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Nutrition Education Effect on Anemia Incidence in Female Adolescents: Meta-Analysis for Future Health Post-COVID-19 Pandemic

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Abstract

Female adolescents are at a heightened risk of anemia due to inadequate iron intake and absorption, blood loss during menstruation, and an escalated need for iron to support rapid growth. This study examined the impact of nutrition education on the incidence of anemia in adolescent girls. The investigation was conducted through a systematic review and meta-analysis, employing articles from reputable sources such as Google Scholar, JAMA Network, PubMed, ScienceDirect, The New England Journal of Medicine, Lancet, and ProQuest, published between 2013 and 2021. The keywords for data retrieval were "nutrition education" and "adolescent anemia girls." Furthermore, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline was used to select and organize publications for this study. Using Review Manager 5.3 Software, full-text articles meeting meta-analysis criteria were selected, resulting in 7 out of the 257 retrieved articles being included. The findings suggested that nutrition education indeed impacts the incidence of anemia in adolescent girls (p -value <0.001 ; aOR = 2.10; 95% CI = 1.60-2.76).

Keywords: adolescents, anemia, health promotion, meta-analysis, nutrition education

Introduction

Anemia is a sign of poor health in terms of nutrition and it is a condition with a decrease in hemoglobin levels below the normal value caused by iron deficiency.¹ Anemia and malnutrition remain global health issues, accounting for 1.6 billion people or 25% of the world's population, especially among women in developing countries, including Indonesia.¹⁻³ The World Health Organization defines adolescents as aged 10-19 years.⁴⁻⁶ Adolescent girls have an excessive chance of developing anemia due to low iron consumption and absorption, blood loss during menstruation, and an accelerated need for iron to support fast growth.⁷

In developing countries, anemia affects a huge wide variety of people.^{8,9} An observation conducted in 34 African countries discovered that the estimated prevalence in adolescents and younger women ranged from 15% to more than 50%.¹⁰ During the El Nino event in 2015/2016, the cost of meals in Woldia City experienced a significant surge due to a considerable decline in crop production in the surrounding district.¹¹ This condition is one of the causes of food shortages in this region and can impact family food availability. The availability of

family food can profoundly impact family food intake, leading to inadequate individual intake of essential nutrients, such as protein, as well as micronutrients like iron, vitamin B12, and other vital elements crucial for preventing anemia.¹²

In India, the problem of malnutrition and micronutrient deficiencies is a huge spread.¹³ Micronutrient deficiencies during early childhood can frequently change in adolescents with long-term effects on health, cognition, education, and productivity.¹³ Several studies have been undertaken to address anemia prevention, encompassing young women and focusing on the well-being of toddlers, small children, pregnant women, and lactating women.¹⁴⁻¹⁶

The cause of the current increase in anemia rates is the coronavirus disease 2019 (COVID-19) pandemic. This condition has led to significant social transformations affecting overall health status, including anemia, and the feasibility of implementing health programs sustainably. The transmission of COVID-19 has a detrimental effect on individuals, primarily manifested through the loss of income, which includes factors such as job loss, unemployment, or layoffs.¹⁷

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This pandemic increases the risk of anemia among female adolescents and pregnant women due to irregular consumption of blood-boosting tablets and weakened economic conditions, reducing nutritional intake.¹⁴ Female adolescents and pregnant women from low-income families are especially vulnerable to reduced access to healthy food, increased food insecurity, long-term uncertainty in finding work, and reduced physical activity.¹⁴

Other studies have shown that nutrition education can enhance adolescents' knowledge, leading to changes in their thinking and an increased awareness of how to prevent anemia.¹⁸ This is achieved through the effective dissemination of nutritional education to adolescents.¹⁸ Education is an important part of human resources and the most important part of human life. In today's education era, technological development encourages the importance or role of education in the nation's life.^{15,16} Education also has several factors that can influence human knowledge, such as the learning strategy or medium used.^{19,20}

Even though many similar primary studies have been conducted, some inconsistent study results remain. Therefore, a comprehensive analysis is needed to obtain a result that can be interpreted as a whole.²¹ This study aimed to analyze the effect of nutrient education on anemia, especially in adolescent girls, to attain convincing and concerning results. It was conducted as a follow-up to conclude the impact of nutrition education on anemia and determine whether health programs can reduce the incidence in adolescent girls.

Method

A total of six writers carried out a systematic literature review of one and five primary and co-authors from March to early May 2021. This study collected the articles from Google Scholar, JAMA Network, PubMed, ScienceDirect, The New England of Medicine, Lancet, and the ProQuest website. These seven databases were selected as well-known health databases with bibliometrics, providing free and easy access to verify other people's work.

The first step was to access the database's website, identify relevant articles, and input keywords indicating study material into the website search engine. On PubMed, Google Scholar, Lancet, JAMA Network, The New England of Medicine, and ProQuest website, the text availability articles (full text and free full text), article types (journal), with the publication of the last nine years (2013–2021) were ticked. For ScienceDirect, after going to the website, all categories for the publication title, as well as subject areas, were ticked by defining the article type as study papers.

Following the Preferred Reporting Items for System-

atic Reviews and Meta-Analyses (PRISMA) guideline, the next step included: 1) Identifying: the authors used quotation marks or apostrophes to designate relevant journal article titles in the search box on the seven website addresses for this study. The boolean symbol "AND" was used between keywords with two or more of them. The keywords used to determine the articles related to Get Nutrition Education (as an exposure) and Anemia (as an outcome) are: "Nutrition education" and "girls' adolescent's anemia" and aOR, "nutrition education" AND "Anemia" AND "adolescents girls" OR "adolescents" OR "young children" AND aOR. Furthermore, the articles that surfaced repeatedly during keyword searches were not reused.

2) Screening: the authors selected an article title corresponding to the theme while screening journal article titles. The inclusion criteria (full-text, open-access articles, adolescents, young girls, and girls' adolescents) were applied to all abstract identifications, which were read and reviewed. Original publications discussing nutrition education and anemia disease met the criteria for inclusion. The study's method was quantitative, and the interviews were performed in person and written in English. While, articles with abstracts that did not match the requirements were discarded.

3) Eligibility: full-text versions of selected publications that match the inclusion criteria were downloaded. Open-access and closed-access journals must also meet the criteria. To obtain a link between nutrition education and anemia, the journals were reviewed and selected. 4) Included: all journal articles that meet the inclusion criteria were sorted by publication year, study location, design, duration, sample size, number of respondents, and adjusted Odd Ratio (aOR) values. This data was required to compute meta-analysis using Review Manager 5.3 Software, an open-source software known as "Review Manager 5 Software".²² Furthermore, the articles that were not discovered had their OR values removed.

Meta-analysis was calculated in the final stage by displaying the three components: 1) figure of heterogeneity (I-squared (I²)) to determine whether the data in the selected journals were homogeneous or heterogeneous, 2) examining the publication bias figure (Funnel Plot) to prevent publication bias, and 3) analyzing effect size figure (Forest Plot) to obtain effect in getting nutrition education with anemia in adolescents girls.^{4,5}

Results

The procedure of identifying suitable articles for meta-analysis evaluating the influence of nutrition education on the incidence of anemia in female adolescents is depicted in Figure 1. After searching seven databases, 257 articles were reported, and only seven were qualified for the study. The features of the eligible article for the

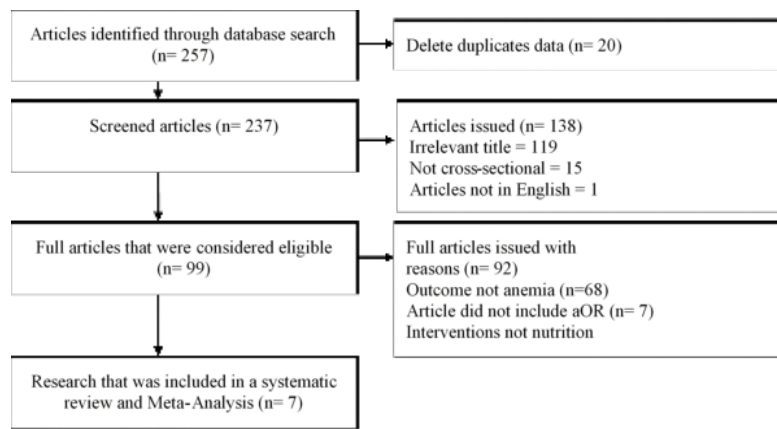


Figure 1. PRISMA Guidelines Flowchart

Table 1. Eligible Articles Characteristics

Author (Year)	Country	Study Design	Period	Sample Size	Respondent (Age)	Intervention	Outcome	aOR
Agustina, et al. ²³ (2020)	Indonesia	Cross-sectional	2016	340	Adolescent girls (12-19)	Frequency of reading newspapers or listening to radio	Blood hemoglobin concentration	1.44
Alemu, et al. ²⁴ (2019)	Ethiopia	Cross-sectional	2011	406	Adolescent girls (10-19)	Knowledge score	Blood hemoglobin concentration	1.15
Bansal, et al. ²⁵ (2020)	India	Cross-sectional	2015-2018	5,897	Adolescent girls (10-19)	Media exposure of adolescents	Minimum dietary diversity (MDD-W) for women and blood hemoglobin concentration	
Endalifer, et al. ²⁶ (2021)	Ethiopia Northeast	Cross-sectional	2016	411	Adolescent girls (11-12)	Knowledge about nutrition	Dietary Diversity Score (DDS) and Hb Level	4.56
Gebreyesus, et al. ²⁷ (2019)	Ethiopia	Cross-sectional	2015	1,325	Adolescent girls (10-14)	Knowing the term "anemia"	Hemoglobin Level	1.58
Handiso, et al. ²⁸ (2020)	Ethiopia Southern	Cross-sectional	2019	845	Adolescent girls (10-19)	Taking nutrition education	24-h dietary recall (24 HR) and Hb Level	2.20
Shemelse, et al. ²⁹ (2020)	Ethiopia	Cross-sectional	2008-2009	5,500	Secondary Data (15-49)	Illiterate	Hemoglobin Level	2.69

Note: aOR = adjusted Odd Ratio

systematic review are shown in Table 1. The majority of the study location were in industrialized countries such as Southern Ethiopia, Northeast Ethiopia, India, and Indonesia.²³⁻²⁹ The studies used a cross-sectional design with data from 2013 and 2021.

Table 1 shows that nutrition education is a predictor of anemia in female adolescents in all of the seven articles. The sample sizes in all articles were large; the lowest number of respondents was 340, while the highest was 5,897. The age groups were divided into 10-19 and 15-49 years, and Table 2 lists all eligible articles.

The aOR values of the seven selected articles are shown in Figure 2. According to a meta-analysis conducted with RevMan 5.3 Software free version, the random effect analysis showed the estimated amount of total heterogeneity using I Squared (I²) of 57% with a p-value of <0.001. Figure 2 shows the forest plot, where female

adolescents who did not receive education/information on nutrition increased the incidence of anemia by 2.10 times with a statistically significant effect (p-value<0.001). Heterogeneity (I²) = 57% indicated the distribution of heterogeneous facts (random effect model).

Figure 3 shows a symmetrical shape in the graph, with 2 and 3 plots on the right and left, indicating a publication bias. The standard error on the left and right plots was 0.8 to 0.2 and 0.5 to 0.3. While, the disproportionate distance between studies in both the right and left plots caused bias.

Discussion

Anemia causes a decrease in the ability to carry oxygen, making the body tired quickly and weak. The cause of anemia in adolescent girls includes menstruation, severe bleeding, nutritional deficiencies (iron, folate, pro-

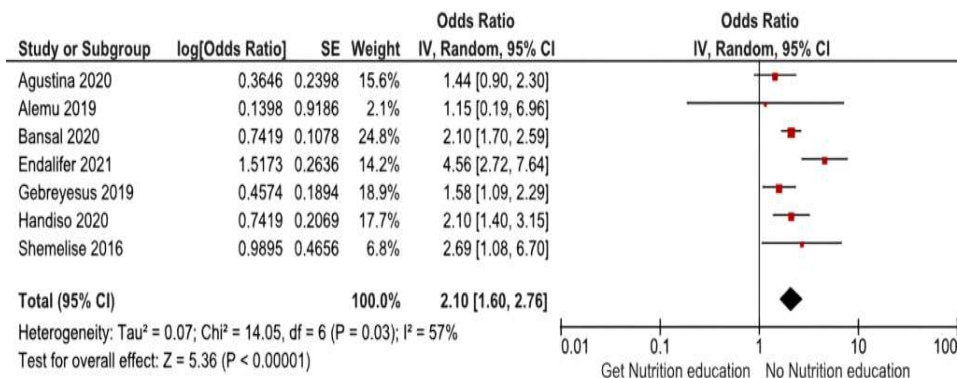


Figure 2. Forest Plot Between Nutrition Education on the Incidence of Anemia in Female Adolescents

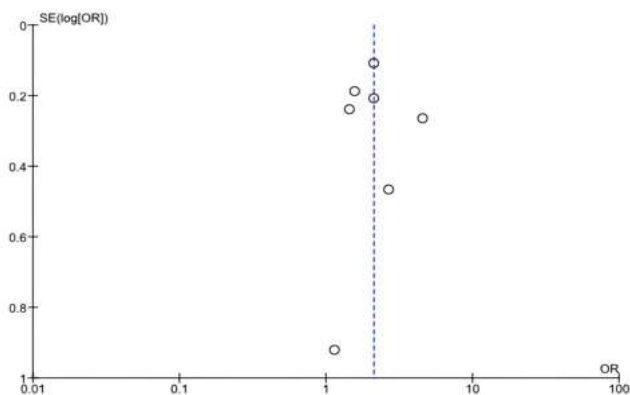


Figure 3. Funnel Plot Between Nutrition Education on the Incidence of Anemia in Female Adolescents

tein), leukemia, and chronic disease.³⁰ In addition, COVID-19 is considered a causative factor due to its ability to assail the respiratory system, resulting in a reduction of hemoglobin and red blood cells responsible for oxygen transportation across the body.¹⁴ Anemia signs include weakness, fatigue, lethargy, lack of enthusiasm in daily activities, and tightness.²¹

Female adolescents from families whose moms had no formal schooling were 3.2 instances more likely to attain low food variety.³¹ While, individuals from families whose fathers only finished grades 1 to 4 were 2.6 times more likely to attain low food variety than those whose fathers finished college.³² Awareness and knowledge can decorate food preferences and eating behavior.³³ Similarly, this knowledgeable family has a better economic status resulting in an excessive quality food plan.³⁴ Comparable findings were also reported by studies performed in Iran, Nigeria, Northern Ethiopia, and Gurage.^{31,33,34}

The absence of nutrient education was significantly associated with lower nutritional range scores among fe-

male adolescents in Southern Ethiopia.³⁵ Female adolescents who did not attend nutrient education were 2.1 times more likely to have a low food variety score in assessment.³⁶ Decision-making strength for nutrition services was statistically associated with the dietary variety scores of observed individuals.³⁷ Furthermore, those with single fathers and mothers became 2.2 and 2.0 times more likely to have low dietary variety scores than those with both. Elevating the level of awareness of nutrition increased the food variety score, and these findings were in line with studies in Ethiopia.³⁷

Other studies showed that adolescents with bad dietary knowledge were genuinely related to inadequate nutrient variety. Rahmiwati, *et al.*, showed that nutrition education is the correct, effective, and sustainable method to prevent iron deficiency anemia.²¹ Jeihooni, *et al.*, also supported the importance of nutrition education to prevent anemia. The study was conducted on 160 students in Fasa City, Fars Province, Iran, from 2018-2019. Education programs must be implemented with a suitable and active education model to enhance the health of adolescent girls, particularly in preventing anemia.³⁸

Another study stated that significant nutrition education intervention increased the knowledge score by 28.6, and there were differences in the level of knowledge after anemia nutrition education intervention was carried out in both groups.³⁹ The results were consistent with studies conducted in Luxembourg and Jimma, which used the increasing knowledge of adolescent girls regarding diseases.⁴⁰ The evidence showed that adolescents with this knowledge consumed more diverse foods.⁴⁰ Future studies are encouraged by including indexing databases and seeking out articles with a different publication year range in more than two languages (English and Indonesian Language). This method aims to enhance the comprehensiveness and inclusivity of the study find-

ings.

Conclusion

Anemia in female adolescents was an indicator of nutritional status. The cause included menstruation, severe bleeding, nutritional deficiencies (iron, folate, protein), leukemia, and chronic disease. This meta-analysis showed that nutrition education affected the risk of anemia in adolescent girls divided into two groups of 10-19 and 15-49 years. Therefore, as a policymaker, the government should pay close attention to the importance of nutrition education for young women to raise nutrition knowledge and avoid anemia.

Abbreviations

COVID-19: coronavirus disease 2019; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis; aOR: Adjusted Odds Ratio.

Ethics Approval and Consent to Participate

Not applicable.

Competing Interest

The author stated no substantial competing financial, professional, or personal interests that could have influenced how the work described in this publication was performed or presented.

Availability of Data and Materials

The data is publicly available from Google Scholar, JAMA Network, PubMed, ScienceDirect, The New England of Medicine, Lancet, and ProQuest databases published from 2013-2021. For more information, the reader can contact the corresponding author.

Authors' Contribution

AR contributed to the manuscript's conceptualization, data screening, supervision, and writing. The manuscript was conceived and written with the help of KD, TK, DMU, RD, and FU.

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