds to the evidence for the elevated bioavailability of the iron found in breastmilk.<sup>21</sup>

The comparative analysis of anemia prevalence employed two international standards and found significant differences at 3 months of age, as a result of the cutoff at

2 months, which is 10.0 g/dL, and minor differences at 4 and 5 months. Both standards demonstrated that there is a worrying percentage of infants who present anemia before reaching 6 months of age. Of even greater concern is that, at 6 months, this percentage reaches 37.5%.

The observation of high rates of anemia in our study is comparable with what was observed by Chaves,<sup>22</sup> who reported average hemoglobin concentrations of 10 and 10.4 g/dL, respectively, at 3 and 6 months, in children on exclusive breastfeeding monitored at a lactation reference center for Portuguese speaking countries. These results were also similar to those reported by Vieira,<sup>23</sup> with infants in the same age group, also seen at a lactation referral center, in Belém do Pará, Brazil.

This elevated anemia rate deserves attention. One point that could be questioned is the cutoff points adopted for hemoglobin levels, since there are disagreements in the literature over the value below which a diagnosis of anemia can be established in children under 6 months on breastfeeding, in addition to the fact that the value propose by the WHO<sup>24</sup> to diagnose anemia after 6 does not always prove suitable. For this reason, in our study we used more than one parameter to define anemia in the sample. The choice of more than one criteria allowed us to asses the prevalence of anemia in the respective age groups with greater confidence.

Another possible hypothesis is that some of these children may exhibit risk factors for iron deficiency, such as low family income, birth weight less than 3,000 g and accelerated growth, and that possibly these factors, in isolation or combination, may have contributed to the reduced hemoglobin levels since one third of the infants

were born underweight and 45% of the families were living below the poverty line, added to the fact that the children exhibited weight gain above what was expected.

Hemoglobin assay is the test of choice for population studies and the last manifestation of iron deficiency.<sup>25</sup> The use of other tests to assess iron deficiency could have helped to deepen the diagnosis of this population's iron reserves. Nevertheless, the objective of this study was to raise the issue, without questioning the importance, benefits and efficacy of exclusive breastfeeding for all infants. The Brazilian Society of Pediatrics proposes that iron supplementation be given to children who are exclusively breastfed from 6 months on.<sup>26,27</sup>

Observed prevalence rates of anemia varied from 8.3 to 37.5% between the third and sixth months of life, which is just cause for pediatricians to be more alert to hemoglobin levels in infants under 6 months old, on exclusive breastfeeding and with risk factors for iron-deficiency.<sup>14</sup> It is always worth emphasizing the importance of breastfeeding, which permits accelerated weight gain and has a protective role, impeding even lower hemoglobin levels in these children.

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