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Meta analysis: Prevalence and effect of knowledge on anemia in adolescent girls

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Abstract

Background: The prevalence of anemia in adolescent girls is high globally and in Indonesia. Various factors, including low-level knowledge, play a role in the onset of anemia in adolescents. The purpose of this study was to analyze the results of studies on anemia knowledge in adolescent girls to obtain a combined effect.

Method: This systematic review included a meta-analysis. The journal sources were Google Scholar, Pub-med, and Scopus, and the search was performed using Publish or Perish Software, applying keywords using Boolean operators. The inclusion criteria were Indonesian or English language articles, full text from 2013 to 2022, cross-sectional studies, adolescent female populations, and multiple logistic regression analyses with adjusted odds ratio measures. A total of 10,499 articles were identified, of which 6 articles met the inclusion criteria. Data analysis using RevMan 5.4.

Results: The prevalence of anemia in adolescent girls was 40.2% (95% CI: 12.98-67.68). Meta-analysis showed that knowledge about anemia had an influence on the incidence of anemia in adolescent girls (SMD=3.06; CI 95%=2.23-4.19; P-value=<0.001). The fixed-effect model was used. The funnel plot indicates that there was no publication bias in this study.

Conclusion: Poor knowledge increases the risk of developing anemia in adolescents. It is recommended to increase literacy through social media related to anemia in adolescent girls and to activate adolescent health programs in schools.

Keywords: Anemia; adolescent; nutrition; knowledge.

INTRODUCTION

Nutrition plays an important role throughout life, from fetuses, infants, children, adolescents, and adults to the elderly. It aims to support optimal growth and development and ultimately create a generation with a superior quality of life(1). Currently, Indonesia is faced with three nutritional burdens (triple burden), which include malnutrition, overnutrition, and micronutrient deficiencies, especially anemia. The prevalence of micronutrient deficiencies is high, particularly anemia due to iron deficiency in women of childbearing age (WCA) and adolescent women(2).

Anemia is a condition in which the number of red blood cells or the concentration of hemoglobin in the blood is below normal. Hemoglobin plays a vital role in transporting oxygen to all parts of the body, and low or abnormal hemoglobin levels can result in a decrease in the ability of the blood to deliver oxygen to the body's tissues (3). In adults, anemia occurs when hemoglobin levels drop below 14 g/dL for men and below 12 g/dL for women of childbearing age and adolescents. Anemia is generally caused by excessive blood loss, insufficient production of red blood cells, or the breakdown of erythrocytes too quickly(4).

Anemia remains a global public health challenge. Anemia is caused by children, adolescent women, menstruating women, and pregnant women after childbirth. The World Health Organization (WHO) estimates that approximately 40% of children aged 6-59 months, 37% of pregnant women, and 30% of women of childbearing age (15-49 years) worldwide experience anemia(3).

Globally, the incidence rate of anemia in Women of Childbearing Age (WCA) is 29.9%, whereas that in WCA who are not pregnant (adolescents) is around 29.6%(5). Africa and Southeast Asia have the highest

prevalence of anemia, with an estimated 106 million women and 103 million children suffering from anemia in Africa and an estimated 244 million women and 83 million children developing anemia in Southeast Asia(6). In Southeast Asia, the incidence of both mild and severe anemia ranges from 25-40%(7).

Anemia tends to occur more frequently in women than men. This is because women generally have lower hemoglobin levels and require higher amounts of iron than men. According to the Recommended Dietary Allowance (RDA), women aged 13–29 years are advised to consume 26 mg of iron daily. According to the results of National Basic Health Research (RISKESDAS), adolescent girls are vulnerable to anemia. In 2018, the prevalence of anemia in adolescent girls reached 32%, an increase from 22.7% in 2013. There is an increase in the incidence of anemia in adolescent girls in Indonesia(8,9).

In general, anemia can affect adolescents by increasing the risk of developing diseases due to weakened immune system. Symptoms that may arise from anemia include weakness, fatigue, lack of energy, lethargy, and difficulty breathing, all of which can reduce motivation in carrying out daily activities(3). In addition, a lack of oxygen supply to the brain caused by anemia can lead to impaired concentration and decreased learning achievement. Anemia not only affects physical and mental health but can also interfere with reproductive organ function in adolescents. During adolescence, the need for iron increases because of blood loss during menstruation in adolescent girls(4).

Many factors can cause anemia, both directly and indirectly. The direct causative factors of anemia in adolescents include daily diet, including frequency of meals, dietary habits, breakfast habits, consumption of substances that inhibit iron absorption, tea or coffee consumption, food diversity, and adolescent knowledge. Other immediate factors include infectious diseases, excessive bleeding, and long menstrual durations(10). Meanwhile, indirect causative factors related to the incidence of anemia in adolescents include low levels of education and socioeconomic conditions of parents, adolescent activities that are not in line with nutritional needs, lack of nutritional education, inadequate adolescent health services, and the living environment(11,12).

Research conducted by Kadek Agus Dwija Putra (2020) found that anemia in adolescent girls in Badung Regency Bali is caused by poor knowledge about anemia, not consuming iron supplements, drinking tea/coffee habits when eating, and excessive menstrual volume(13). Research by Nurmala Dewayanti (2021) found that adolescents who do not consume iron supplements, lack of knowledge about anemia, abnormal menstrual patterns, low family income, and poor nutritional status are strongly related to the incidence of anemia in adolescent girls(14). Another study conducted by Simatupang, et al. (2023) proved that knowledge, consumption of blood-boosting tablets, breakfast habits, and the frequency of heavy meals per day affect the incidence of anemia in adolescent girls(15).

The results of research on anemia in adolescent girls differ among primary studies. There are different variations and prevalence rates in each study in different regions. Systematic review is a type of research that reviews the results of research and collects all empirical evidence that meets the eligibility criteria to answer research questions (16). A systematic review that considers specific eligibility criteria for all global studies is needed. The goal is to summarize the results of various studies, which will then be processed through meta-analysis to combine quantitative findings and obtain a measure of effect or level of relationship.

This study aimed to conduct a meta-analysis on the prevalence of anemia and assess the influence of knowledge on the incidence of anemia in adolescent girls.

METHOD

This systematic review and meta-analysis. The research was conducted from June to October 2023. We searched for

primary study articles related to the prevalence and knowledge of anemia in adolescent girls from 3 databases, Google Scholar, Pub-med, and Scopus, using Publish or Perish Software. The search keyword uses Boolean operators "((((Determinant) OR (Determinant) OR (Risk Factor) OR (Causative Factor) OR (Causative Factor) OR (Knowledge)) AND ((Anemia) OR (Anemia))) AND ((Adolescent Girl) OR (Teenage Girl) OR (Adolescent Girl)))". The researcher extracted the data from the article using Microsoft Excel and exported it to Review Manager 5.4 for meta-analysis. This Systematic Review and meta-analysis was presented with PRISMA (Preferred Reporting Items for Systematic Review and Meta Analyses) reporting items. In the initial search, 10,499 articles were obtained (Google Scholar: 9,854, Pubmed:151, and Scopus: 494). After duplicate checking, identification, and screening, 42 articles were identified. Of the 42 articles, 36 articles were issued that were not relevant to the research criteria. Then, the authors checked the feasibility of 9 articles using the STROBE (Strengthening The Reporting of Observational Studies In Epidemiology) criterion, followed by a meta-analysis using the RevMan application.

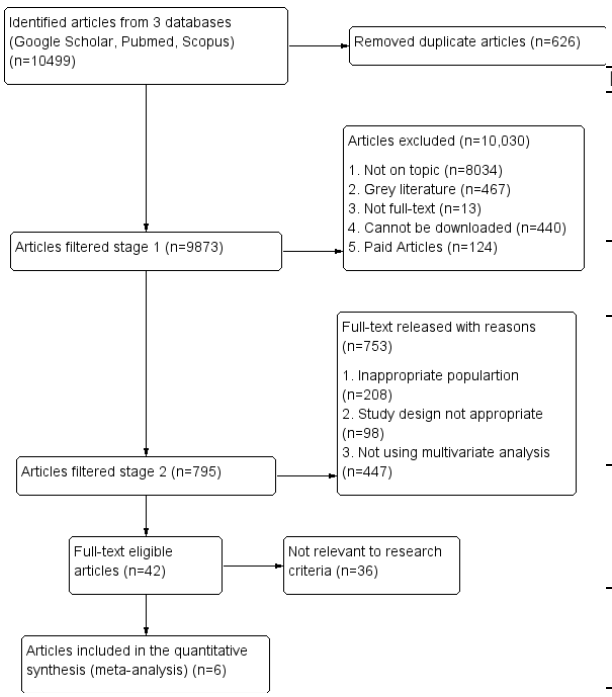

Figure 1. PRISMA Plot

The inclusion criteria were as follows: 1) the article was accessed through 3 (three) Google scholar, Pub-med, and Scopus databases; 2) the research subjects were adolescent girls aged 10-19 years (in accordance with the Regulation of the Minister of Health of the Republic of Indonesia number 25 of 2016); 3) manuscripts available in full text; 4) articles in Indonesian or English; 5) the year of publication of the article ranges from 2013 to 2022; 6) the article had results related to the incidence of anemia; 7) relevant to the research topic being conducted, namely the prevalence and determinants of anemia in adolescent girls and 8) the article is a primary research with a cross sectional study design. Meanwhile, the exclusion criteria: 1) articles that do not conduct multivariate analysis (double logistic regression with adjusted odds ratio); 2) articles that are paid (but with effort) and 3) manuscripts cannot be downloaded.

RESULTS

The research related to the prevalence and influence of anemia knowledge in adolescent girls consists of 6 articles from Indonesia (Table 1).

Table 1. Description of primary studies included in the meta-analysis

No	Authors	Year	Title	Sample
1	Akma Listiani (17)	2016	Analysis of factors related to the incidence of iron deficiency anemia in young women at SMKN 1 Terbanggi Besar, Central Lampung	255
2	Rini Hariani, *et al*(18)	2018	Factors associated with anemia in high school students in Pekanbaru	65
3	Shinta Fransiska Simanungkalit, *et al*(19)	2019	Knowledge And Consumption Behavior of Young Women Related to Anemia Status	172
4	Endah Yulianingsih, *et al*(20)	2020	Risk Factors Determinants Anemia Events in Adolescent Puskesmas in Kota Selatan	306
5	Kadek Agus Dwija Putra, *et*	2020	The relationship between body image and tea drinking habits with anemia among	106

No	Authors	Year	Title	Sample
	al(13)		adolescent girls in Badung District, Bali, Indonesia	
6	Aras Utami, *et al*(21)	2022	Prevalence of Anemia and Correlation with Knowledge, Nutritional Status, Dietary Habits among Adolescent Girls at Islamic Boarding School	162

The study found six articles as sources of meta-analysis on the prevalence of anemia in adolescent girls. The highest prevalence of anemia was found in a study conducted by Rini Hariani, et al (2018) in Pekan Baru at 67.7%, and the lowest prevalence of anemia was found in a study by Kadek Agus Dwija Putra, et al (2020) in Badung at 13.2% (Figure 2). The average prevalence of anemia was 40.33% (95% CI: 12.98-67.68) with a median value of 40.20% and a variability of 26.06%. The prevalence varied between 13.20% and 67.70% (Table 2).

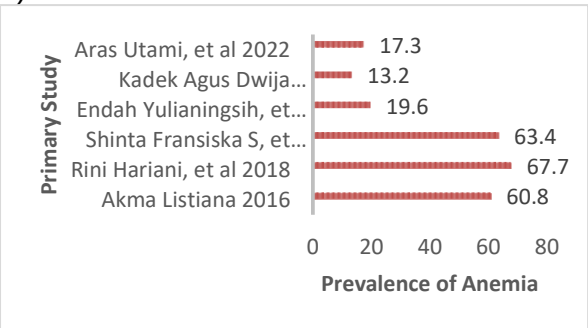

Figure 2. Graph of Anemia Prevalence in Adolescent Girls

Table 2. Description of the Prevalence of Anemia in 6 Primary Studies

Min	*Max*	*Mean*	*95% CI*		*Median*	*SD*
			Lower	***Upper***		
13,20	67,70	40,33	12,98	67,68	40,20	26,06

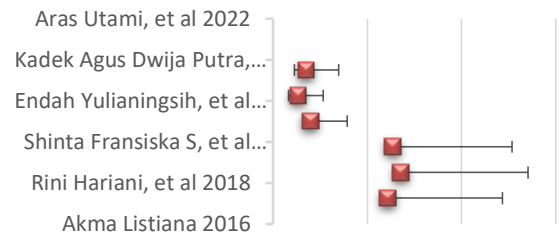

Figure 3. Forest Plot of the Prevalence of Anemia in 6 Primary Studies

The study found that the prevalence of anemia in adolescent girls in each primary study varied widely, as indicated by a red box in each study that was not adjacent or not inside between the two lines. The average prevalence of anemia in adolescent girls is 40.2% greater than that in adolescents aged 5-14 years (16.3%) and 15-24 years (15.5%) in Indonesia (22). In addition, the line on the box indicates the confidence interval length. *The long confidence interval* was found in the primary study conducted by Shinta Fransiska S, *et al* (2019), Rini Hariani, *et al* (2018), and Akma Listiani, *et al* (2016). Meanwhile, a short *confidence interval* was found in a primary study by Kadek Agus Dwija Putra, *et al* (2020) (Figure 3).

The results of the analysis showed that the heterogeneity value of this study was 0%, indicating that there was no heterogeneity in the estimated effect between the primary studies. The effect estimation analysis is a fixed-effects model. The study found that adolescent girls with low anemia knowledge were three times more likely to develop anemia than adolescent girls with good anemia knowledge. This result proved to be statistically significant (Standardized Mean Difference=3.06; CI 95%=2.23-4.19; P-value= < 0.001) (Figure 4). *The funnel plot* shows that the distribution of effect estimates from this meta-analysis primary study is more to the right of the vertical line of the estimated mean than to the left, indicating that there is relatively no publication bias (Figure 5).

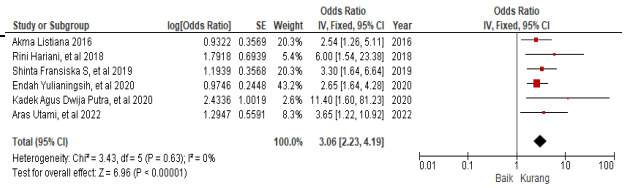

Figure 4. Forest Plot Knowledge on Anemia in Adolescent Girls

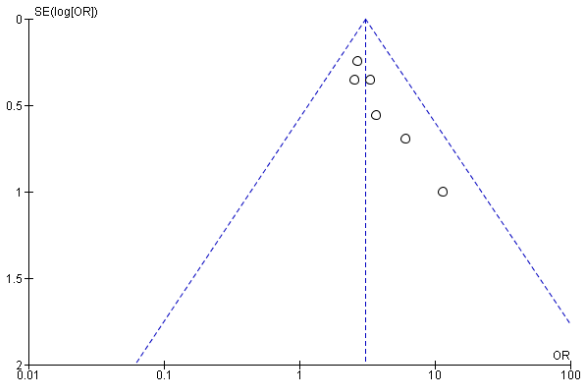

Figure 5. Funnel Plot Knowledge on Anemia in Adolescent Girls

DISCUSSION

The research findings from six primary studies showed that the highest anemia occurred in the study conducted in Pekan Baru. Although the highest anemia was found in a study conducted by Rini Hariani, *et al* (2018) but could not indicate that the highest anemia of adolescent girls in Indonesia was found in Pekan Baru, it happened because the number of samples taken was less than other studies.

The average incidence of anemia in adolescent girls is still high, reaching 40%. The results of this study agree with the research of Siti Nunung Nurjanah (2021), who found that the average anemia in adolescent girls is quite high at 82%(23). This study is not in line with Permatasari (2020), who found that the average anemia of adolescent girls is slightly lower but still a problem, which is 20.9%(24).

The results of this study found that the influence of knowledge on the incidence of anemia in adolescent girls was significant, where adolescent girls with low knowledge were at greater risk of developing anemia than adolescent girls with good knowledge.

The analysis model used in primary studies related to knowledge about the incidence of anemia in adolescent girls is a fixed-effects model, which indicates that the primary studies conducted are from the same population. The six primary studies that analyzed knowledge related to the incidence of anemia in adolescent girls only came from Indonesia.

In addition, the obtained analysis model is a fixed-effect model and does not have a large heterogeneity value, meaning that the primary study analyzed is homogeneous, characterized by fixed values adjacent to the forest plot. The results confirmed that poor of knowledge increase the risk of developing anemia in adolescent girls.

This result is in line with research conducted by Destania Kinthan Larasati (2021) and Eka Rati Astuti (2023), which found that there is a relationship between the level of knowledge and the incidence of anemia in adolescent girls, where good knowledge about anemia and nutrition will affect the diet of adolescents to be able to prevent anemia(25,26).

The results of other meta-analysis studies that were searched related to knowledge were not found worldwide because only literature review studies were conducted. Based on the search of research articles, many literature review studies were found related to the relationship between knowledge and the incidence of anemia in adolescent girls.

A literature review study by Nuryusri'a Arffa Fais Idris et al. (2020) explained that lack of knowledge affects poor habits in choosing food and preventing anemia. Knowledge influences attitudes and behaviors related to food choices. The use of iron tablets during menstruation can affect the nutritional status of individuals with anemia. In addition, the knowledge of young women about anemia only reaches the stage of knowing, and it is not followed by application in daily life such as eating foods that contain a lot of iron, not drinking tea after meals, exercising, and getting enough rest(27).

Another literature study was also conducted by Destania Kinthan Larasati, *et al* (2021), who found that adolescent knowledge related to anemia is related to the incidence of anemia in adolescent girls because good knowledge about anemia and

nutrition will affect diet in adolescents so that it can prevent anemia(28).

In UNICEF's theory, knowledge is an indirect cause of the incidence of anemia, which is supported by the findings of this study that knowledge has a large and significant influence on the incidence of anemia, especially the attitudes and behaviors of adolescent girls to prevent anemia. This finding proves that education for adolescent girls is very important, especially to reduce the incidence of anemia, starting from the attitude and behavior of the adolescent itself.

Although the government has tried to reduce the incidence of anemia, if young women do not participate in prevention, it will be very difficult to achieve the target that has been determined. Therefore, it is necessary to provide more in-depth education about anemia so that young women can understand the various efforts that must be made to prevent anemia. After adolescents understand this, it is hoped that they can change attitudes and especially preventive behaviors such as consuming tablets to increase blood, a balanced diet by consuming vegetables and fruits that contain high levels of Fe, or other good diets such as not consuming tea with heavy meals(29).

The need to improve adolescent health programs in schools such as Adolescent Care Health Services (Pelayanan Kesehatan Peduli Remaja or PKPR). The government has made various efforts to achieve balanced nutrition education, food fortification, and blood supplementation (Tablet Tambah Darah or TTD) (30). In addition, the government also proposed the CERIA application (prevent anemia of adolescent girls) to record and report the consumption of TTD and the results of the measurement of the nutritional status of adolescent girls (31). Some services related to the formation of anemia ambassadors in schools show an increase in knowledge, and adolescents can become health literacy agents(32,33).

This systematic review only considered primary studies relating to adolescent women's knowledge of anemia a limitation of this study. In addition, this study did not include primary studies that examined other anemia-causing factors. The study also limited searches to Google Scholar, Pubmed, and Scopus for articles that were either unpaid or downloadable. In addition, there were differences in the measurement indicators in each primary study regarding the knowledge level of young women.

CONCLUSIONS

The meta-analysis of the six cross-sectional studies was conducted in Indonesia. The average prevalence of anemia among adolescents was 40.2%. The prevalence of anemia among adolescent girls in each study varied greatly, with the highest incidence of anemia in the research of Rini Hariani, *et al* (2018) in Pekan Baru at 67.7% and the lowest prevalence of anemia in the research of Kadek Agus Dwija Putra, *et al* (2020) in Badung at 13.2%. Low knowledge is associated with anemia incidence in adolescent girls. It is recommended to increase literacy through social media related to anemia to perform prevention starting from yourself.

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