metaanalysis

by Anita Rahmiwati

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

Anita Rahmiwati[1]*, Kusharisupeni Djokosujono[2], Tri Krianto[3], Diah Mulyawati Utari[4], Ratna Djuwita[5], Feranita Utama[6]

[1]*Nutrition Department Faculty of Public Health, Universitas Sriwijaya, Indonesia,*
[2]*Public Health Nutrition Department Faculty of Public Health, Universitas Indonesia, Indonesia*
[3]*Health Education and Behavioral Science Faculty of Public Health, Universitas Indonesia, Indonesia*
[4]*Public Health Nutrition Department Faculty of Public Health, Universitas Indonesia, Indonesia*
[5]*Epidemiology Department Faculty of Public Health, Universitas Indonesia, Indonesia*
[6] *Public Health Departement Faculty of Public Health, Universitas Sriwijaya, Indonesia*

Corresponding Author: Anita Rahmiwati, Nutrition Department Faculty of Public Health, Universitas Sriwijaya, Indonesia, Email: anita_rahmiwati@fkm.unsri.ac.id

Abstract

Adolescents girls are at a heightened risk of anemia due to factors, such as inadequate iron intake and absorption, blood loss during menstruation, and an escalated need for iron to support rapid growth. Therefore, this study examined the impact of nutrition education on the incidence of anemia in adolescents girls. The investigation was conducted through a systematic review and meta-analysis, employing data from reputable sources such as Google Scholar, JAMA Network, PubMed, Science Direct, The New England Journal of Medicine, Lancet, and ProQuest papers published between 2013 and 2021. The selected keywords for data retrieval were "nutrition education" and "adolescents 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 adolescents girls (p-value < 0.001; aOR = 2.10; 95% CI=1.60-2.76).

Keywords: Adolescents, Anemia, Health Promotion, Meta-analysis, Nutrition Education

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Introduction

Anemia is a sign of poor health in terms of nutrition[1] and it is a condition with a decrease in hemoglobin levels below the normal value caused by iron deficiency.[2,3,4] 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.[5,6,7] The World Health Organization (WHO) defines adolescents as aged 10-19 years.[8,9,10] Adolescents 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.[11]

In developing countries, anemia affects a huge wide variety of people.[12] An observation conducted in 34 African countries discovered that the estimated prevalence in adolescents and younger women ranged from 15% to more than 50%.[13] African country Ethiopia, more precisely situated in the North Wollo of the Amhara region, is frequently plagued by drought. 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.[14] This condition is one of the causes of food shortages in this region and can have an impact on family food availability. The availability of family food can have a profound impact on 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.

In India, the problem of malnutrition and micronutrient deficiencies is a huge spread.[15] Micronutrient deficiencies during early childhood can frequently change in adolescents with long-term effect on health, cognition, education, and productivity.[15] Numerous 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.[16,17,18]

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 detrimental effect on

individuals, primarily manifested through the loss of income, which includes factors such as job loss, unemployment, or termination of employment.[19]

This pandemic increases the risk of anemia among adolescents girls and pregnant women due to irregular consumption of blood-boosting tablets and weakened economic conditions, reducing nutritional intake.[16] Adolescents girls 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.[16]

Other studies have shown that nutrition education can enhance the knowledge of adolescents, leading to changes in their thinking and an increased awareness of how to prevent anemia. This is achieved through effective dissemination of nutritional education to adolescents.[20] Education is an important part of human resources and the most important part of human life.[17,18] In today's education era, technological development encourages the importance or role of education in the nation's life. 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 effect of nutrient education on anemia, especially in adolescents girls, to attain convincing and concerning results. It was conducted as a follow-up to obtain a conclusion about the impact of nutrition education on anemia, and to determine whether health programs can reduce the incidence in adolescents 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. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were the acronym for systematic review and meta-analysis standards.[8] This study collected the articles from Google Scholar, JAMA Network, PubMed, Science Direct, 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 website of the database, 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 Science Direct, 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 PRISMA guideline, the next step includes 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 many times 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. Meanwhile, 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".[27] 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.[8,9]

Results

The procedure of identifying suitable papers for meta-analysis evaluating the influence of nutrition education on the incidence of anemia in adolescents girls is depicted in Figure 1. After searching seven databases, 257 articles were reported and only 7 were qualified for the study. The features of the eligible article for the 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.[22,23] 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 adolescents girls in all of the seven articles. The sample sizes in all of the articles were large, and 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 of the eligible articles. The studies showed that a lack of nutrition education might lead to anemia in adolescents girls

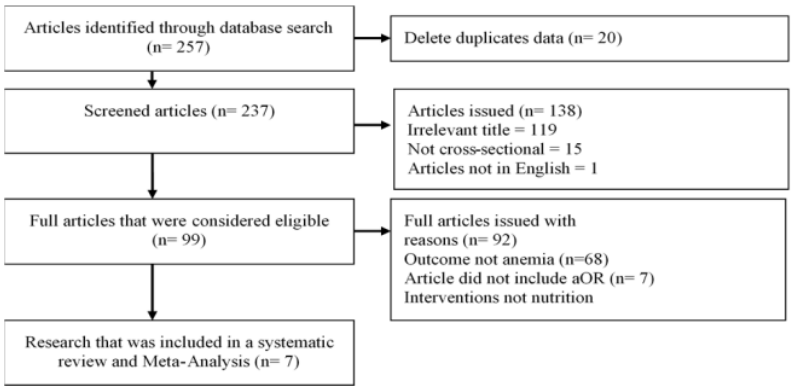

Figure 1. PRISMA Guidelines Flowchart

Table 1. Eligible Articles Characteristics

Author	Year	Country	Study Design	Period	Sample Size	Respondent (age in a year)	Intervention	Outcomes	aOR
Agustina *et al*.[22]	2020	Indonesia	Cross-sectional	2016	340	Adolescents girls (12-19)	Frequency of reading newspapers or listening to radio	Blood hemoglobin concentration	1.44
Alemu *et al*.[23]	2019	Ethiopia	Cross-sectional	2011	406	Adolescents girls (10-19)	Knowledge score	Blood hemoglobin concentration	1.15
Bansal *et al*.	2020	India	Cross-sectional	2015-2018	5,897	Adolescents girls (10-19)	Media exposure of adolescents	Minimum dietary diversity (MDD-W) for women and blood hemoglobin concentration	2.10
Endalifer *et al*.	2021	Northeast Ethiopia	Cross-sectional	2016	411	Adolescents girls (11-12)	Knowledge about nutrition	Dietary Diversity Score (DDS) and Hb Level	4.56
Gebreyesus *et al*.	2019	Ethiopia	Cross-sectional	2015	1,323	Adolescents girls (10-14)	Knowing the term "anemia"	Hemoglobin Level	1.58
Handiso *et al*.	2020	Southern Ethiopia	Cross-sectional	2019	843	Adolescents girls (10-19)	Taking nutrition education	24-h dietary recall (24 HR) and Hb Level	2.20
Shemelise *et al*.	2020	Ethiopia	Cross-sectional	2008-2009	5,500	Participants Secondary Data (15-49)	Illiterate	Hemoglobin Level	2.69

The aOR values of the 7 selected articles are shown in Figure 3. According to meta-analysis conducted with RevMan 5.3 Software free version, the analysis of the random effect showed the estimated amount of total heterogeneity using I Squared (I2) of 57% with a p-value <0.001. Figure 3 shows the forest plot, where adolescents girls who did not receive education/information about nutrition increased the incidence of anemia by 2.10 times with statistically significant effect (p-value <0.001). Heterogeneity (I2) = 57% indicated the distribution of heterogeneous facts (random effect model).

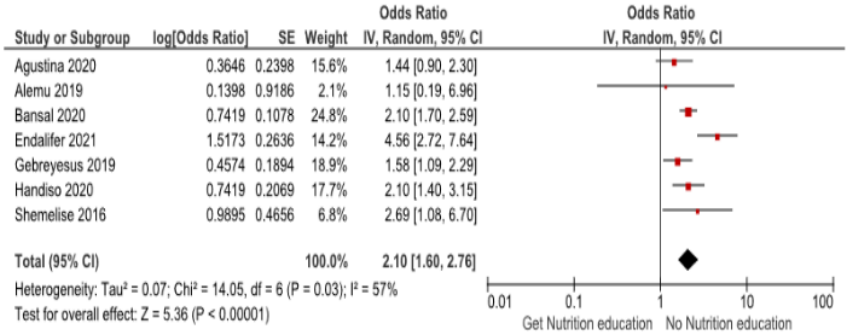

Figure 2. Forest Plot Between Nutrition Education on the Incidence of Anemia in Adolescents Girls

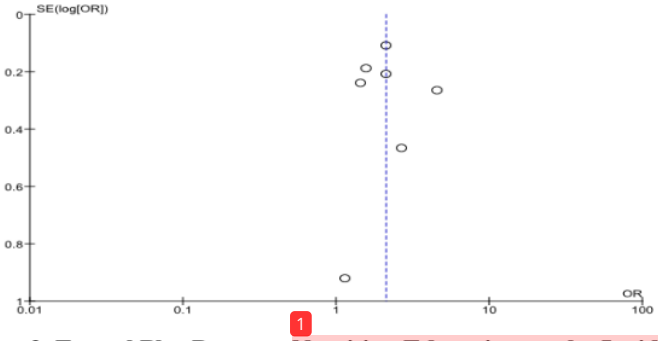

Figure 3. Funnel Plot Between Nutrition Education on the Incidence of Anemia in Adolescents Girls

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. Meanwhile, the disproportionate distance between studies in both the right and left plots caused bias.

Discussion

Nutritional status was determined by anthropometric measurements and biochemical assessments with particular reference to their socioeconomic status.[3] Furthermore, anemia in adolescents girls acted as an indicator of nutritional status[28] and the ordinary Hb range in adolescents girls was 11 mgHb/100 mL to 13 mgHb/100 mL.[29] Anemia is the state of the number of erythrocytes or Hb levels in the blood less than normal (12 g/dl).[29] This causes a decrease in the ability to carry oxygen, hence the body becomes tired quickly and weak. The cause of anemia in adolescents girls includes menstruation, bleeding severe, nutritional deficiencies (iron, folate, protein), leukemia, and chronic disease.[2] 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.[16] Anemia signs include weakness, fatigue, lethargy, lack of enthusiasm in daily activities, and tightness.[21]

Children and pregnant women are especially vulnerable, with an increased maternal and child mortality risk.[29] The prevalence remains high globally, particularly in low-income settings, where a significant proportion of young children and women of childbearing age can be assumed to be anemic. Iron deficiency anemia has also been shown to affect cognitive and physical development in children and reduce productivity in adults.[24]

Adolescents girls from families whose moms had no formal schooling had been 3.2 instances more likely to attain low food variety.[28] Meanwhile, 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.[26] Awareness and knowledge can decorate food preferences and eating behavior.[25] Similarly, this knowledgeable family has a better economic status resulting in an excessive quality food plan.[29] Comparable findings were also reported by studies performed in Iran, Nigeria, Northern Ethiopia, and Gurage Ethiopia.[27]

The absence of nutrient education was found to be significantly associated with lower nutritional range scores among adolescents girls in Southern Ethiopia.[32] Adolescents girls who did not attend nutrient education were 2.1 times more likely to have a low food variety score in assessment.[31] Decision-making strength for nutrition services was statistically associated with the dietary variety scores of observed individuals. 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 conducted in Africa and Ethiopia.[30,31,32]

Other studies showed that adolescents with bad dietary knowledge were genuinely related to inadequate nutrient variety. Rahmiwati *et al*., (2023) showed that nutrition education is the correct, effective, and sustainable method to prevent iron deficiency anemia.[21] Jeihooni et al. (2021) also supported the importance of nutrition education for the prevention of anemia. The study was conducted on 160 students in Fasa City, Fars Province, Iran, during the period 2018-2019. Education programs must be implemented with a suitable and active education model to enhance the health of adolescents girls, particularly in preventing anemia.[33] Nova, Allenidekania, and Agustini (2019) stated that significant nutrition education intervention increased the knowledge score by 28.6. According to Waluyo, Hidayanty, and Seweng (2018), there were differences in the level of knowledge after anemia nutrition education intervention was carried out in both groups. The intervention group had a higher increase in knowledge with an average of 2.88 compared to the control.[33,34]

The results were consistent with studies conducted in Luxembourg and Jimma, which used the increasing knowledge of adolescents girls regarding diseases. The evidence showed that adolescents who possessed this knowledge consumed a more diverse range of foods.[33,34] Furthermore, evidence from Greek studies highlighted that possessing crucial knowledge about nutrition was important for maintaining good health. Future analyses were encouraged by including indexing databases and seeking out articles with a different publication year range in more than two languages (English and Indonesian). This method aimed to enhance the comprehensiveness and inclusivity of the study findings.

Conclusion

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

Abbreviations

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

Ethical 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, Science Direct, The New England of Medicine, Lancet, and ProQuest databases published from 2013-2021. The data for this study was gathered from seven relevant studies that were cited in the references. 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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