ORIGINAL ARTICLE

Normal Hemoglobin Values in 12-24 Month Old Children

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ABSTRACT One hundred and thirty-one children aged 12 to 24 months attending the Under Five Clinic of The Department of Child Health, Medical School, Padjadjaran University/Hasan Sadikin General Hospital in Bandung were studied. These subjects were "healthy" and they had no laboratory evidence neither of folic acid, vitamin B12 or iron deficiency, nor thalassemia minor, and/or hemoglobinopathy. These individuals were considered adequately nourished from the erithropoietic point of view, and they constituted the "normal" subjects from which values of hemoglobin were calculated. Results from this highly selected subjects indicated that the mean hemoglobin value was 127.2 g/l (range: 111.6-142.8 g/l). The lower limit of the hemoglobin value in this study is within the normal range according to the WHO criteria for normal hemoglobin values in children 6 months to 6 years of age. **[Paediatr Indones 1995; 35:18-22]**

Introduction

Iron deficiency is by far the most common cause of a subnormal hemoglobin concentration in developing countries as well as in affluent societies.[1] It is particularly prevalent among infants and young children. In Indonesia the prevalence of iron deficiency anemia in children aged six months and 6 years of age belonging to a low socioeconomic but well-nourished group ranged from 37.8 to 73%.[2] It has a peak prevalence during the first 2 years of life because rapid growth imposes large iron needs and most infant diets contain a marginal supply of iron. Among many ethnic groups including Indonesia,[3] thalassemia minor is next in incidence. In each condition, anemia is usually mild and is overlap with normal range. Other important conditions that may influence hemoglobin values in Indonesia are general nutritional status and vitamin A deficiency.[4]

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In order to obtain reliable reference standars, the reference population must be screened to exclude iron deficiency and such relatively common conditions as thalassemia minor or insufficient nutritional status.

It is also necessary to take into consideration the consistently lower mean concentration of hemoglobin in blacks than whites (about 5 g/l) that apeears to be independent of iron deficiency or thalassemia minor.[5]

The present study was undertaken to determine normal hemoglobin values among 12 to 24 months old children in the Department of Child Health, Medical School, Padjadjaran University-Hasan Sadikin Hospital, Bandung.

Methods

Subjects

The study was approved by the Comission of Medical Research Ethics of the Medical School, Padjadjaran University-Hasan Sadikin Hospital in Bandung, Indonesia.

To be eligible into the study, subjects had to fulfil the following selection criteria: birth weight equal to or greater than 2500 g; no major congenital anomalies; no clinically identified neuromotor delay; no major acute or chronic illness; no folic acid and iron deficiency; no signs of abnormal hemoglobin or thalassemia; and weight, length, and head circumference within 2 standard deviations of the reference standards from the US National Center for Health Statistics.[6]

Thus, the 131 children met the criteria for "health" and for normal laboratory examinations i.e., the number of hypersegmentation of neutrophil cells was less than 5%, transferrin saturation >10%, serum ferritin >12 µg/l, HbF <2%, HbA2 <3.5%, and no abnormal hemoglobin was found.

Hematological methods

Veinpuncture specimens were collected by the technician after obtaining a given child's history and completing the physical examination. All assays were conducted by other laboratory personnel. Hemoglobin determinations were performed by cyanmethemoglobin method using Merck hemoglobin standard.

For those children from whom blood was collected by veinpuncture, the following additional assays were performed on 8 ml of blood: peripheral smear stained with Giemsa strain, serum iron (Ferrimat kit, Bio Merieux), total iron binding capacity (TIBC kit and Ferrimat kit, Bio Merieux), serum ferritin (Enzym-immuno assay method with serum ferritin kit, Bio Merieux), folic acid or vitamin B12,[7] hemoglobin electrophoresis (Helena Laboratories), and HbA2 by microcolumn chromatography (Helena Laboratories). Transferrin saturation was calculated by the ratio of serum iron to total iron binding capacity, x 100.

Statistical analyses

Mean and standard deviation (SD) of the hemoglobin values of the subjects were calculated. The normal range of hemoglobin values was presented as mean $\pm$ 2 SD.

Results

The characteristics of 329 children attending the Under Five Clinic during 7 months are illustrated in Table 1.

Table 1. The characteristics of 329 children attending the Under Five Clinic (During 7 months)

Characteristics	N	%
Disqualified (Medical and Laboratory)	62	18.9
Declined participation	15	4.6
Folic acid/vit. B12 deficiency	4	1.2
Iron deficiency	113	34.3
Thalassemia minor	4	1.2
Qualifying and consenting	131	39.8
Total	329	100

A total of 329 children were screened (Table 1), and 267 accepted as subject after a brief medical history and physical examination. The 267 children who met the study's entrance criteria at screening were asked to come to the department of Clinical Pathology for hematologic examinations on venous blood. A total of 146 children met both medical and laboratory criteria for study participation. The parents of 15 (4.6%) of these children declined to participate in the study.

Mean weight, length and weight for length percentile of 131 subjects (Table 2) are normal according to NCHS (1977) (between 10 and 25 percentile of NCHS standard).

Mean and median values and standard deviations for transferrin saturation and serum ferritin of the subjects are given in Table 3. The individuals transferrin saturation and serum ferritin concentration of the subjects were normal on all cases.

Table 2. Sex, mean (SEM) age, birth weigth, weight, length, and weight for length percentile 131 subjects

	Mean (SEM)
Sex (% male)	52
Birth weight (g)	3134 (64)
Weight (kg)	10.3 (0.1)
Length(cm)	78.9 (0.5)
Weight for length percentile	25.6 (3.3)

Table 3. Mean (x), median (SD) transferrin saturation and serum ferritin of 131 subjects

	Mean	Median	SD
Transferrin saturation (%)	29.5	23.4	18
Serum ferritin (μ/l)	49.2	33.7	36.5

Table 4. Mean (x) hemoglobin value of subjects by sex

	N	Hemoglobin (g/l)	p
Male	68	127.4	
			> 0.05
Female	63	127.0	

Table 4 shows the hemoglobin concentration of male and female children. The mean hemoglobin of male and female children is respectively 127.4 and 127.0 g/l. This difference was not statistically significant (p >0.05). Thus, for further calculation of hemoglobin, the hemoglobin values of male and female children are combined. The mean and median hemoglobin concentration for the combined sex group are 127.2 g/l and 127.0 g/l consecutively, and their standard deviation is 7.8. The lower limit of hemoglobin concentration is 127.2 (2 x 7.8) = 111.6 g/l, and its upper limit is 127.2 + (2 x 7.8) = 142.8 g/l.

Discussion

There are two general approaches in establishing the criteria of normality[8] one involves studying a random sample of the total population. One disadvantage of this approach is that it does not exclude values of abnormal individuals.

A second method for deriving normative data involves the exclusion of all subjects with evidence of common abnormalities or adverse environmental circumstances that might be expected to bias the data. The prevalence of iron deiciency in children in Indonesia is high.[2,4] Iron deficiency has a peak prevalence in infants during the first two years of life[1,9] and almost any sampling of this age group will include substancial numbers of children with iron deficiency anemia. Beside that, there are also high prevalence of undernutrition (UNICEF, 1991) and other factors that influence hemoglobin values i.e., folic acid/vitamin B12, acute and chronic infections, etc., The prevalence of thalassemia minor will vary according to the ethnic make-up of the popula-tion. Since normal standards are to be applied in screening at common conditions, it is desirable that the standards are calculated after excluding as many factors leading to bias as possible.

Normal hemoglobin concentration of children 6 months to 6 years of age living at sea level is equal to or more than 110 g/l.[10] For those children living at a altitude above sea level an approximate correction for attitude can be obtained by increasing the values by 4% per 1000 meters elevation.[11] Bandung plateau is located at about 600 meters above sea level. Thus, the normal hemoglobin values for children at that ages living in Bandung plateau is more than 112.4 g/l (110 + 600/1000 x 4 g/l). The lower limit of normal hemoglobin concentration of this study was 111.6 g/l. This value was not so much different from WHO's criteria.

The lower limit of normal hemoglobin concentration of an other study[12] for children 1 to 4 years of age living at 751-1500 meters above sea level was 118 g/l (mean hemoglobin value 130 g/l, SD 11). This value was not so different from the lower limit of normal hemoglobin concentration of this study.

As conclusion, the lower limits of normal hemoglobin values among "normal" children 12 to 24 months of age living at about 600 meters above sea level was 111.6 g/l. Hemoglobin concentration below this value is concidered as anemia.

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