

Prevalence of anemia among preschoolers and response to iron supplementation

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Abstract

Objectives: To assess the prevalence of anemia among children attending public preschools in Ilhabela, state of São Paulo, Brazil, and their response to a treatment regimen.

Methods: Between 2007 and 2008, the weight, height, and hemoglobin levels of 667 children were measured in the school setting. Anemic children were prescribed a 12-week course of ferrous sulfate, and follow-up assessment visits were scheduled for halfway through this course and the end of treatment.

Results: The prevalence of anemia was 25.6% (N = 170). The lowest hemoglobin level measured was 9.5 g/dL. Anemia was most prevalent (36%) in children between the ages of 60 and 65 months. Median hemoglobin levels rose to 11.8 g/dL from 10.5 g/dL after treatment; 76% of children recovered from anemia.

Conclusion: Screening for anemia in the school setting and prompt therapy, including mid-treatment follow-up, proved to be an effective strategy for facing this major public health issue.

J Pediatr (Rio J). 2011;87(1):76-79: Anemia, schoolchildren, prevalence, hemoglobin meter.

Introduction

Anemia is defined as any pathological process in which hemoglobin (Hb) levels are abnormally low.¹ The foremost cause of childhood anemia is iron deficiency.² An iron- and micronutrient-poor diet, repeat infections, and chronic blood loss, in turn, are the most common causes of iron deficiency anemia.³

According to the World Health Organization (WHO),² over 2 billion people worldwide live with anemia – one-third of the world population. Several isolated studies conducted in Brazil have detected high prevalence rates, ranging from

30.2% in Pelotas, state of Rio Grande do Sul,⁴ to 36.4% in the state of Paraíba⁵ and 43.6% in the state of São Paulo.⁶ Some of these studies suggest a secular trend toward increasing prevalence rates of anemia in Brazil.^{5,7}

The real prevalence of anemia in the municipality of Ilhabela, state of São Paulo, Brazil, is unknown. This article sought to ascertain the prevalence of anemia among preschoolers attending municipal schools in Ilhabela and assess iron supplementation treatment response rates, using a novel strategy of mid-treatment and end-of-treatment

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assessment of improvement in Hb levels with portable, point-of-care hemoglobin testing.

Methods

The municipality of Ilhabela, on the coast of the state of São Paulo, has a population of 23,886⁸. In 2007, 920 children were enrolled in its municipal preschools. Its Human Development Index is 0.781, and the child mortality rate was 14.83% as of 2006.⁹ The area is served by a municipal hospital with an emergency department, opened in 2002, and seven primary health care units.

This uncontrolled intervention study was carried out between August 2007 and March 2008. The target audience comprised all children enrolled in the municipality's 11 public schools. A series of lectures were held to educate parents on anemia and healthy eating and distribute informed consent forms allowing participation in the study. All measurements (weight, height, Hb) were obtained at the participating schools.

Blood samples were obtained by the fingerstick method: capillary blood was drawn from the tip of the left middle finger and the second drop was collected with a 10- μ l micropipette. Hb measurements were performed immediately with an Agabe[®] (Exa-m, Brazil) portable hemoglobinometer.

This device uses photometric cyanmethemoglobin estimation to determine Hb levels and allows single-step measurement, providing an immediate reading. Cutoff points for diagnosis of anemia were set at circulating Hb values < 11 or < 11.5 mg/dL for children under the ages of 60 months or between the ages of 60 months and 11 years respectively, as recommended by WHO.²

Children with a diagnosis of anemia were referred to local primary health care units. Those with Hb levels < 11 mg/dL were treated by the physician in charge of the study and monitored for 12 weeks. These children attended three appointments, scheduled 6 weeks apart. During the first visit, children were examined and iron supplementation was prescribed (ferrous sulfate, 4 mg/kg/d given in two daily doses). Mebendazole was prescribed when children had not received anthelmintic coverage for more than 6 months, and any nutritional recommendations were reinforced. The second visit was scheduled for the sixth week after treatment was begun. This is an unconventional approach to management of anemia, and allows care providers to reinforce recommendations and measure Hb with the patient's mother present. Children whose Hb levels had not improved at 12-week follow-up were referred for further testing.

Height and weight were assessed with a SECA[®] brand stadiometer and portable digital scales (Filizola, São Paulo, Brazil). All children were weighed and measured by the same trained professional at two different points in time.

The arithmetic means of both measurements were then tallied as the final result.

Nutritional status was assessed on the basis of 2007 WHO growth reference data [body mass index (BMI)-for-age and gender z scores] and classified according to 2008 Brazilian Food and Dietary Surveillance System standards.¹⁰ Age was calculated from the birth date provided on each child's enrollment application. No birth dates were available for 13 children in the sample.

Descriptive statistics were calculated in Microsoft Excel and box-and-whisker diagrams were plotted in Prism. Analysis of variance was performed with the PRIMER statistical software package. The significance level was set at 5% ($p < 0.05$).

The study was approved by the Brazilian National Research Ethics Committee (CONEP) with judgment no. 463/2007.

Results

The final sample comprised 667 children (339 girls and 328 boys; 73% of the total 920 enrolled in municipal preschools) with a mean age of 82 months (range, 50–82 months).

The prevalence of anemia was 25.6%; 170 children were affected, all of whom had either mild ($Hb \geq 10$ g/dL) or moderate ($Hb 7.0$ – 9.9 g/dL)¹¹ anemia. The lowest Hb measurement was 9.5 g/dL.

Children were subdivided into four groups according to BMI-for-age: underweight, adequate weight, overweight, and obesity. Prevalence rates of underweight, overweight, and obesity were 1.1, 13.6, and 6.8% respectively.

For assessment of possible age dependence of Hb levels, children were grouped into six age ranges and means and standard deviations were calculated for Hb measurements (Table 1). Analysis of variance (ANOVA) revealed statistically significant differences among mean Hb values in the various groups, with a trend toward continuous elevation of mean Hb levels with increasing age in all ranges.

The prevalence of anemia in each of these age ranges was calculated according to WHO-recommended criteria. Anemia was most prevalent (36%) among children between the ages of 60 and 65 months (Table 1).

Of the 97 children with Hb levels < 11 g/dL, 91 attended their first appointment, and 84 of these began treatment. Six children were excluded from treatment because the initial diagnosis was changed after their first appointment, and one was excluded due to chronic anemia. Seventy-one children attended their second and third (final) follow-up visits.

The median Hb level of anemic children in the study sample rose from 10.5 g/dL at baseline to 11.5 g/dL at

Table 1 - Mean Hb levels and prevalence of anemia by age range

Age (months)	N*	Hb (g/dL)	SEM	Prevalence (%)
48-53	4	11.50	0.09	0.0
54-59	89	11.62	0.09	20.2
60-65	161	11.72	0.07	36.0
66-71	159	11.90	0.07	27.7
72-77	171	11.99	0.07	23.4
78-83	70	12.00	0.11	24.3

Hb = hemoglobin level; SEM = standard error of the mean.

* Total N = 654 (667 originally; 13 children excluded due to missing age data).

6 weeks and 11.8 g/dL after the full course of treatment (Figure 1).

Of the 84 who received ferrous sulfate, 68 finished treatment with Hb levels above 11 g/dL, and 64 were no longer anemic, for a 76% recovery rate. The 15 who remained anemic despite completing the course of treatment were referred for further testing and clinical attention. Only five children were lost to follow-up.

Discussion

Hb levels were found to rise gradually with age, but the prevalence of anemia peaked between the ages of 60 and 71 months. This may be due to an abrupt change in the diagnostic criteria for anemia at exactly 60 months. After this age, the Hb cutoff point is 11.5, not 11.0 g/dL. In a study of 426 children in Maceió, state of Alagoas,¹² which

used a 12 g/dL cutoff for children older than 60 months (as recommended by WHO until 2001), the prevalence of anemia was determined as 25.4%. Using the new cutoff point of 11.5 g/dL, as in the present study, this rate would drop to 9.9%. Development of a hemoglobin-for-age reference curve, by analogy with those used for assessment of weight, height, and blood pressure in children, may be a more appropriate way of diagnosing anemia with greater accuracy.

The present study used a novel approach to diagnosis and treatment of iron deficiency anemia, which consisted of screening in the school environment and mid-treatment and end-of-study visits in the presence of the child's guardian. This study design, which was devised with the purpose of allowing early detection of anemia and improving treatment adherence, proved effective – it led to high rates of recovery from anemia and successfully increased Hb levels. In a study of 73 preschoolers in Santa Maria, state of Rio Grande do Sul, Farias et al.¹³ found that 59% of those given ferrous sulfate and 33% of those given carbonyl iron still had Hb levels below 11.0 g/dL after 90 days of supplementation. The better outcomes obtained in the present study may have been due to the use of mid-treatment assessment/intervention; this warrants further comparative studies using appropriate methods for determination of a causal relationship.

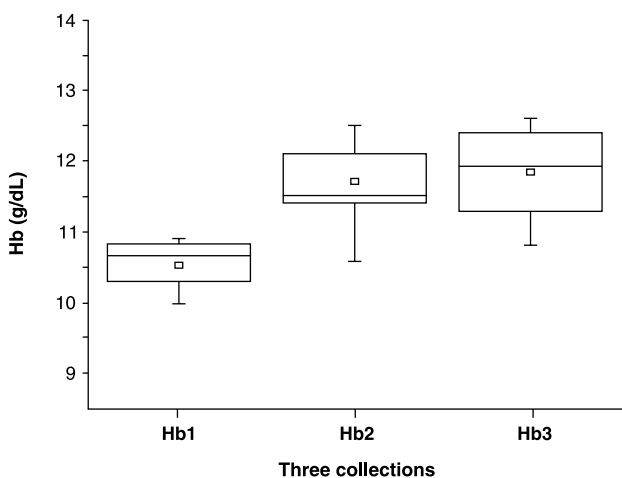
This novel therapeutic approach increased median Hb levels and led to recovery of 76% of children with a diagnosis of anemia. Immediate diagnosis of anemia in the community setting and prompt initiation of treatment and follow-up appear to have played an essential role in the success of this intervention.

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References

1. World Health Organization (WHO). Nutritional anemias: report of a WHO Scientific Group. Technical Report Series no. 405. Geneva: WHO; 1968.
2. World Health Organization (WHO). Iron deficiency anaemia: assessment, prevention and control. A guide for programme managers. Geneva: WHO/UNICEF/UNU; 2001.



Hb = hemoglobin level.

Figure 1 – Progression of Hb levels in anemic children during treatment

3. Queiroz SS, Torres MA. Anemia ferropriva na infância. *J Pediatr (Rio J)*. 2000;76:5298-304.
4. Assunção MC, Santos IS, Barros AJ, Gigante DP, Victora CG. Anemia em menores de seis anos: estudo de base populacional em Pelotas, RS. *Rev Saude Publica*. 2007;41:539-48.
5. Oliveira RS, Diniz Ad Ada S, 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.
6. Konstanyner T, Taddei JA, Oliveira MN, Palma D, Colugnati FA. Isolated and combined risks for anemia in children attending the nurseries of daycare centers. *J Pediatr (Rio J)*. 2009;85:209-16.
7. Ministério da Saúde. Caderno de Informações de Saúde São Paulo, município Ilhabela. [banco de dados na internet] <http://tabnet.datasus.gov.br/tabdata/cadernos/sp.htm>. Access: 23/08/2009.
8. Instituto Brasileiro de Geografia e Estatística (IBGE), Brasil. 2007. <http://www.ibge.gov.br/cidadesat/topwindow>. Acesso: 21/01/2010.
9. Santos, LM (org.). Bibliografia sobre deficiência de micronutrientes no Brasil 1990-2000. Anemia. Brasília: Organização Pan-Americana da Saúde; 2002.
10. Ministério da Saúde. Secretaria de Atenção à Saúde. Departamento de Atenção Básica. Coordenação Geral da Política de Alimentação e Nutrição. Vigilância Alimentar e Nutricional SISVAN. Orientações para a coleta e análise de dados antropométricos em serviços de saúde. Norma Técnica - SISVAN; 2008. http://www.sonutricao.com.br/downloads/sisvan_norma_tecnica_preliminar_crianças.pdf. Access: 21/06/2010.
11. Badham J, Kraemer K, Zimmermann MB. Nutritional anemia. Basel, Switzerland: Sigh and Life Press; 2007.
12. Santos CD, Santos LM, Figueiroa JN, Marroquim PM, Oliveira MA. Anemia em escolares da primeira série do ensino fundamental da rede pública de Maceió, Alagoas, Brasil. *Cad Saude Publica*. 2002;18:1757-63.
13. Farias IL, Colpo E, Botton SR, Silveira RB, Fleig A, Schimitz CA, et al. Carbonyl iron reduces anemia and improves effectiveness of treatment in under six-year-old children. *Rev Bras Hematol Hemoter*. 2009;31:125-31.

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