

Analysis of Ferritin Levels as a Risk Factor for Anemia in Adolescent Girls on the West Lombok Coast

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Abstract: Iron deficiency anemia (ADB) is a nutritional disorder that often occurs, especially in adolescent girls, due to increased nutrient requirements during growth and menstruation. Assessing ferritin levels is an important step in determining the status of iron stores in the body and identifying individuals at risk of iron deficiency anemia, especially in resource-constrained environments such as coastal areas. This study aims to determine the prevalence of anemia and iron deficiency in adolescent girls in the coastal areas of Lombok, Indonesia and analyze the relationship between ferritin levels as a risk factor for the incidence of iron deficiency anemia. The design of this study was a *cross-sectional* study conducted on 101 young women aged 15 - 19 years in the coastal areas of West Lombok. Ferritin levels were measured to determine iron deficiency status (< 15 ng/ml) and hemoglobin levels were used to determine anemia in adolescent girls (HB < 12 g/dl). The *Chi-Square* and relative risk tests were used for statistical analysis of the relationship and risk between iron deficiency and the incidence of anemia. The results of the study found that the prevalence of iron deficiency was 40 (39.6%) and anemia was 21 (20.79%). Of the respondents who experienced anemia, 13 (61.9%) were iron deficiency anemia. There was a significant association between anemia and iron deficiency ($p = 0.004$) and an *odd ratio* value of 4.154 was obtained, indicating that adolescent girls with iron deficiency (low ferritin levels) had a 4.154 times greater risk of developing anemia compared to adolescent girls with normal ferritin levels.

Keywords: ferritin, hemoglobin, iron deficiency anemia, adolescent girls, coastal areas

Introduction

Anemia is a condition characterized by a decrease in the volume of red blood cells and a decrease in the concentration of hemoglobin in the blood. In general, anemia is the end result of a nutritional deficiency of iron, folate, vitamin B12 and several other nutrients. Although many other causes of anemia such as bleeding, infections, genetic disorders, and chronic

diseases have been identified, nutritional deficiencies, mainly due to a lack of biologically available iron, account for the majority of anemia cases (Chapparo and Suchdev, 2019). The most common cause of anemia worldwide is iron deficiency. Iron is an important component of the hemoglobin molecule (Kulik and Dubel, 2023). Iron deficiency anemia is a common health problem among adolescent girls, especially in developing countries. According to the *World*

Health Organization (WHO), the prevalence of anemia among adolescent girls worldwide reaches 20 - 25%, with iron deficiency as the main cause (WHO, 2022). In Indonesia, based on Riskesdas 2018 data, the prevalence of anemia in adolescent girls reached 26.8%. This group is prone to ADB due to the high need for iron for growth and development and the presence of blood loss due to menstruation.

Iron is essential for most living beings, as it plays a role in various vital processes ranging from the oxidative mechanisms of cells to the transport of oxygen to tissues. Iron homeostasis is regulated primarily by iron absorption and not by excretion; Therefore, the iron levels in the serum reflect the balance between the amount of iron absorbed and the amount used by the body. Iron deficiency develops gradually and progressively until anemia occurs. The first stage of anemia consists of iron depletion or negative iron levels. It is characterized by a period of greater vulnerability (affecting iron stores) and can slowly progress to more severe deficiency, with functional consequences. When iron stores are depleted, ferritin levels drop, with an iron value of <12 ng/ml corresponding to depleted iron stores

In coastal areas, the prevalence of anemia tends to be higher due to low socioeconomic conditions, lack of access to nutritious food and a high risk of infections such as worms which often cause chronic blood loss (Yuniarti et al, 2017). According to research by Kumar et al. (2022), iron deficiency in adolescent girls is often associated with insufficient iron intake and low iron absorption. Therefore, ferritin examination or iron deposits of the body can be used as an important indicator to assess the nutritional status of iron in this group of adolescents. This research is important to do because anemia in adolescent girls, especially iron deficiency anemia, can interfere with reproductive health in the future and potentially increase the risk of stunting in children to be born. The purpose of this study is to analyze ferritin levels as a risk factor for iron deficiency anemia in adolescent girls in coastal areas of Lombok Island.

Materials and Methods

This study is a descriptive analytical research, and uses a *cross-sectional* approach.

The respondent is a student of SMA Negeri 1 Lembar, West Lombok who is 12-19 years old in August 2024, in accordance with the inclusion criteria and consent sheet for blood sampling. The data collection technique used research instruments in the form of questionnaires and blood sampling for laboratory examinations to measure serum ferritin levels using the ELISA (*Enzyme Linked Immunosorbent Assay*) method and examination of hemoglobin levels with hematology *auto analyzers*. Ferritin levels <15 ng/ml are defined as iron deficiency, while hemoglobin levels < 12 g/dL are declared as anemia (who, 2022). Statistical analysis was performed using the *Chi square test* to see the relationship between ferritin levels and the incidence of anemia, and the relative risk was calculated to determine the magnitude of the risk of anemia in adolescent girls with iron deficiency.

This research has met the ethical *clearance* requirements obtained from the ethics commission of the Faculty of Medicine and Health Sciences, University of Mataram No. and all data and samples have been accompanied by an *informed consent* sheet.

Results and Discussion

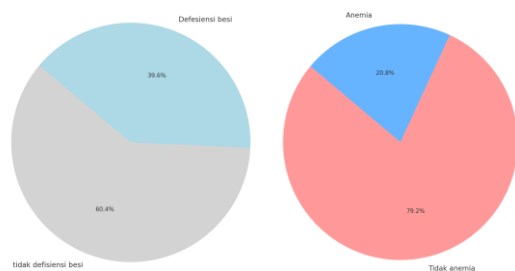
Respondent Characteristics

The respondents who participated in this study were 107 students who were included in the inclusion criteria and filled out questionnaires. However, only 101 students could have their blood samples taken, 4 students were not successfully taken blood samples because 2 refused and 4 blood counts were not eligible for ferritin and hemoglobin levels were not checked. The general characteristics of the respondents can be seen in table 1 (appendix 1).

Overview of Ferritin Levels and Incidence of Anemia

Of the 107 respondents, 2 respondents refused to have their blood samples taken and 4 of the respondents did not meet the requirements for laboratory examination, so that only 101 samples could be checked for ferritin and hemoglobin levels. From the results of laboratory examinations, ferritin levels were obtained that 40 (39.6%) female students experienced iron deficiency, namely with ferritin levels < 15 ng/dl

and 61 (60.4%) female students with normal ferritin levels. Meanwhile, for hemoglobin levels, 21 (20.79%) students experienced anemia, namely their hemoglobin levels were < 12 g/dl and 80 (79.21%) normal hemoglobin levels. An overview of the percentage of iron deficiency and anemia can be seen in figure 1.



Picture 1. Description of the incidence of iron deficiency and anemia in respondents.

Analysis of Ferritin Levels as a Risk Factor for Anemia Incidence

To analyze the relationship between ferritin levels and the risk of anemia incidence, a *cross-tabulation table* was made, as shown in Table 1, and the relationship between ferritin levels and anemia incidence was performed with a *chi-square* test with a result *p value*=0.004 which showed that there was a significant relationship between ferritin levels and anemia incidence. Further analysis using *cross tabulation* and calculating the risk factor value of iron deficiency to the incidence of anemia, an *Odd Ratio* value of 4.154 was obtained, which means that adolescent girls with iron deficiency (low ferritin levels) have a 4.154 times greater risk of developing anemia compared to adolescent girls with normal ferritin levels.

Table 1. *Cross-tabulation* of status of ferritin levels and hemoglobin levels

Hb Rate Status	Status Kadar Ferritin		Total	
	Deficiency Iron n (%)	No Iron Deficiency n (%)		
Anemia n (%)	14(13,86)	7(6,93)	21(20,79)	p = 0,004 OR = 4,154
No Anemia n (%)	26(25,74)	54(53,47)	80(79,21)	
Total	40(39,6)	61(60,4)	101(100)	

The results of the study showed that out of a total of 14 (13.86%) respondents, they had iron deficiency anemia, but if calculated from 21 (20.79) female students who experienced anemia, there were 14 (66.6%) students who had iron deficiency anemia. For students who are not anemic, but have iron deficiency of 26 (25.74%), where these students need to be evaluated so as not to fall into anemia.

Discussion

Ferritin Levels and Incidence of Anemia

In accordance with the WHO guidelines on ferritin testing to assess iron status in individuals and populations, which states that healthy individuals without inflammation aged 10 – 20 years are declared iron deficient if serum ferritin levels < 15ng/dL and in this study, based on these guidelines, the results of laboratory tests of ferritin levels in this study were obtained by 40 (39.6%) female students with iron deficiency. These results are in line with research by Mohamed Aabdien, et al (2022) which examined ferritin levels in adolescents aged 10 – 19 years and found a prevalence of iron deficiency of 26.4%. In Indonesia, a study by Eka S Sumarlan, et al. (2018) on Iron Status, Prevalence and Risk Factors for Iron Deficiency Anemia in adolescents aged 12-15 years found that the prevalence of iron deficiency without anemia was 17.2%. The high prevalence of iron deficiency in adolescent girls requires special attention because iron deficiency can cause various disorders in the body's organs such as muscles, heart, nerves and the hematological system. The body urgently needs iron, especially for the synthesis of hemoglobin (Hb), which is a molecule for the erythroblastic process or the formation of red blood cells. Iron deficiency is a reduction or depletion of the total amount of iron in the body, especially iron deposits found in macrophages and hepatocytes. (WHO, 2020) (Aabdien *et al.*, 2022) (Sumarlan *et al.*, 2018a) (Camaschella, 2019)

A chronic manifestation of iron deficiency, clinically is a condition of anemia or called iron deficiency anemia (ADB) or nutrient anemia. Iron deficiency can interfere with the optimal functioning of the hormonal system and the immunological (immune) system and is linked to increased metal absorption ability. So

there needs to be intervention to overcome this. (Manikam, 2021; Sumarlan *et al.*, 2018b)

The development of iron deficiency that is not resolved is anemia, in this study the incidence of anemia was 21 (20.79%) female students, namely the hemoglobin level was < 12 g/dl. The same results were obtained from the research of Maida Pardosi, et al at SMA 1 Kutalim Baru Deli Serdang, where the prevalence of anemia was 28.85% of the research subjects. In a study of 3 regions in Central Java on the Prevalence of Anemia and Its Determinants in Adolescent Women in Central Java, it was found that the prevalence of anemia was 26.3% and the prevalence of anemia was larger, namely 58.7% from the 2022 Shinta Novelia research in Kampung Sawah District, South Tangerang and 50.6% anemia in the examination of hemoglobin levels at Lampung Junior High School. (Pardosi, 2019) (Masfiah *et al.*, 2021) (Novelia and Full moon Series, 2022) (Yudina and Fayasari, 2020)

Of the total number of female students who experienced anemia, 14 (66.6%) were iron deficiency anemia. These results are in accordance with the statement from the WHO in "Nutritional Anaemia: Tools for Effective Prevention and Control" that iron deficiency contributes about 50% of anemia cases in pregnant and non-pregnant women and about 42% in children < 5 years of age. Anemia can be a significant problem in the population, if the prevalence of anemia is 5.0 – 19.9% can cause mild problems, the prevalence of 10.0 – 39.9% is a moderate problem, and > 40% will be a severe problem in the population. (WHO, 2017) (WHO, 2017)

If calculated from the total respondents, students who experienced iron deficiency anemia were 13.86%, the results are in line with the research of Eka S Sumarlan which obtained the results of 13.5% of respondents experiencing iron deficiency anemia (*Iron Deficiency Anaemia*). (Sumarlan *et al.*, 2018c)

Analysis of Ferritin Levels as a Risk Factor for Anemia Incidence

Serum ferritin is the value of iron stores in the body. Serum ferritin levels increase if there is an increase in iron stores in the body with no infection or inflammatory processes and serum ferritin levels will decrease if there is a decrease

in iron stores. If iron reserves are depleted, there will be an increase in transferrin receptors to bind iron. Iron status can also be assessed by TIBC, Zinc concentration, transferrin saturation, protoporphyrin levels, erythrocyte index and bone marrow biopsy examination (WHO, 2017, 2020) (Corbett Jane Vincent and Banks Angela D, 2013; Pasricha *et al.*, 2021; Sumarlan *et al.*, 2018b).

Adolescent girls (rematri) according to WHO are women aged 10 – 19 years, during puberty are at high risk of iron deficiency anemia due to the amount of iron lost during menstruation and the need for iron for growth and development of the body. The prevalence of iron deficiency cases in adolescents is around 14.1% to 18.4%; with a prevalence of iron deficiency anemia of around 5.8%. In this study, it was found that 13.86% of female students with iron deficiency anemia and iron deficiency students without anemia were 25.74%, a figure almost the same as the prevalence of deficiency in the study in Qatar, which was 26.4%. The chi-square test and the (WHO, 2014, 2024) (Aabdien *et al.*, 2022) calculation of the OR value to determine the risk found a significant association between anemia and iron deficiency ($p = 0.004$) and an *odd ratio* value of 4.154 was obtained, indicating that adolescent girls with iron deficiency (low ferritin levels) had a 4.154 times greater risk of developing anemia compared to adolescent girls with normal ferritin levels.

Conclusion

In this study, it was shown that the incidence of iron deficiency (38.61%) was greater than the occurrence of anemia (20.79%). There was a significant association of ferritin levels with the incidence of anemia in adolescent girls with $p=0.027$, especially iron deficiency anemia and adolescents with iron deficiency had a 4.154 times greater risk of developing anemia compared to adolescent girls with normal ferritin levels. Thus, ferritin level testing can be considered to assess iron storage status to assess iron deficiency as a risk factor for anemia in adolescent girls.

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