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Original Article

Anemia among children and adolescents in a rural area

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Abstract

Background Anemia in children and adolescents affects growth and development. It is a preventable disease, but unfortunately is often ignored until the symptoms occur. There have been limited reports on the prevalence of anemia in children and adolescents in Indonesia, especially from rural areas.

Objective To describe the prevalence of anemia in children and adolescents in district of Malinau, a rural area in East Kalimantan Province.

Methods This cross-sectional study was done in June 2010 using laboratory records between July 2009 to January 2010. Laboratory records of patients aged between 6 months and 18 years which investigated were complete blood count (CBC) from ambulatory, inpatient, and emergency care of Malinau Public Hospital in East Kalimantan. *Mentzer and England & Fraser* indices were used to differentiate iron deficiency anemia (IDA) and thalassemia among microcytic hypochromic anemic patients.

Results This study involved 709 laboratory records. Prevalence of anemia was 53.9% (95% CI 50.2% to 57.5%). The prevalence of IDA among age groups were as follows: 29.4% (95% CI 24.3 to 34.5%) in 6–59 months group, 16% (95% CI 11 to 21%) in 5–11.9 years, and 15.2% (95% CI 10.2 to 20.2%) in 12–18 years. Children aged 6–59 months tended to have more anemia than those aged 5–11.9 years (OR 2.184, 95% CI 1.398 to 3.413) or aged 12-18 years (OR 2.319, 95% CI 1.464 to 3.674).

Conclusion The prevalence of anemia in children and adolescents of the Malinau Regency is 53.9% (95% CI 50.2 to 57.5%), quite similar to that of other developing countries. A government program to overcome anemia is recommended, not only for pregnant women, but also for children and adolescents. **[Paediatr Indones. 2014;54:88-93.]**.

Keywords: *anemia, iron deficiency anemia, children, adolescents*

Anemia is one of the health burdens worldwide. The prevalence of anemia is high in preschool children (47.4%) and in pregnant women (41.8%), but lower in school age children (25.4%).[1] About 44.5% of preschool-aged children in Indonesia have anemia.[1] Most anemia in children and adolescents is caused by iron deficiency.[2,3] In adolescents, the incidence of iron deficiency anemia (IDA) tends to increase with age and its effect is particularly marked during a growth spurt, with the highest prevalence occurring at 12-15 years of age. Among them, IDA is more common in girls than in boys.[3] WHO reported that for children in low- and middle-income countries, iron deficiency is one of five leading risks affecting mortality- and disability-adjusted life years (DALYs), a "common currency by which deaths at different ages and disability may be measured".[4]

Iron deficiency anemia is a clinical finding resulting from chronic iron deficiency.[3] Although IDA usually appears only in mild anemia, it badly affects the health, development, and immune system of children and pregnant women.[5] Moreover, iron itself plays a role in neurological functioning, behavioral problems, and cognitive development.[6-8] Ironically, IDA is the

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most preventable anemia.[2] The main etiologies of IDA are inadequate iron intake, poor iron absorption, and a higher need for iron at particular periods in life (e.g., growth and pregnancy).[1]

Anemia is simply assessed by measuring the hemoglobin concentration below normal range. In contrast, it is difficult to differentiate IDA from thalassemia, since both had microcytic hypochromic anemia.[1,2] Others causes are sideroblastic anemia, chronic disease, and lead poisoning.[8,9] There are many screening indices to differentiate IDA and thalassemia (e.g., the *Mentzer, Srivastava, Green & King, England & Fraser, Shine & Lal, Ricerca*, and the RBC distribution width indices, as well as RBC distribution width).[10,11] In our study, Mentzer index as well as the England & Fraser indices were used to avoid costly examinations, such as iron status and hemoglobin analyses.

There has been little data from Indonesia on anemia prevalence, particularly on IDA in rural areas. World Health Organization estimated the anemia prevalence in Indonesia using a regression model from other countries with anemia prevalence data in other countries.[1] Moreover, the 2007 Indonesian Basic Health Research report only showed the prevalence of anemia in urban areas (14.8%).[12] Therefore, we aimed to describe the prevalence of IDA in children and adolescents aged 6 months – 18 years in Malinau, a rural area of the East Kalimantan Province.

Methods

Data for this cross-sectional study was taken from the laboratory records from July 2009 to January 2010 of Malinau Public Hospital in East Kalimantan, Indonesia. This hospital is the only health center with laboratory facilities in the Malinau Regency. From, the 2010 Indonesian census, Malinau, a rural area, consisted of 75,295 citizens. Citizens below 15 years of age constituted 24.5% of the population.[13]

The laboratory records reviewed in this study were from patients of the ambulatory, inpatient, or emergency care departments, aged between 6 months and 18 years who underwent complete blood counts (CBC). Duplicate data from the same patients were not included; the highest hemoglobin levels were used for the study. Moreover, pregnant women were excluded.

The diagnosis of anemia was made based on low hemoglobin level according to the WHO (**Table 1**). Patients were considered to be microcytic if their mean corpuscular volume (MCV) was <80 fl; and hypochromic if their mean corpuscular hemoglobin was <27 pg.[14] The Mentzer[15] (MCV/RBC) and England & Fraser indices[16] (MCV-RBC-5*Hb) were used to all subjects with microcytic hypochromic anemia in order to differentiate between thalassemia and IDA. For the Mentzer index, a score of >3 was considered to be IDA.[15] For the England & Fraser index, a positive score was considered to be IDA.[16]

Table 1. Hemoglobin cut-off for anemia according to the WHO.[1]

Age categories and gender	Hemoglobin level (g/dL)
6–59 months	11
5–11.9 years	11.5
12–14.9 years	12
Female aged ≥15 years, not pregnant	12
Female aged ≥15 years, pregnant	11
Male ≥5 years	13

Numerical data was described by mean and standard deviation when the distribution of data was normal, while median and range were used if the distribution of data was not normal. Statistical analyses utilized the Chi-square test and Fisher's test as the alternative. P values <0.05 were considered to be statistically significant. The SPSS® Statistics 17.0 software was used for the analysis.

All data was treated in accordance with the ethical principles for medical research in the Declaration of Helsinki. This study was approved by the Medical Committee of the Malinau Public Hospital.

Results

Between July 2009 and January 2010, there were 709 laboratory records of children and adolescents included in this study. The characteristics of subjects are given in **Table 2**. Overall, the prevalence of anemia was 53.9% (n=382, 95%CI 50.2% to 57.5%), and 40.1% (n=153) of anemic subjects had microcytic hypochromic anemia. The distribution of anemic subjects among the three age groups is shown in **Table 3**.

Table 2. Subjects characteristics

Characteristics		
Median age (range), years		7 (0.5–18)
Complete blood count	Hemoglobin (range), g/dL	11.3 (4.2–17)
	Hematocrit (range), %	37 (13.5–49.8)
	Leucocyte (range), /uL	9000 (1500–42900)
	Red blood cells (range), million c ell	4.49 (1.59–6.9)
	Platelets (range), /uL	302000 (101000–693000)
Gender, n(%)	Male	349 (49.2)
	Female	360 (50.8)
Age groups, n(%)	6 –59 months	306 (43.2)
	5 -11.9 years	206 (29.1)
	12–18 years	197 (27.8)

Since we found significant difference in distribution of anemia among age groups, we did a post-hoc analysis. We found that the age group of 6–59 months had more anemia than the 5–11.9 year group (χ^2, P= 0.013) with an odds ratio (OR) of 1.571 (95% CI 1.102 to 2.241). In addition, the age group of 12–18 years had more anemia than the 5-11.9 year group (χ^2, P= 0.014) with OR 1.637 (95% CI 1.104 to 2.427). However, there was no significant difference between the age groups of 6-59 months and 12-18 years (χ^2, P= 0.824).

Almost all microcytic hypocromic subjects were diagnosed with IDA using the *Mentzer* index, while all were diagnosed with IDA using the *England & Frazer* index (**Table 4**). We analyzed the IDA distribution between age groups using the *England & Frazer* index. Iron deficiency anemia was associated with the age grouping (χ^2, P< 0.001). The post-hoc analysis revealed that the age group of 6–59 months had significantly more IDA than the 5–11.9 year group (χ^2, P= 0.001) with OR 2.184 (95% CI 1.398 to 3.413). In addition, the 6–59 month age group had significantly more IDA than the 12-18 year group (χ^2, P<0.001) with OR 2.319 (95% CI 1.464 to 3.674). However, no significant difference was found between the 6–11.9 year and 12–18 year age groups (χ^2, P= 0.827).

Table 3. Distribution of anemia among the age groups and gender

	Anemia n=382	Not anemia n=327
6-59 months, n(%)		
Female	87 (22.8)	65 (19.9)
Male	87 (22.8)	67 (20.5)
5-11.9 years, n(%)		
Female	47 (12.3)	46 (14.1)
Male	47 (12.3)	66 (20.2)
12-18 years, n(%)		
Female	72 (18.8)	43 (13.1)
Male	42 (11.0)	40 (12.2)

χ2 test, P=0.018

Discussion

In our study, anemia was found in 53.9% of subjects, a large percentage of whom were in the 6–59 month age group, followed by the 12–18 year age group. We did not assess subjects below 6 months of age because in the first two months of life, hemoglobin levels typically decrease, due to physiologic anemia of infancy. Moreover, from 6 months onward, infants experience multiple dietary changes, which can be critical if they do not receive appropriate diet.[17]

Table 4. Prevalence of IDA using the *Mentzer and England & Frazer* indices

	Age group		
	6–59 months n (%)	5–11.9 years n (%)	12–18 years n (%)
Microcytic hypochromic anemia	90 (29.4)	33 (16.0)	30 (15.2)
Iron deficiency anemia *(Mentzer)*	81 (26.5)	28 (13.6)	26 (13.2)
Iron deficiency anemia *(England & Frazer)*	90 (29.4)	33 (16.0)	30 (15.2)
	95%CI 24.3 to 34.5	95%CI 11 to 21	95%CI 10.2 to 20.2

We found an anemia prevalence of 26.5% in the 6–59 month age group. This finding is similar to other studies that found the prevalence of anemia in Mexico was approximately 20%.[18,19] However, higher prevalence in Bangladesh[20] and a lower prevalence in Estonia[21] were found.

The prevalence of anemia in the 5–12 year age group was 45.66%, similar to the findings of a study performed in a rural area of Malaysia.[22] Most Indonesians eat mainly rice with a little protein (*tempe* or *tahu*). Particularly in Malinau, people eat rice with poultry and fish, but rarely eat other meat. This diet leads to low iron intake, and taken together with poverty and infection, might contribute to the high prevalence of anemia in this rural area.[22]

In age group of 12–18 years, the prevalence of anemia was 57.9%. Our result was higher than those of studies in Mexico (8.5%)[23] and Turkey (5.6%).[24] Although Mexico, Turkey, Indonesia, and India, were equally classified as low- and middle-income countries,[4] their anemia prevalences vary. In contrast, results from a study in Karnataka, India, (45.2%) were similar to those of our study.[25] Both Malinau and Karnataka are rural areas in low- and middle-income countries, so similar results would be expected. The incidence of anemia is closely related to poverty, limiting one's ability to access animal-based food.[24]

Girls aged 12-18 years had a higher prevalence of anemia (62.6%). Shah *et al.* also stated that prevalence of anemia in adolescent girls in Nepal was 68.8%.[26] Also, in India, a study found anemia was higher in female adolescents (23.9%).[27] Moreover, in urban slum area in India, the prevalence of anemia in adolescent girls can exceed 90.1%.[28] It was concluded that the causes anemia were menstrual losses that demanded more iron intake[23] and growth spurts.[24] Moreover, accelerated increase due to pubertal growth, high rate of infection, worm infestation, and early marriage also played role in anemia in boys and girls.[3]

In our study using the *England & Frazer* index, 40% of all anemic subjects had IDA. Other studies also reported that IDA played major role in anemia.[29-32] De la Cruz-Gongora *et al.*[18] had similar results and they found other causes to be folate and vitamin B_{12} deficiency. We did not assess these conditions in our study. Iron deficiency anemia was more common in the 6–59 month age group, followed by the 5–11.9 year and 12–18 year age groups. The same sequence was also seen in rural Amazonia.[33] One of the reasons for this condition may be that Malinau infants do not have access to iron-enriched infant cereals. Moreover, there is no IDA prevention program for infants. Since iron requirement is positively related with growth velocity, it also decreases in older age. So, there may be a physiological explanation for the lower prevalence of anemia in higher age.[20]

Iron deficiency anemia was found in 15.2% of adolescents, lower compared to the National Household Health Survey 2001 that reported IDA to be 30%.[3] Unfortunately, 26.3% of married adolescents have begun childbearing before the age of 19 years.[34] The Indonesian government provides free daily iron and folic acid supplementation program for pregnant women, but this program should be broadened to include all adolescents. If maternal iron stores are depleted, the mother's anemia results in impaired fetal development.[17] Hence, if iron is depleted before pregnancy, it will worsen the condition of both mother and fetus. There were 42.7% of the adolescents who had anemia other than IDA. We did not assess other etiologies, but it has been suggested that anemia may be caused mainly by chronic diseases and blood loss during menstruation in adolescent girls, and rarely by acquired hemolytic anemia, leukemia, or other bone marrow disorders.[35]

A limitation of our study was that this research was laboratory test-based. As such, we did not account for clinical signs or symptoms to determine the etiology of the anemia. Although we were able to exclude pregnant patients, patients who came to the hospital and underwent laboratory tests were ill patients, possibly leading to a higher prevalence of anemia.

Iron deficiency anemia correlates with many conditions, such as socioeconomic status, parental education, low intake of iron-rich foods, duration of breastfeeding, acute and chronic infections, as well as increased iron loss during growth, puberty, and bleeding.[29-32,36] Social determinants and health status cannot be separated, particularly in IDA. Paternal schooling is directly related to income, while maternal schooling is related to child care, especially in Indonesia, as most mothers have the role of housewives.[36] Untreated water was also identified as a risk factor that can lead to intestinal parasites.[36]

Iron deficiency anemia is a vicious cyclical problem in the community. If the condition of the family is in poverty, the individual particularly pregnant woman is vulnerable to have IDA.[36] Infants born to women from impoverished familes, are potentially resulting in lowered intelligence.[37] Thus, the affected child may have overall limited growth, as growth retardation occurs during the growth spurt of adolescence.[38] Moreover, education of future mothers may be limited, due to low intelligence or lack of finances to pay for educational fees. Subsequently, the cycle will repeat as from the beginning.

Many studies have recommended programs to reduce the burden of anemia. Improving education, especially maternal education in the community about iron-rich food sources, feeding practices, sanitation and personal hygiene should be reinforced[29,30,39] along with, fortification of iron supplementation, and eradication of parasitic infections. Since anemia also corresponds with poor socioeconomic status, improving the entire household economy may play a major role in reducing the burden of disease.[29-31,36]

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