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RESEARCH ARTICLE **OPEN ACCESS**

Nutritional Deficiency Anemia Status among Adolescent Girls in North Lombok District, West Nusa Tenggara, Indonesia

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Abstract:

Introduction: Anemia is a major health problem affecting adolescents worldwide. This problem should receive proper attention due to its significant adverse health, social, and economic impacts. This study aims to collect comprehensive data and factors associated with anemia status in adolescent girls.

Methods: This study used a quantitative approach with a cross-sectional study method. The population was all girls aged 15-19 in the working area of Bayan and Gangga Health Centers, North Lombok, Indonesia. The sample size was 400. Anemia status was determined by hemoglobin examination, incidence of Chronic Energy Deficiency (CED) status, and nutritional status by mid-upper arm circumference (MUAC) measurement and body mass index-for-age Z-score measurement.

Results: A total of 76% of adolescents were anemic. Tests showed a strong link between anemia and: hematocrit level, CED, and nutritional status in adolescent girls ($p < 0.05$). The tests showed a strong link between CED status and anemia in adolescent girls ($p < 0.05$).

Conclusion: Adolescent girls who experience iron deficiency anemia are more likely to be found in those who experience CED. Adolescent girls must pay more attention to adequate and varied food intake to improve nutritional status and prevent iron deficiency anemia.

Keywords: Anemia, Adolescents, Girl, Chronic energy deficiency, MUAC, BMI.

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1. INTRODUCTION

The adolescent population is estimated at 1.8 billion, almost one-fifth of the world population. About 87-90% of these adolescents live in developing and developed countries [1]. Adolescence is an important period during which physical growth occurs rapidly; height can increase by up to 20%, weight by 40%, and bone mass by up to 60%. All organs, including muscle mass, heart, lungs, and kidneys, also develop rapidly at this stage. To support increased muscle mass, adolescents require calcium and vitamin D intake, but unfortunately, between 17% and 47% of adolescents are vitamin D deficient, with this prevalence being higher than that of children [2].

Increased iron requirements are crucial to compensate for blood loss during menstruation, leading to greater nutritional demands. Hence, health issues such as anemia and under-nutrition have become a primary concern that needs to be addressed, given their significant impact on adolescents' health and social and economic well-being worldwide [3]. Adequate physical growth is a crucial indicator of health in childhood through adolescence. Globally, the prevalence of underweight among children and adolescents is 8.4% among girls [4]. The World Health Organization (WHO) defines anemia as hemoglobin (Hb) levels below 11 g/dL for girls and below 12 g/dL for boys [5]. Worldwide, about 24.8% of adolescent girls are anemic [6].

In Indonesia, the prevalence of anemia among women aged (15-49 years) increased from 21.6% in 2018 to 22.3% in 2019 [7]. Basic Health Research data shows an increasing trend in anemia among adolescents, year by year. For ages 5-14, prevalence rates were 9.40%, 26.40%, and 26.80%. For ages 15-24, it rose to 6.90%, 18.40%, and 32% in 2018. This means that 3-4 out of 10 adolescents are anemic. That's about 7.5 million Indonesian adolescents at risk of stunted growth, poor cognitive development, and infectious diseases [8]. Anemia in adolescents is a moderate public health issue (20-39%). The global target is to cut anemia rates by 50% from a baseline of 14.3% by 2025 [9]. According to WHO, anemia in adolescents can negatively affect physical growth, cognitive development, and individual productivity. In addition, poor nutritional status can affect the health of future mothers and fetuses, so it is important to make efforts for prevention and early detection [10].

In West Nusa Tenggara Province, the prevalence of anemia reached 48%, much higher than the national average [11]. The 2018 Indonesian Demographic and Health Survey (IDHS) found that only 3.7% of reproductive-age women received over 52 iron tablets in the past year, and only 1.4% consumed the tablets. In West Nusa Tenggara Province, iron tablet acceptance among adolescent girls varied from 52.79% in 2017 to 30.08% in 2020. In 2019, it was 44.58% and 67.19% [12].

North Lombok Regency is the youngest of the ten regencies in West Nusa Tenggara Province. It was created by Indonesian Law No. 26 of 2008 on July 21, 2008 [13]. In mid-2018, a 7.0 S.R. earthquake hit North Lombok. It caused a disaster on Lombok Island. Then, in 2020, came the Covid-19 pandemic. This condition caused damage to all infrastructure and stalled activities in various sectors.

Based on data on the percentage of poverty in the province and districts/cities in West Nusa Tenggara in 2023-2024. North Lombok Regency has the highest poverty rate in West Nusa Tenggara, 25.80%. The distribution of extreme poverty pockets in North Lombok Regency is in the Bayan and Gangga sub-districts. Bayan Village, in Bayan Sub-district, has the most poor people. There are 372 families or 1,543 individuals [14].

In post-disaster areas, adolescents may have poor nutrition. Nutrition case management prioritizes vulnerable groups, like children under five and pregnant women. It does not focus on them. Besides, family food security and the community's economy change. This affects family nutrition, including that of adolescents [15].

The preliminary study found no cases of anemia in adolescent girls. This was due to a lack of coordinated hemoglobin (Hb) screening exams. Related parties have made independent requests for the team to conduct Hb screening. Anemia data in each health center is only obtained from adolescent girls who come with complaints of anemia. The problem is worse due to limited funds for screening. Also, there are too few adolescent program officers for the many schools and students needing routine checks. Thus, this study aimed to collect comprehensive data and factors associated with anemia status in adolescent girls.

2. MATERIALS AND METHODS

This study used a quantitative, cross-sectional approach to evaluate anemia in adolescent girls. It measured Hematocrit, mid-upper arm circumference (MUAC), and BMI. The study included all girls aged 15-19 in the work areas of Bayan and Gangga Health Centers. The total sample was 400. The sampling technique was carried out randomly (random sampling) on students attending schools in the Bayan area.

Healthcare professionals check for anemia using the HemoCue Hb 301 Microcuvette. They test hemoglobin (Hb) and hematocrit (Ht) levels. The anthropometric method assesses nutritional status. It measures body weight with the OneMed BR 9707 scale and height with a microtoice. Anthropometric data were then analyzed to determine the Body Mass Index according to age (body mass index-for-age z-score). A tape measure was used to measure mid-upper arm circumference (MUAC). Adolescents who are anemic have Hb levels <12 g/dL. Hematocrit levels were abnormal if they were <38% or >48%. Chronic Energy Deficiency (CED) was if the mid-upper arm circumference was <23.5 cm. Underweight status was if the body mass index-for-age Z-score was <18.4.

After two days of training, researchers and enumerators collected height and weight data. Health center officers measured Hb and Ht. Before the study, we explained its purpose. Then, we provided informed consent for adolescents and parents to sign. The aims and objectives of the research were also written in the informed consent.

After the respondent signs the consent form, the researchers must get the parents' consent before testing. Also, the researchers take the parents' consent as proof of their willingness to take part in this study.

Data analysis used SPSS ver. 25. It used bivariate analysis with a chi-square test. It also used multivariate analysis with a logistic regression test. The study obtained a research ethics permit. Its protocol number is 5368/UN4.14.1/TP.01.02/2023. It is from the Faculty of Public Health Research Ethics Committee, Hasanuddin University.

3. RESULTS

This study surveyed 400 adolescent girls. The distribution is split into equal parts. 200 came from the Gangga sub-district and 200 from the Bayan sub-district. The following are the results of the analysis of respondent characteristics:

Table **1** shows that the characteristics of the sample based on age consisted primarily of adolescents aged 15-17 years, totaling 355 individuals, which represents 88.8%. In the BMI category, most adolescents were underweight (52.5%). Normal-BMI adolescents were 168 (42%). Overweight adolescents were 22 (5.5%). In the Anemia Status category, 304 adolescents (76%) had anemia. 96 adolescents (24%) did not. In the Hematocrit Level category, most adolescents had abnormal levels. This included 355 (88.8%) in the Mid-upper arm circumference (MUAC) category. Also, 288 adolescents had a MUAC <23.5 cm, indicating Chronic Energy Deficiency (CED). The respondents, based on class, had 32 adolescents (8%) in class IX, 137 (34.3%) in class X, 113 (28.2%) in class XI, and 118 (29.5%) in class XII.

Table **2** shows that the age group 15-17 has the most adolescent anemia (75.8%). The statistical test results of Age on Adolescent Anemia Status showed a value of p=0.767 (p>0.05), which means there is no correlation between age and anemia status in adolescents. Adolescents with normal hematocrit levels and not anemic status were 45 adolescents (100%). Adolescents with abnormal hematocrit levels had a higher incidence of anemia, specifically 304 adolescents, which represents 85.6%. Statistical tests showed a correlation between hematocrit level and anemia in adolescents, with p=0.001 (p<0.05). Anemia is more common in adolescents with CED (85.1%) than in normal adolescents. Tests also showed a link between CED and anemia status (p=0.001). The bivariate analysis found that underweight adolescents had the most anemia, at 81.9%. Statistical tests showed a significant link between BMI category and anemia status.

Table 1. Respondent characteristics.

Variable	n =400	%
Age (in years)		
15-17	355	88.8
18-19	45	11.3
BMI		
Underweight	210	52.5
Normal	168	42
Overweight	22	5.5
Anemic Status		
Not anemic	96	24
Anemia	304	76
Hematocrit Level (Ht)		
Normal	45	11.3
Not Normal	355	88.8
Incidence of Chronic Energy Deficiency (CED)		
Normal	112	28
CED	288	72
Class		
IX	32	8
X	137	34.3
XI	113	28.2
XII	118	29.5
School		
Almakrif Gangga High School	20	5
Bayan High School	126	31.5
Gangga High School	129	32.3
Gangga Vocational High School	74	18.5
Gangga 1 Public Vocational High School	21	5.3
SATAP Gangga	30	7.5

Note: Source: Primary Data, 2023.

Table 2. Bivariate analysis results.

Variable	Anemic Status				Total		*p*-value
	Not Anemic	%	Anemia	%	n	%	
Age (in years)							
15-17	86	24.2	296	75.8	355	100	0.767
18-19	10	22.2	35	77.8	45	100	
Hematocrit Level (Ht)							
Normal	45	100	0	0	45	100	0.001
Not Normal	51	14.4	304	85.6	355	100	
Incidence of Chronic Energy Deficiency (CED)							
CED	43	14.9	245	85.1	288	100	0.001
Normal	53	47.3	59	52.7	112	100	
BMI							
Overweight	6	27.3	16	72.7	22	100	0.014
Underweight	38	18.1	172	81.9	210	100	
Normal	52	31	116	69	168	100	

Note: Source: Primary Data, 2023.

Table 3. Results of logistic regression test of associated variables in bivariate analysis.

Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Hematocrit Level (Ht)	-23.110	5670.300	.000	1	0.997	0.000
Incidence of Chronic Energy Deficiency (CED)	-1.754	0.354	24.577	1	0.000	0.173
BMI	-0.490	0.578	0.718	1	0.397	0.613
Constant	2.702	0.619	19.064	1	0.000	14.912
Variable(s) entered in step 1: Hematocrit, CED, BMI						

Note: Source: Primary Data, 2023.

Table **3** shows the results of the multivariate analysis. One variable that remained significant to the status of anemia in adolescents was the incidence of CED, with a *p*-value of 0.000 (<0.05). In contrast, the Hematocrit and BMI variables had a value of p=0.997 and p=0.397, respectively; this indicates that the Hematocrit and BMI variables do not have a correlation with anemia status in adolescents.

4. DISCUSSION

Women have the highest risk of suffering from anemia, especially adolescent girls [16]. Anemia in adolescent girls is a major public health issue, especially in developing countries. The prevalence of anemia in girls aged 15-24 is around 32%, which means 3-4 out of 10 adolescents suffer from anemia [17, 7]. The results showed that anemia affected 76% of adolescents or 304 individuals. A 2024 study found several risk factors for iron deficiency anemia in adolescents in developing countries. They are: food intake practices, parasitic infections, menstruation, and low parental education [18]. Anemia can lead to lethargy, reduced memory ability, and suboptimal academic performance. Anemia also increases the risk of maternal death, premature birth, and low birth weight in subsequent pregnancies [19].

The results showed that 75.8% of 15-17 year-olds had anemia. This age group has the highest rate of adolescent anemia. Adolescence is a time of growth toward adult maturity. Adolescence brings continuous changes in a person's physical, biological, and psychological state. An imbalance between intake and needs causes nutritional problems. These include both undernutrition and overnutrition [20]. Anemia in adolescents (10-19 years) is a major cause of illness and death in low- and middle-income countries. It has long-term health and economic effects [21].

Most adolescents in the Hematocrit level category had abnormal hematocrit values, with a count of 355 representing 88.8%. Hematocrit (Ht) is the percentage of red blood cell (RBC) volume in the blood. Hematocrit values are expressed in units of percent (%). Each person has a different normal range of hematocrit, depending on age and gender [22]. If the hematocrit test result is below the normal range, this condition indicates a reduction in the number of red blood cells in the body. Low hematocrit levels usually indicate anemia, which can be caused by iron, folate, or vitamin B12 deficiency [23]. Hematocrit in adolescents can fluctuate depending on age, gender, and nutritional status. The bivariate test results showed that the hematocrit value was related to anemia status in adolescents with a value of p=0.001 (p<0.05). The multivariate test found no link between hematocrit and anemia status. Hematocrit is a key test for diagnosing anemia. But, its accuracy can be affected by various factors, including the context in which it is used. Hematocrit and hemoglobin are highly correlated. But, in

children, it may vary. Researchers recommend directly determining hemoglobin in clinical and epidemiological studies for accurate anemia assessment.

The mid-upper arm circumference (MUAC) is used to measure nutritional status and can describe fat reserves in the body. A person's upper arm circumference determines the risk of chronic energy deficiency (CED) [24]. The study found that 288 adolescents had a mid-upper arm circumference (MUAC) <23.5 cm, indicating Chronic Energy Deficiency (CED). Statistical tests showed that MUAC was linked to anemia in adolescents (p=0.001). Multivariate tests showed that MUAC was also significant for anemia (p=0.000). Low energy and protein intake can cause deficiencies. They reduce the body's resistance to infection and impair nutrient absorption, including iron. Iron is abundant in animal protein, and if there is impaired iron absorption, there will be a possibility of anemia [24].

Previous research that has been conducted found that there is a correlation between the size of the upper arm circumference and the incidence of adult adolescent anemia. The results showed that the lower the arm circumference value, the lower the hemoglobin level, and vice versa. The correlation between upper arm circumference and the incidence of anemia was 66% [25]. A study indicated that there is a significant relationship between MUAC and anemia among female adolescents. Specifically, those with lower MUAC sizes had a higher prevalence of anemia. The odds ratio suggested that adolescents with inadequate MUAC were approximately 2.447 times more likely to experience anemia compared to those with normal MUAC sizes [26].

There is a positive correlation between mid-upper arm circumference and anemia, particularly in vulnerable groups such as adolescents and pregnant women. Adequate MUAC is a key indicator of nutritional status. It helps prevent anemia and improve health outcomes. Studies have also explored the broader implications of MUAC as an indicator of nutritional status across different demographics. For instance, research has shown that women with lower MUAC are at higher risk for chronic energy deficiency (CED), which is associated with increased rates of anemia [27, 28].

Body Mass Index (BMI) is a simple measurement tool to monitor nutritional status. Nutritional status positively correlates with Hemoglobin concentration, meaning that the worse a person's nutritional status, the lower the Hb level [28]. The studies show a link between BMI and anemia. Underweight people are at higher risk for anemia. Overweight and obese people may have lower risks in some cases. These findings suggest that nutrition affects hemoglobin levels and anemia rates. The bivariate analysis found that 81.9% of underweight adolescents had anemia. A statistical test showed a significant link between BMI and anemia. This finding aligns with Gebreyesus's 2019 research. It found a link between anemia and BMI. Participants with a low BMI had a 3.2 times greater chance of having anemia [29].

A study in Indonesia found that underweight adolescent girls had a 1.4 times higher risk of anemia than those with a normal BMI. Their BMI was below 18.5. This shows that poor nutritional status, such as underweight, can increase the risk of anemia [30]. Research conducted by Dewi in 2024 showed that there was a correlation between BMI and the incidence of anemia in adolescent girls. The results of the correlation test with chi-square show that p = 0.037 ($p < 0.05$) indicates a correlation between BMI and anemia. Adolescents with a normal BMI have a more negligible risk of anemia because food already contains all the nutrients the body needs [31]. There is also a study analyzing non-pregnant women aged 19–49 years found a significant association between low MUAC and increased rates of anemia. The highest prevalence was in underweight women with low MUAC (43.8%). Overweight/obese women with normal MUAC had the lowest rates (18.2%). This indicates that both BMI and MUAC are important indicators of nutritional health related to anemia [27].

A BDHS data analysis found that underweight women were more likely to be anemic. In contrast, overweight and obese women had a lower risk. The study used various statistics to assess the link between BMI and hemoglobin levels. It found that a higher BMI is linked to a lower anemia risk in women aged 15-49 [32].

Like other studies, this one has limitations. It used a cross-sectional design to collect respondents at one time and place. This was due to a busy study schedule and many traditional cultural rituals.

CONCLUSION

The high rates of anemia, CED, and underweight BMI in this study show a high prevalence of nutritional problems among adolescents. This highlights the need to focus on the school environment and individual factors that affect nutrition. Adolescent girls experiencing CED are more often found to have adolescent iron deficiency anemia. Adolescent girls need to pay more attention to food intake in sufficient and varied quantities to improve their nutritional status and prevent iron deficiency anemia. Educational programs regarding balanced nutrition and routine health checks need to be implemented to prevent and reduce the prevalence of anemia.

AUTHORS' CONTRIBUTION

It is hereby acknowledged that all authors have accepted responsibility for the manuscript's content and consented to its submission. They have meticulously reviewed all results and unanimously approved the final version of the manuscript.

LIST OF ABBREVIATIONS

CED	=	Chronic Energy Deficiency
MUAC	=	Mid-upper arm circumference
BMI	=	Body Mass Index
Hb	=	Hemoglobin

Ht	=	Hematocrit
WHO	=	World Health Organization
RBC	=	Red Blood Cell

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study received ethical approval from the Faculty of Public Health Research Ethics Committee University of Hasanuddin, Indonesia under protocol number 5368/ UN4.14.1/TP.01.02/2023.

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Informed consent was obtained from the participants.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The authors confirm that the data supporting the findings of this research are available within the article.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial, or otherwise.

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Declared none.

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