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# Prevalence of anemia and iron profile among children and adolescent with low socio-economic status

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ABSTRACT

*Background:* A national health survey in Indonesia conducted in 2013 showed that the prevalence of anemia in school-aged children and adolescents tripled from a survey conducted in 2007. Children and adolescents are particularly susceptible to iron deficiency anemia (IDA) and iron deficiency (ID) because of their rapid growth and puberty. Teenage girls are at risk because of their menstrual bleeding. Low socioeconomic status in children and adolescents is also a strong risk factor for experiencing iron deficiency. Studies regarding the prevalence of ID and IDA in Indonesia still vary and are lacking. This study aims to describe the prevalence of anemia in children and adolescents with low socioeconomic conditions.

*Methods:* This is a cross-sectional study conducted at two schools in the suburbs of Jakarta on children and adolescents aged 6–18 years old. Personal data and laboratory identities (complete peripheral blood count, reticulocyte hemoglobin content, ferritin, transferrin saturation, and C-reactive protein) were collected to determine iron status. Analysis was performed using SPSS program version 22.0.

*Results:* The overall prevalence of anemia was 14.0%. The prevalence of IDA, ID without anemia, and iron depletion was 5.8%, 18.4%, and 4.3%, respectively. The prevalence of IDA, ID, and iron depletion was higher in females than in males.

*Conclusion:* The overall prevalence of anemia in children and adolescents is lower than the national data. Special consideration needs to be taken for the female population, who are more at risk of developing ID and IDA.

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## 1. Introduction

Anemia has been a public health problem worldwide. The World Health Organization (WHO) reports that the prevalence of anemia is the highest in children (42.6%) and the lowest in nonpregnant women (29.0%) [1]. The 2013 National Health Survey in Indonesia showed that the prevalence of anemia in children aged 1–4 years, 5–14 years, and 15–24 years were 28.1%, 26.4%, and 18.4%, respectively [2]. There was an increase in prevalence compared with that in the previous survey conducted in 2007, which was 27.7%, 9.4%, and 6.9% for children aged 1–4 years, 5–14 years, and 15–24 years, respectively [3]. In particular, the prevalence of anemia in school-aged children and adolescents almost tripled. The National Health Survey also showed that anemia prevalence is higher in the suburbs than in urban areas [2].

Iron deficiency (ID) is the most common micronutrient deficiency in the world and the most common cause of anemia [4,5]. Studies on the prevalence of iron deficiency anemia (IDA) in Indonesia are still scarce, and the result varies between studies, especially in school-aged children and adolescents. A study in 50 school-aged Indonesian children (6–12 years) found the prevalence of IDA to be 32% [6], while a retrospective study involving 709 laboratory records of Indonesian children and adolescents showed an IDA prevalence of 16% in the 5–11.9 years age group and 15.2% in the 12–18 years age group [7].

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Indonesia is a low-to middle-income country, with 10.6% of its population still living in poverty in 2017 [8]. Poverty is the root cause of most undernutrition, such as iron deficiency [9]. Children and adolescents with low-socioeconomic status are more susceptible to iron deficiency because of low iron intake and food low in bioavailable iron, which can be worsened by chronic blood loss due to parasitic infections and malaria [10]. Other factors such as chronic blood loss from menstruation and iron malabsorption from gastrointestinal problems can cause IDA in older children and adolescents [5,11].

Studies showed that even the early stage of iron deficiency can affect motor and cognitive abilities and cause behavior disturbances in children that may be irreversible [10,12,13]. Iron deficiency anemia in adolescence also has a wide range of consequences, such as impaired physical and mental growth and development as well as reduced physical fitness, work capacity, and school performance [14]. Therefore, it is important to detect and screen for iron deficiency at its earliest stage. However, research on the prevalence of iron deficiency and IDA in children and adolescents is still very limited in Indonesia. This study aims to observe the prevalence of ID and IDA in a population with the higher risk of developing ID.

## 2. Methods

### 2.1. Sample selection

This is a cross-sectional study conducted from March to October 2016. The population of this study was school-aged children and adolescents from two schools located in suburb slum areas of Jakarta, Indonesia. We define school-aged children as children aged 6–9 years old; we describe adolescents as young people between the age of 10 and 18 years old. The adolescents recruited in this study were from an informal school for scavengers living in those areas using consecutive sampling. A total of 242 children aged 6–18 years were enrolled as subjects in this study. Exclusion criteria of this study are (1) hematological or systemic disease such as infection, inflammation, malignancy, and other chronic diseases that could affect the parameters analyzed; (2) history of blood transfusion in the past 3 months; (3) received iron therapy; or (4) presented with a value of high-sensitivity C-reactive protein (hs-CRP).

### 2.2. Ethical consideration

Written consent was obtained from the subjects, parents, or legal guardians of the subjects. This study was approved by the Faculty of Medicine Universitas Indonesia Ethical Committee, Indonesia.

### 2.3. Data collection

Venous blood samples were drawn after history taking and physical examination of the subjects. All venous blood samples were analyzed at two different laboratories using ADVIA 2120 and Sysmex ST 2000i. The following indices were measured: hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), Ret-He, ferritin, serum iron (SI), and total iron-binding capacity (TIBC). Transferrin saturation (TS) was calculated using SI and TIBC [TS = (SI/TIBC) x 100] [15].

Iron deficiency anemia is defined by the WHO criteria of (1) a low Hb value according to age: Hb < 11.5 g/dL in 6–11 years old children; Hb < 12 g/dL in 12–15 years old children; and 15–18 years old nonpregnant females; and Hb < 13 g/dL in 15–18 years old males [16] with one out of two criteria: TS < 15% and/or ferritin <15 mg/L [17]. Iron deficiency without anemia is diagnosed if the subjects have normal Hb according to age and one out of two criteria: TS <15% and/or ferritin <15 mg/L [17,18]. Diagnostic criteria of iron depletion are normal Hb according to age, normal TS, and ferritin <15 mg/L [18].

### 2.4. Statistical analysis

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 22.0. The chi-square test was used for testing relationships between categorical variables. Independent T-Test was performed to compare mean values between two groups, and ANOVA test was performed to compare mean values between three groups or more. Normality test was performed using Kolmogorov Smirnov. *P* value of less than 0.05 was considered as statistically significant.

## 3. Results

A total of 242 children were enrolled in this study. Twenty-nine subjects were excluded from the study due to illnesses and high hs-CRP level. Other subjects with incomplete data were also excluded from this study. A total of 207 subjects were analyzed in this study. The subjects had median age of 11 years (7–18 years) with a male–to-female ratio of 1:1 (103 males and 104 females).

### 3.1. Prevalence of iron depletion, ID, and IDA

We found an overall prevalence of anemia in 14.0% (29 subjects), and 62.9% were males and 37.1% were females. Iron deficiency was the cause of anemia in 41.4% anemic subjects (12 subjects). From 29 subjects who were anemic, 23 had microcytic anemia (MCV < 80 fL) and six subjects had normocytic anemia. A total of 131 subjects had normal iron status (63.3%), 12 subjects had IDA (5.8%), 38 subjects had ID (18.4%), and nine subjects had iron depletion (4.3%). We did not find any significance between the prevalence of iron status according to age group (children vs. adolescents). Iron status in children according to their age group is displayed in Table 1.

Overall, males have a higher prevalence of anemia (62.9%) than

**Table 1**
Iron status in children according to age group.

| Stage | 6–9 years (n = 45) | 10–18 years (n = 162) | Total (n = 207) | *p* |
|---|---|---|---|---|
| Normal | 25 (19.1) | 106 (80.9) | 131 (63.3) | |
| Anemia | 9 (31.0) | 20 (69.0) | 29 (14.0) | 0.191 |
| IDA | 5 (41.7) | 7 (58.3) | 12 (5.8) | 0.104 |
| Iron deficiency | 7 (18.4) | 31 (81.6) | 38 (18.4) | 0.583 |
| Iron depleted | 4 (44.4) | 5 (55.6) | 9 (4.3) | 0.106 |

Data was displayed as n (%).
IDA, indicated iron deficiency anemia.
Test using Chi-Square.

**Table 2**
Iron status in children according to sex.

| Stage | Females (n = 104) | Males (n = 103) | Total (n = 207) | *p* |
|---|---|---|---|---|
| Normal | 63 (48.1) | 68 (51.9) | 131 (63.3) | |
| Anemia | 14 (37.1) | 15 (62.9) | 29 (16.9) | 0.819 |
| IDA | 8 (57.1) | 4 (42.9) | 12 (5.8) | 0.241 |
| Iron deficiency | 20 (55.6) | 18 (44.4) | 38 (18.4) | 0.744 |
| Iron depleted | 7 (77.8) | 2 (22.2) | 9 (4.3) | 0.170 |

Data was displayed as n (%).
IDA, indicated iron deficiency anemia.
Test using Chi-Square.

**Table 3**
Iron status in children aged 6–9 years old.

| Stage | Females (n = 21) | Males (n = 24) | Total (n = 45) |
|---|---|---|---|
| Normal | 13 (52.0) | 12 (48.0) | 25 (55.6) |
| Anemia | 3 (33.3) | 6 (66.7) | 9 (20) |
| IDA | 2 (40.0) | 3 (60.0) | 5 (11.1) |
| Iron deficiency | 2 (28.6) | 5 (71.4) | 7 (15.6) |
| Iron depleted | 3 (75.0) | 1 (25.0) | 4 (8.9) |

Data was displayed as n (%).
IDA, indicated iron deficiency anemia.

**Table 4**
Iron status in adolescents aged 10-18 years old.

| Stage | Females (n = 83) | Males (n = 79) | Total (n = 162) |
|---|---|---|---|
| Normal | 50 (47.2) | 56 (52.8) | 106 (65.4) |
| Anemia | 11 (55.0) | 9 (45.0) | 20 (12.3) |
| IDA | 6 (85.7) | 1 (14.3) | 7 (4.3) |
| Iron deficiency | 18 (58.1) | 13 (41.9) | 31 (19.1) |
| Iron depleted | 4 (80.0) | 1 (20.0) | 5 (3.1) |

Data was displayed as n (%).
IDA, indicated iron deficiency anemia.

females (37.1%). However, the prevalence of IDA, ID, and iron depletion was higher in the female population. There were no significant differences between gender in all groups (Table 2).

There were a total of 45 subjects in the children age group, which included 21 females (46.7%) and 24 males (53.3%). Twenty percent (nine subjects) had anemia. The overall prevalence of IDA, ID, and iron depletion was 11.1%, 15.6%, and 4%, respectively. The prevalence of anemia and iron deficiency was higher in the male population (Table 3).

The adolescent group consisted of 162 subjects, and 51.2% were females and 48.8% were males. The prevalence of anemia, IDA, ID, and iron depletion was higher in the female group (Table 4).

### *3.2. Hematological characteristics of children and adolescents*

Table 5 shows the mean hematological parameters in children aged 6–18 years, and the comparison between mean values for Hb,

**Table 5**
Mean haematological parameters in children aged 6–18 years.

| Parameter | N | Mean ± SD/Median (Min-Max) | 95%CI |
|---|---|---|---|
| Haemoglobin (g/dL) | 207 | 13 ± 1.3 | 12.8–13.1 |
| MCV (fL) | 207 | 77.4 (53.3–91.1) | 76.0–77.9 |
| Ferritin (μg/L) | 207 | 36.6 (4.6–131.1) | 37.0–43.8 |
| TS (%) | 207 | 20.5 (3.8–59.5) | 20.5–23.03 |
| Ret-He (pg) | 207 | 28.8 (17.5–34.7) | 27.7–28.5 |

Normality test using Kolmogorov-Smirnoff and data was transformed using log10(Data).
MCV indicates mean corpuscular volume; Ret-He, reticulocyte haemoglobin content; TS, transferrin saturation.

**Table 6**
Comparison of mean haematological parameters in children and adolescence.

| Parameter | 6–9 years (n = 45) | 10–18 years (n = 162) | *p* |
|---|---|---|---|
| Haemoglobin (g/dL) | 12.0 ± 0.9 | 13.2 ± 1.3 | 0.000 |
| MCV (fL) | 74.4 ± 5.6 | 77.6 ± 7.1 | 0.002 |
| Ferritin (μg/L) | 38.8 ± 23.0 | 40.8 ± 25.2 | 0.634 |
| TS (%) | 20.4 ± 9.0 | 22.1 ± 9.2 | 0.253 |
| Ret-He (pg) | 27.8 ± 2.6 | 28.2 ± 3.0 | 0.420 |

Data are presented as Mean ± SD.
Homogeneity test using Levene's test of homogeneity.
Test using Independent Sample T-Test.
MCV indicates mean corpuscular volume; Ret-He, reticulocyte haemoglobin content; TS, transferrin saturation.

**Table 7**
Comparison of mean haematological between sex.

| Parameter | Females (n = 104) | Males (n = 103) | *p* |
|---|---|---|---|
| Haemoglobin (g/dL) | 12.9 ± 1.2 | 13.0 ± 1.4 | 0.566 |
| MCV (fL) | 78.0 ± 5.9 | 75.8 ± 7.7 | 0.017 |
| Ferritin (μg/L) | 37.3 ± 25.0 | 43.5 ± 24.2 | 0.073 |
| TS (%) | 22.0 ± 9.8 | 22.6 ± 8.6 | 0.757 |
| Ret-He (pg) | 28.4 ± 2.7 | 27.9 ± 3.1 | 0.221 |

Data are presented as Mean ± SD.
Homogeneity test using Levene's test of homogeneity.
Test using Independent Sample T-Test.
MCV indicates mean corpuscular volume; Ret-He, reticulocyte haemoglobin content; TS, transferrin saturation.

MCV, ferritin, TS, and Ret-He according to age group and sex is depicted in Tables 6 and 7. Adolescents had higher hematological profile than children aged 6–9 years. Our analysis also showed that there were significant differences in Hb and MCV levels between groups; however no significant differences were found for other parameters. According to sex, there were significant differences in MCV ($P$= 0.017); however there were no significant differences in other hematological parameters. Hematological parameters according to the iron status are displayed in Table 8.

## 4. Discussion

This study found an overall prevalence of anemia of 13.0%. This prevalence is lower than that in the national report in Indonesia that found an overall prevalence of anemia of 26.4% in children aged 5–14 years old and 18.4% in young adults aged 15–24 years old [2]. Anemia is still a common problem in developing countries, affecting 27% of the world's population in 2013. Developing countries account for more than 89% of the burden [19]. The Global Burden of Disease (GBD) 2013 also reported an overall prevalence of anemia in Indonesia of 27.4% [19].

This study found an overall prevalence of IDA of 5.8% and iron deficiency as the cause of anemia in 44.4% anemic subjects. Twenty-five anemic subjects had microcytic anemia, two subjects had normocytic anemia, and none had macrocytic anemia. However, we did not assess other causes of anemia other than iron deficiency. Studies found that iron deficiency anemia is the most common cause of anemia (approximately 60% of overall causes), while other causes of anemia include thalassemia trait (5.40%), malaria (4.17%), gastritis and duodenitis (3.27%), and other neglected tropical diseases (3.09%) [19]. Hemoglobinopathies, such as thalassemia, which presented as microcytic anemia, was prevalent in Southeast Asia, including Indonesia [20]. A study in Indonesia that screened 241 healthy volunteers found 45% had thalassemia trait [21].

This study was conducted on children with low-socioeconomic status. Low socioeconomic status has been known to be a risk factor of ID and IDA [22]. However, we found that our prevalence of IDA is lower than that reported in other studies conducted in Indonesia

**Table 8**
Comparison of mean values for Hb, MCV, ferritin, TS and Ret-He according to iron status.

| Parameter | Normal (n = 132) | Iron depleted (n = 9) | ID (n = 39) | IDA (n = 12) | *P* |
|---|---|---|---|---|---|
| Haemoglobin (g/dL) | 13.4 (1.17) | 12.8 (0.78) | 12.9 (0.91) | 11.1 (0.47) | .000[b] |
| MCV (fL) | 78.8 (5.42) | 78.1 (4.98) | 75.1 (5.12) | 75.6 (5.93) | .001[a] |
| Serum Ferritin (μg/L) | 45.7 (23.79) | 11.9 (2.65) | 29.8 (20.40) | 22.2 (20.02) | .000[b] |
| Transferrin Saturation (%) | 25.5 (7.62) | 19.8 (5.25) | 11.1 (2.86) | 10.7 (6.02) | .000[b] |
| Ret-He (pg) | 29.1 (2.09) | 29.2 (0.91) | 27.3 (2.15) | 26.5 (2.95) | .000[a] |

Data are presented as Mean ± SD/Median (Min − Max).
Homogeneity test using Levene's test of homogeneity.
[a] Test using ANOVA (Turkey HSD post-hoc analysis)Ret-He: normal and ID (p = 0.000); normal and IDA (p = 0.001); iron depleted and IDA (p = 0.021)MCV: normal and ID (p = 0.001).
[b] Test using Welch ANOVA (Games Howell post-hoc analysis)Ferritin: normal/ID and iron depleted (p = 0.000); normal and ID (p = 0.001); normal and IDA (p = 0.009)TS: normal and ID/IDA (p = 0.000); iron depleted and ID (p = 0.000), iron depleted and IDA (p = 0.009)Hb: normal and ID (p = 0.036); normal/ID and IDA (p = 0.000); iron depleted and IDA (P = 0.001)ID indicates iron deficiency; IDA, iron deficiency anemia; Ret-He, reticulocyte hemoglobin content.

that found a prevalence of IDA of 32% in children aged 6–12 years old [6]. According to a study in Korean adolescent girls, the prevalence of IDA was decreasing as household income increased, which may be due to the fact that girls from higher socioeconomic status consume more iron and vitamin [23]. However, a study in adolescent girls in Indonesia found that there was no association between socioeconomic status and the prevalence of ID and IDA [24].

In this study, we found that the prevalence of anemia, ID, and iron depletion were higher in the adolescent group. This may be because there were more samples in the adolescent group than in the children group (162 vs. 45). We also found that females had higher prevalence of IDA, ID, and iron depletion (Table 2). However, there were no significant differences in hematological parameters between gender as shown in Table 5. Adolescent girls were more susceptible to IDA because they experienced menstruation [25]. There were additional iron requirements for adolescent girls beyond the growth requirements because of the amount of iron lost during menses. The additional requirements for iron to balance the menstrual blood losses was approximately 2.1 mg/day more than the daily iron requirement [26].

Administration of iron supplementation during pregnancy is too late to prevent IDA because the subjects do not have sufficient iron stores when they enter pregnancy. Thus, primary health care should focus on ID prevention before pregnancy but from adolescence or childhood. Health care workers should be more vigilant in screening for IDA in adolescent females who are more at risk for developing IDA. Currently, The Indonesian Pediatric Society recommends giving daily iron supplementation in children aged 6–12 years old two times a week for three consecutive months and iron and folic acid supplementation in adolescence females (age 12–18 years old) two times a week for three consecutive months [27]; while the WHO gave recommendations of giving daily iron supplementation in children aged 5–12 years old in areas where the prevalence of anemia is higher than 40%. Weekly iron and folic acid supplementation is recommended in all adolescent females and menstruating women where the prevalence of anemia is higher than 20% [28].

The main limitation of this study is that the sample size was not large enough. We also did not adjust altitude as a cut-off point for anemia, and we did not explore other causes of anemia. We also did not compare the prevalence of IDA and ID between children with low socioeconomic status and children with high socioeconomic status. Larger scale studies need to be done to compare the prevalence of anemia in children and adolescent in Indonesia.

## Credit author statement

**Murti Andriastuti**: conceptualization, methodology, resources, supervision, project administration, funding acquisition, and writing – review and editing. **Ganda Ilmana:** conceptualization, software, investigation, project administration, formal analysis, and data curation. **Serra Avilia Nawangwulan**: methodology, verification, formal analysis, investigation, data curation, and writing – original draft. **Kartika Anastasia Kosasih**: data curation, validation, writing – original draft, and visualization.

## Originality and plagiarism

The authors ensure that they have written original work and have properly cited every work or words of other works.

## Data access and retention

The authors have provided raw data in connection with the paper for editorial review and prepared to provide public access to such data.

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The authors ensure that they did not publish a manuscript that contains the same research in multiple journals.

## Fundamental errors

The authors will notify the journal editor or publisher and cooperate with the editor to retract or correct the paper if we found significant error or inaccuracy in our work.

## Reporting standards

The authors have reported original research according to the work performed and have discussed its significance in an objective manner.

## Use of patient images or case detail

This study has been approved by Faculty of Medicine, Universitas Indonesia, Ethics Committee. Written informed consent was obtained from the subjects or parents and legal guardians of subjects.

## Declaration of competing interest

The authors confirmed no potential conflict of interest with regard to the research, authorship, or publication of this article.

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