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FACTORS ASSOCIATED WITH ANEMIA AMONG ADOLESCENT GIRLS AGED 10-19 YEARS IN CENTRAL KALIMANTAN

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ABSTRACT

Anemia is a global adolescent health problem related to nutrition and often occurs in developing countries, including Indonesia. A lack of red blood cells or a hemoglobin level lower than 12 g/dL is known as anemia and is mainly experienced by women of childbearing age, including teenage girls. This study aims to determine the risk factors associated with anemia among adolescent girls aged 10 to 19 years in 12 Central Kalimantan schools. This study was observational-analytic with a cross-sectional design. Data (n = 355 adolescent girls) were from secondary data from the data screening for Hb levels in the School Adolescent Girls Health Education program by PT Rimba Makmur Utama. Multiple logistic regression tests analyzed the risk factors (socio-demographic and health characteristics) associated with anemia. Analysis showed that 32.1% had anemia. Most of them were 10 to 14 years old. Consumption of iron supplements in the last week (PR: 0.450, 95% CI: [0.253-0.802]) and BMI-for-age (PR: 1.599, 95% CI: [1.005-2.544]) was significantly associated with anemia. Age, parent's education, parental income, menstruation status, consumption of iron supplements, and consumption of deworming tablets were not associated with anemia. Optimized iron supplementation programs for adolescent girls 10 to 19 ages can decrease anemia prevalence.

Keywords: anemia, adolescents, iron supplement

Introduction

Adolescence is a transitional phase from childhood to adulthood between 10 and 19 years old, and it involves physical, sexual, psychological, and social development growth.[1] That growth affects how they act. Adolescence is the predominant phase for getting used to healthy living behavior. However, the adolescent phase is also vulnerable to health problems that can lead to death. Globally, about 1.1 million of 1.2 billion adolescents die each year.[1] A few causes of these problems are associated with water, hygiene, and sanitation; alcohol use and promiscuous sex; nutritional deficiencies, and physical inactivity. Anemia, a global adolescent health problem related to nutrition, often occurs in low- and middle-income countries (LMICs) such as Indonesia.

Anemia is particularly affecting adolescent girls, women of childbearing age, pregnant women, and children.[2,3] Indonesia Health Survey 2023 found that the prevalence of anemia was 16.3% among children aged 5-14 years and 15.5% aged 15-24 years.[4] It means that 1-2 of 10 people suffer from anemia. Although the proportion has decreased from the Riskesdas data (2018),[5] the percentage is still alarming if converted into absolute numbers, meaning that around 7.2 million children aged 5 to 14 years and around 6.9 million children aged 15-24 years suffer from anemia. Anemia can lead to decreased immunity, decreased cognitive ability, and inhibited adolescent growth.[6,7] If it continues into adulthood, anemia increases the risk of a mother giving birth to a premature baby, low birth weight, stunted children, and the risk of maternal death during childbirth.[8] Such cognitive decline will also majorly impact Indonesia's future economic productivity.[6]

Anemia is a condition in which a person lacks red blood cells or hemoglobin levels with an average of more than equal to 12 g/dL.[9] Anemia was affected by several factors like as biological factors (malnutrition, growth, physiology, gender, age, and race), associated with infection and inflammation (helminth infection, schistosomiasis, malaria, HIV, and tuberculosis), genetic abnormalities in hemoglobin (thalassemia and sickle cell anemia disease), climate change and environmental pollution, poverty and education, and the influence of water, sanitation, and hygiene.[10,11]

Biologically, adolescent girls are one of the groups that are prone to anemia due to menstruation. Anemia affects teenage girls between 15 and 19 years old.[12] During menstruation, the body must excrete iron through bleeding as much as 10 to 14 mg monthly.[13] Iron is the predominant nutrition of hemoglobin to transfer oxygen throughout the body. Iron was taken from animal proteins such as liver, meat (beef and goat), poultry (chicken, duck, bird), and fish. About 20 to 30 percent of these heme iron can be absorbed. Iron supplementation can also prevent anemia, especially iron deficiency anemia.[8,14] Indonesia is doing that supplementation program.

Worm infections can reduce nutrient absorption such as iron, vitamins (A, B2, B6, B9, B12, C, D, and E), and zinc which plays a role in red blood cell formation. Worming people are very

prone to anemia.[15] Body mass index (BMI) is also one of the anemia risk factors. Adolescent girls with low BMI are 3.2 times more likely to experience anemia than other girls.[16]

Central Kalimantan is a province with a proportion of adolescent girls 10 to 19 years old who received or bought iron supplements in the last 12 months (72.8%) but still below the national level (73.5%).[4] However, only a few studies have been conducted regarding anemia and its risk factors in Central Kalimantan. Research on adolescent girls of MTsN Barito Utara found that 10.2% were anemic and there was a relationship between nutritional status and anemia.[17] Sleeping habits among adolescents in Pahandut Health Center Palangkaraya had a significant relationship with anemia.[18] Therefore, this study aims to determine the anemia risk factors of adolescent girls in 12 Central Kalimantan schools, especially in Katingan and Kotawaringin Timur District. These schools were located in 4 sub-districts (Seranau, Pulau Hanaut, Mendawai, and Kamipang).

Methods

This study was observational-analytic with a cross-sectional design. Data were from Hb examination of PT Rimba Makmur Utama Adolescent Girls Health Education Program from January to February 2024. There are 355 girls aged 10 to 19 years from grades 7, 8, 10, and 11 of 12 secondary schools who attend this program and this article analyzes this.

The study population was adolescent girls in 12 schools from four sub-districts in Central Kalimantan. There are 355 girls aged 10 to 19 years from grades 7, 8, 10, and 11 of secondary schools who had their Hb examined. This article analyzed them. The twelve schools were from Kamipang (SMPN 1 Atap 2 Kamipang and SMAS PGRI Desa Telaga), Mendawai (SMPN 1 Mendawai and INITIAL A), Pulau Hanaut (MTS Sirajul Munir, SMPN 1 Pulau Hanaut, SMK Pulau Hanaut), and Seranau (SMAS PGRI 2 Sampit, SMPN 6 Sampit, SMP 1 Atap 1 Seranau, SMK Ambarwati, and SMPN 5 Sampit). Table 1 shows the details of adolescent girls who participated in the Hb level checking program at the PT Rimba Makmur Utama Adolescent Girls Health Education Program.

Table 1. Number of Adolescent Girls Per Schools

No	Name of School	Number of Adolescent Girls
1.	SMPN 1 Atap 2 Kamipang	21
2.	SMAS PGRI Desa Telaga	24
3.	SMPN 1 Mendawai	37
4.	INITIAL A	38
5.	MTS Sirajul Munir	51
6.	SMPN 1 Pulau Hanaut	18
7.	SMK Pulau Hanaut	36
8.	SMAS PGRI 2 Sampit	33
9.	SMPN 6 Sampit	40
10.	SMP 1 Atap 1 Seranau	12
11.	SMK Ambarwati	11
12.	SMPN 5 Sampit	34
	Total	355

*Note: INITIAL A means “the school does not want to include its name, but approves to use their data”

PT Rimba Makmur Utama adolescent school-girls health education program collaborated with the sub-district Public Health Center. The first agendas for this program were hemoglobin examination, anthropometric measurements, and filling out questionnaires. All teenage girls in grades 7, 8, 10, and 11 of 12 secondary schools participated in the program. The schools were selected because they are located near the company's working area. The author analyzed that data for this study. However, PT Rimba Makmur Utama used them to identify anemic adolescent girls who will follow the education program for every school.

The hemoglobin examination was conducted by local health center health workers using the Easytouch GCHB. Blood samples were taken by pricking the adolescent's finger using a sterile blood lancet after wiping it with an alcohol swab. About ten microliters of blood sample dropped on the hemoglobin strip. The result came out in less than 1 minute.

Anthropometric measurements (height and weight) aim to determine body mass index (BMI). Height was measured using a GEA stature meter, and adolescents removed their shoes, stood upright, and stuck their bodies (heads, shoulders, buttocks, and heels) on the wall. Body weight was measured using a digital scale by removing shoes, watches, and belts and removing wallets and cell phones (if seen pocketing). For the nutritional status of adolescents, BMI-for-age was calculated using WHO Anthroplus.

The questionnaire contained several questions regarding socio-demographic characteristics (age, parental education, and parental income) and health status (menstrual status, consumption of iron supplements in the last week, and consumption of deworming tablets during six months). The secondary data has obtained a certificate of ethical feasibility from the Health Research Ethics Committee (Komisi Etik Penelitian Kesehatan) Fakultas Keperawatan Universitas Airlangga with number 3338-KEPK.

Anemia is the dependent variable defined as a hemoglobin level of less than 12 g/dL. Three categories of anemia were mild anemia (11.0 - 11.9 g/dL), moderate anemia (8.0 - 10.9 g/dL), and severe anemia (<8 g/dL).[19] Moderate and severe anemia was merged into "moderate/severe anemia". Other than that, it is normal. Independent variables are socio-demographic characteristics (age, parental education, and parental income) and health status (consumption of iron supplements in the last week, consumption of deworming tablets during six months, and BMI).

Age is divided between 10 to 14 years and 15 to 19 years.[20] Parental education is the reading and writing ability of the parents and classifies into literate (both parents can read and write) and illiterate (one of the parents cannot read and write).[20] Parents' monthly income based on BPS classification (2021) consists of five categories, however, the study classifies them into low (less than 3 million IDR) and high (more than 3 million IDR) because of the respondent characteristics.[21]

Menstrual status is examined based on whether they have menstruated or not. Consumption of iron supplements is whether they took iron tablets in the last week.[20] Deworming consumption is

whether they took deworming medication for six months.[20] BMI results from dividing body weight (kilograms) by the square of height (meters).[22] According to the WHO, the nutritional status of adolescents uses BMI-for-age with criteria based on Z-score. There are four categories such as severe thinness (<-3 SD), thinness (< -2 SD), normal (-2 SD to +1 SD), overweight (>+1 SD), and obesity (>+2 SD)[23]. This study classifies them into normal (-2 SD to +1 SD) and the others as abnormal.

Descriptive statistics determines the subject characteristics in terms of frequency and percentage. A Chi-square test determines the relationship between risk factors and anemia based on three categories: no anemia (normal), mild anemia, and moderate/severe anemia through a significance p-value <0.05. Multiple logistic regression test (OR with 95.0% CI) analyzes the association of several risk factors with the incidence of anemia in adolescent girls 10 to 19 years old.

Results

A total of 355 adolescent girls enrolled across 12 schools participated in the study. The prevalence of anemia was 114 adolescents (32.1%)(Figure 1). About 21.1% of them were from SMPN 1 Mendawai. Moderate anemia was the most common (15.8%), followed by mild (14.6%) and severe (0.8%). Hemoglobin's mean was 13.0 g/dL.

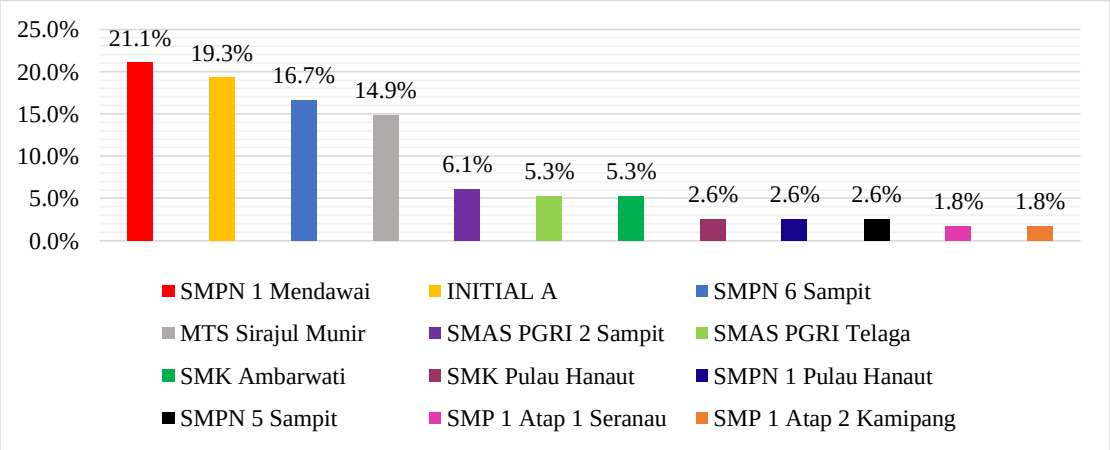

Figure 1. Prevalence of Anemia among Secondary School Adolescent Girl's Anemia

The majority of anemia patients were adolescent girls aged 10-14 years (32.1%), low-income parents (69.9%), literate parents (91.3%), already menstruating (31.9%), not taking iron supplements in the past week (35%), not taking deworming tablets in the past six months (n=96, 30.7%), and normal BMI (30.1%).

Based on socio-demographic characteristics (Table 2), the majority of adolescent girls were aged 10 to 14 years (55.2%), had literate parents (91.3%), and had low-income parents (69.6%). For health status (Table 2), around 89,3% had menstruating, and 74,9% did not consume iron

supplements in the last week. Most adolescent girls did not take deworming tablets in the last six months (88.2%) and had normal BMI (64.5%).

Based on bivariate analysis (Table 2) between risk factors and the three categories of anemia (no anemia, mild anemia, and moderate/severe anemia), consumption of iron supplements in the last week had a significant association with the incidence of anemia (p-value < 0.05). Adolescent girls who did not consume iron supplements in the last week were associated with anemia compared to those who consumed them.

Table 2. Adolescent Girls' Characteristics (10-19 years) Based on Risk Factors

Risk Factors	No Anemia (N=244)	Mild Anemia (N=52)	Moderate/Severe Anemia (N=59)	*p-value*
Age				
10-14 years	133 (67.9)	29 (14.8)	34 (17.3)	0.907
15-19 years	111 (69.8)	23 (14.5)	25 (15.7)	
Parent's Education				
Literate parents	219 (67.6)	48 (14.8)	57 (17.6)	0.236
Illiterate parents	25 (80.6)	4 (12.9)	2 (6.5)	
Parental Income				
Low (<Rp3.000.000)	167 (67.6)	39 (15.8)	41 (16.6)	0.647
High (>Rp3.000.000)	77 (71.3)	13 (12.0)	18 (16.7)	
Menstruation Status				
Having menstruated	216 (68.1)	50 (15.8)	51 (16.1)	0.201
Non-menstruating	28 (73.7)	2 (5.3)	8 (21.1)	
Consumption of iron supplements in the last week				
Yes	71 (79.8)	10 (11.2)	8 (9.0)	0.027*
No	173 (65.0)	42 (15.8)	51 (19.2)	
Consumption of deworming tablets in the last six months				
Yes	27 (64.3)	4 (9.5)	11 (26.2)	0.164
No	217 (69.3)	48 (15.3)	48 (15.3)	
Body Mass Index (BMI) for Age				
Normal	166 (72.5)	30 (13.1)	33 (14.4)	0.118
Not Normal	78 (61.9)	22 (17.5)	26 (20.6)	

Value is n (%). p-values analyzed by Chi-Square.
**p-value < 0.05 interpreted as correlating with the dependent variable.*

Multivariable analysis (Table 3) revealed that consumption of iron supplements in the last week and BMI for age were associated with anemia. Consumption of iron supplements was strongly associated with anemia with PRs 0.450 (95% CI: [0.253-0.802]). It means that adolescent girls who did not consume iron supplements in the past week had a 0.450 times risk of anemia compared to those who consumed them. The odds of anemia were higher in adolescent girls with BMI-for-age not normal (PR: 1.599, 95% CI: [1.005-2.544]).

Table 3. Multiple Logistic Regression Analysis on Risk Factors Associated with Anemia among Adolescent Girls (10-19 years)

Variable	Category	Anemia		*p-value*	*Prevalence Ratio (95.0% CI)*
		Yes	No		
Parent's Education	Illiterate parents	108 (33.3%)	216 (66.7%)	0,123	0,481 (0,190 – 1,218)
	Literate parents	6 (19.4%)	25 (80.6%)		
Consumption of iron supplements in the last week	No	96 (36.1%)	170 (63.9%)	0,006	0,450 (0,253 – 0,802)
	Yes	18 (20.2%)	71 (79.8%)		
Body Mass Index (BMI) for Age	Not Normal	49 (38.9%)	77 (61.1%)	0,047	1,599 (1,005 – 2,544)
	Normal	65 (28.4%)	164 (71.6%)		

Discussion

Iron deficiency is the leading cause of anemia among children and women of childbearing age.[24] WHO recommends iron-folic acid supplementation to all women during pregnancy, adolescents, and school-aged children.[14] Through the Public Health Center, the Indonesian government has a program to provide blood supplement tablets to prevent anemia, which began in 2014.[8] The program targets adolescent girls ranging from 12 to 18 years of age in junior and senior high school or equivalent. A school-based weekly iron supplementation could increase hemoglobin levels and reduce anemia rates among adolescent girls in Ghana.[14] The Indonesian Health Survey 2023 states that the proportion of adolescent girls 10 to 19 years old who received or bought iron supplements in the last 12 months in Central Kalimantan was only around 72.8%. This figure is still below the national figure of 73.5%.[4]

One-third of adolescent girls had anemia. Adolescent girls who did not consume iron supplements in the past week had a 0.450 times risk of anemia compared to those who consumed them. The study in India also found that Northeast adolescent girls who did not consume iron supplements in the past week were associated with anemia compared to those who consumed them.[20] The mean hemoglobin and ferritin levels increased in 200 adolescent girls of Haryana, India who completed 90 doses of daily supplementation.[25] Likewise Ghanaian adolescent girls, hemoglobin increased by 0.15 g/dL after the iron folic acid (IFA) intervention for 1 year.[14] The prevalence of anemia among adolescent girls was found in Weekly Iron Folic Acid Supplementation (WIFAS) non-implemented schools in Kathmandu (20,9%) than implemented (14%).[26] This finding is consistent with previous studies on adolescent girls in Indonesia such as SMPN 1 Gunungsari (Banten)[27] and Soreang (Jawa Barat).[9] If anemia persists in teenage girls, it can lead to decreased cognitive ability and inhibit their growth. Adolescent girls have a lack of concentration and focus, poor performance, and reduced exercise tolerance.[28] If it continues into

adulthood, anemia increases the risk of a mother giving birth to a premature baby, low birth weight, and stunted children.[8]

BMI-for-age was associated with anemia (Table 3). Adolescent girls who have BMI-for-age not normal had a 1.599 times risk of anemia compared to those who are normal. Abnormal BMI (underweight, overweight, and obesity) can cause other health problems. The previous study showed that those who were underweight had more than double the risk of anemia compared to those with normal weight.(29) Underweight can increase the risk of osteoporosis, weaken the immune system, interfere with the respiratory system, cause infertility in women, reduce cognitive abilities, and slow maturity.[25] Overweight was significantly associated with anemia among adolescent girls at Islamic Boarding School. The research found an odds ratio 3,658 which means that overweight girls are 3.6 times more at risk of anemia than normal.[31] Obesity can decrease the risk of anemia in adolescents aged 10-13 years.[32] Being overweight and obese also can increase the risk of non-communicable diseases in adulthood such as type 2 diabetes and cardiovascular disease.[33]

Adolescent girls who experience anemia are mostly aged 10 to 14 years. This age range is the first and second highest age of adolescents who first menstruate in Central Kalimantan.[4] The proportion of anemia by age is 34.5% (11-12 years) and 24.0% (13-14 years). Adolescents at the age group of 10-13 years experience rapid growth, very active metabolism, and body changes occur.[32] The adolescent was having menstruated at this age. Adolescent girls who had started menstruating should be considered because it is the risk factor for anemia with an odds ratio of 2.58.[34] Menstruation is a natural process of adolescent girls in puberty where blood is released as much as 50-80 cc and iron as much as 30-40 mg per menstrual period.[35] If there is a nutritional imbalance such as less iron intake, it can lead to anemia.[34,36] Nutrition education, such as anemia, iron supplements, and healthy food, is essential. Education can increase dietary iron and vitamin C intake and reduce anemia. [34,37] E-booklets can be used as an educational innovation.[38]

Most of the adolescent girls also showed that they had experienced menstruation. Although menstrual status is not associated with anemia, the percentage of anemic girls who had menstruated (31.9%) is greater than those who had not (26.4%). Another study also has reported that anemia was more common in adolescents who were already menstruating (8,6%) than those who were not (0,5%).[32] Iron supplementation can prevent anemia in girls who have menstruated. However, the percentage of them was not much different with girls who did not consume iron supplements in the past week (35.0%). It means some adolescent girls have menstruated but did not consume iron supplements in the past week. Our findings were similar to a previous study in Karanganyar, menstruation status such as the first occurrence, bleeding quantity, and cycle duration and regularity were not associated with anemia.[29]

Although consumption of deworming tablets during the last six months was not associated with anemia, the percentage of anemia was higher among adolescent girls who did not consume deworming tablets. Consuming deworming tablets once every six months could not be ignored to prevent intestinal parasite infections. Having intestinal parasite infections may increase the risk of anemia by 2.84 times.[15] Parasite infection may interfere with nutrient absorption and metabolism or increase nutrient losses.[39] Our findings were different from the previous study in South India, adolescents who did not consume deworming tablets in the last six months had a 1.77 times risk of anemia.[20] Anemia decreased in preschool children who took multiple micronutrient supplements and deworming drugs six months before the survey.[40]

Parent education has no significant relationship with anemia similar to the study among Indians aged 10-19 years old.[20] However, it is necessary to conduct further qualitative studies to determine the causes of anemia in adolescent girls with literate parents because the study found that anemia occurs among literate parents. Each study has a different definition of parental (mother and father) education level. The previous finding divided them into four categories as primary school, secondary school, senior high school, and bachelor's degree. It was found that there was no relationship between father's and mother's education and anemia,[31] similar to the study in rural western China.[41]

Our findings on the association between parental income and anemia are aligned with previous studies on adolescents in India.[20] Table 2 shows that low-parental income has a higher anemia than high-income. Adolescents from high-income households had less probability of being anemic, with an odds of 0.55.[41] Individuals from higher socioeconomic may have adequate access to healthcare services (including iron supplementation and deworming), food diversity, and consume healthy food. [39,41] Parent education and income are indeed distal factors, which means indirect causes as a cause of anemia.[20]

The limitations of this study are seen in the method, the participants, and the hemoglobin measuring. Cross-sectional studies only show associations, not causality. There was social bias among teenage girls because they may answer the questionnaire according to their desire to look good by choosing the most positive answer. Hemoglobin screening uses a digital hemoglobinometer because of its practical use reaching the target of 12 schools. The study could not identify the specific causes of anemia in each individual from blood.

Conclusion

Anemia is a problem for adolescent girls in several schools in Central Kalimantan. Consumed iron supplements in the past week and BMI-for-age were significantly associated with anemia among secondary school girls. They did not take advantage of the government's iron supplementation given to secondary school girls aged 12 to 18 years or equivalent. The

supplementation target should be 10-19 years because anemia was common in the 10-14 age group. Consuming a healthy diet with micronutrients such as iron, vitamin B12, folic acid, vitamin A, and vitamin C is important to prevent anemia. In addition, the government should provide health education for adolescent girls, especially about the impact of anemia and nutrition intake, and monitor iron supplement consumption at least once a month by health workers and counseling teachers.

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Conflict of Interest

The authors have no conflict of interest in this research.

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