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LITERATURE REVIEW

META ANALYSIS: EFFECT OF FOOD DIVERSITY, TEA OR COFFEE CONSUMPTION ON ANEMIA IN ADOLESCENT GIRLS

Meta Analisis: Pengaruh Keanekaragaman Pangan dan Konsumsi Teh atau Kopi Terhadap Anemia Pada Remaja Putri

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ABSTRACT

Background: The prevalence of anemia in adolescent girls in the world is 29.60%, and in Indonesia is 32%. A number of primary studies reveal various determinants that contribute to the occurrence of anemia in adolescent girls. **Purpose:** To analyze the results of primary studies related to consumption patterns (food diversity and tea/coffee consumption) and the occurrence of anemia in adolescent girls. **Methods:** The research design was a systematic review with meta-analysis. Journal sources from three databases (Google Scholar, Pubmed, and Scopus) using Publish or Perish software with keywords using boolean operators and featured with PRISMA. Inclusion criteria were full text from 2013 to 2022, articles in Indonesian or English language, cross-sectional studies, and the population was adolescent girls, using multiple logistic regression analysis with adjusted odds ratio. The study obtained nine articles from 11,421 articles identified. Data analysis using Rev.Man 5.4. **Results:** The prevalence of anemia in adolescent girls was 30.83% (95% CI: 15.71-45.95). Food diversity (SMD=1.87; 95% CI=0.88-3.97; P-value=0.10) and tea or coffee consumption (SMD=2.46; 95% CI=1.15-5.27; P-value=0.02) influence the incidence of anemia in adolescent girls. **Conclusion:** Low food diversity and tea or coffee consumption increase the risk of anemia in adolescent girls. Implementing balanced nutritional guidelines to prevent anemia is recommended.

ABSTRAK

How to Cite: Diastanti, Y., Kalsum, U., Guspianto, G., & Noerjoedianto, D. (2024). Meta analysis: effect of food diversity, tea or coffee consumption on anemia in adolescent girls. *Jurnal Berkala Epidemiologi, 12*(3), 280–289. https://dx.doi.org/10.20473/jbe.v12i32024.280–289

Latar Belakang: *Prevalensi anemia pada remaja putri di dunia sebesar 29,60% dan di Indonesia sebesar 32%. Sejumlah studi primer telah mengungkapkan berbagai determinan atau faktor yang berkontribusi terhadap anemia pada remaja putri.* ***Tujuan:*** *menganalisis hasil-hasil studi primer terkait pola konsumsi (keanekaragaman pangan dan konsumsi teh/kopi) dengan kejadian anemia pada remaja putri.****Metode:*** *Desain penelitian adalah systematic review dengan meta analisis. Sumber jurnal dari 3 database yaitu Google Scholar, Pubmed, dan Scopus menggunakan Software Publish or Perish dengan kata kunci menggunakan boolean operators dan ditampilkan dengan PRISMA. Kriteria inklusi adalah full text tahun 2013-2022, artikel berbahasa Indonesia atau Inggris, studi cross sectional, populasi adalah remaja putri, menggunakan analisis mutivariate regresi logistik ganda dengan ukuran adjusted odds ratio. Diperoleh 9 artikel dari 11.421 artikel yang diidentifikasi. Analisis data menggunakan RevMan 5.4.* ***Hasil:*** *Prevalensi Anemia pada remaja putri sebesar 30.83% (95% CI: 15.71-45.95). Keanekaragaman pangan (SMD=1,87 CI 95% = 0,88 - 3,97; P-value = 0,10) dan konsumsi teh atau kopi (SMD=2,46; CI 95% = 1,15 - 5,27; P-value = 0,02) berpengaruh terhadap kejadian anemia pada remaja putri.* ***Simpulan:*** *Keanekaragaman pangan yang rendah dan mengkonsumsi teh/kopi meningkatkan risiko terjadinya anemia pada remaja putri. Disarankan untuk menerapkan pedoman gizi seimbang agar tercegah dari anemia.*

INTRODUCTION

Nutrition is essential, from fetuses to the elderly, for growth and development to create a quality generation. Currently, Indonesia is facing a triple burden of nutrition, namely malnutrition, overnutrition and micronutrient deficiencies such as anemia. Indonesia has been facing a triple burden of nutrition since at least the early 2010s, characterized by the coexistence of malnutrition, overnutrition, and micronutrient deficiencies such as anemia. According to the 2021 Indonesia Nutrition Status Report (SSGI) from the Indonesian Ministry of Health, around 24.40% of children under five suffer from stunting, 8% are overweight or obese, and 48.9% of women of reproductive age experience anemia. This illustrates the widespread and complex nature of the nutritional challenges in the country. The prevalence of micronutrient deficiencies is still high, especially iron deficiency anemia in women of childbearing age and adolescent girls (1).

Anemia is a severe public health problem globally that attacks children, adolescent girls and women of childbearing age (WCA), as well as pregnant women after giving birth (2,3). The World Health Organization (WHO) estimates that 40% of children aged 6-59 months, 37% of pregnant women, and 30% of women of childbearing age (15-49 years) worldwide experience anemia. Globally, the prevalence of anemia in WCA was 29.90%, and in non-pregnant (adolescent), WCA was 29.60% (4). Africa and Southeast Asia were the regions with the highest cases of anemia with an estimated 106 million women and 103 million children affected by anemia in Africa and 244 million women and 83 million children affected by anemia in Southeast Asia (5).

Anemia is a condition in which the number of red blood cells or hemoglobin levels in the blood is below the normal threshold (6). Hemoglobin plays an important role in carrying oxygen to all parts of the body. When someone has deficient or abnormal hemoglobin levels, it can reduce the blood's ability to deliver oxygen to body tissues. Anemia in adults occurs if the hemoglobin level is less than 14 g/dL for men and less than 12 g/dL for women of childbearing age and adolescent girls (7).

Anemia is more common in women than in men. This is due to the fact that women generally have lower hemoglobin levels than men, in addition to having a higher need for iron and experiencing menstruation every month. According to the Nutritional Adequacy Rate (AKG) table, women aged between 13 and 29 years need 26 mg of iron every day. Data from the Indonesia Health Survey (SKI, 2023) indicates that the prevalence of anemia among individuals aged 15-24 is 15.5%, while

among women, the prevalence is 18.0% (8). According to Basic Health Research (Riskesdas), teenage girls are vulnerable to anemia. In 2018, the prevalence of anemia among adolescent girls in Indonesia was 32%, up from 22.70% in 2013. There has been an increase in the prevalence of anemia among adolescent girls (9). Previous study results found that the prevalence of anemia in adolescent girls in 2019 was 42.17% (10).

Adolescent girls are the group that needs the most nutrients. Many adolescent girls experience a lack of nutrients in their daily food consumption. Adolescent girls need iron to be higher than adolescent boys because it is needed to replace the iron lost during menstruation (7). The impact of anemia on adolescent girls is that it can reduce immunity, disrupt concentration, decrease academic achievement, interfere with fitness and lack productivity, a significant risk of death during childbirth, one cause of premature birth and Low Birth Weight (LBW) babies (10).

Several conditions can cause anemia. The primary causes are low red blood cell synthesis, excessive red blood cell oxidation, and excessive red blood cell loss (11). Inadequate food intake, poor food quality, unhygienic hygiene practices, environmental conditions, lack of access to health care, and poverty are other factors that contribute to malnutrition. The direct cause of anemia in adolescents is daily food intake (eating patterns), namely meal frequency, dietary habits, breakfast habits or consumption of iron absorption inhibitors, tea or coffee consumption, food diversity, and adolescent knowledge. Other immediate causes are infectious diseases, excessive bleeding and long menstrual duration (11–13). Meanwhile, indirect causes related to the incidence of anemia in adolescents are low parental education, socio-economic levels and adolescent activities that are not in accordance with nutritional consumption, inadequate nutritional education and health services for adolescents, and the area where they live (14).

In adolescence, they are very concerned about their appearance (body image), so adolescent girls often regulate their diet too strictly, consume foods low in fibre, lack vegetables and fruit and pay less attention to the nutrition of the food they consume, resulting in anemia (14). Kelemu et al (15) found that low food diversity is associated with the incidence of anemia in adolescent girls. This is because teenagers who consume a poor variety and quality of food tend not to meet the nutritional intake they should. Meanwhile, adolescence is a period where increased nutritional needs must be met, especially iron. Research by Tura et al (16) also found that apart from low food diversity, the consumption of tea or coffee is related to the incidence of anemia in adolescent girls.

The results of research on consumption patterns, especially food diversity and tea or coffee consumption as a direct cause of anemia in adolescent girls, were numerous, and different results were obtained in each primary research that was carried out. There were variations and different prevalences in each study in various regions. A systematic review is a type of research that examines research results and collects all empirical evidence that meets the eligibility criteria to answer research questions (17). The effect of food diversity tea or coffee consumption on anemia in adolescent girls in previous studies is consistent. It is necessary to carry out a systematic review by combining all existing research in the world based on eligibility criteria to see the average of various research results, followed by a meta-analysis to combine quantitative research results and obtain an effect size or level of relationship.

The research aimed to conduct a meta-analysis of the prevalence of anemia and assess the influence of consumption patterns (food diversity and consumption of tea or coffee) on the incidence of anemia in adolescent girls.

METHODS

This research uses a systematic review design with meta-analysis. The research was conducted from June to October 2023. Search for primary study articles related to consumption patterns of adolescent girls with anemia in adolescent girls from 3 databases, namely Google Scholar, Pubmed, and Scopus, using Publish or Perish software. Search keywords using Boolean operators "((((determinant) OR (determinant) OR (risk factor) OR (risk factor) OR (causative factor) OR (causative factor) OR (food diversity) OR (tea/coffee consumption)) AND ((anemia) OR (anaemia))) AND ((adolescent girl) OR (teenage girl) OR (adolescent girl)))". Researchers extracted data from articles using Microsoft Excel tools and exported them to Review Manager 5.4 to conduct a meta-analysis. This Systematic Review was presented with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) reporting items. In the initial search, 11,421 articles were obtained (Google Scholar:10,853, Pubmed: 141, and Scopus: 427 articles). After checking duplication, identification and screening, 43 articles

were filtered, of which 34 articles were excluded that were not relevant to the research criteria. Then, the author checked the suitability of 9 articles using the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) criteria, followed by meta-analysis using the Rev.Man application.

Inclusion and Exclusion Criteria

There were several inclusion criteria: 1) articles accessed through 3 (three) databases (Google Scholar, Pubmed and Scopus); 2) research subjects were adolescent girls aged 10-19 years (under the Regulation of the Minister of Health of the Republic of Indonesia number 25 of 2016); 3) the manuscript was available in full-text form; 4) articles use Indonesian or English language; 5) article publication year ranges from 2013 to 2022; 6) the article has results or data 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 was primary research with a cross-sectional study design. Therefore, there were several exclusion criteria: 1) articles that did not perform multivariate analysis (multiple logistic regression with adjusted odds ratio); 2) articles are paid (with effort); and 3) manuscripts cannot be downloaded.

Data Feasibility Assessment

Eligibility or feasibility assessment is based on the data in the article by looking at it as a whole (full text), which meets previously determined criteria, including inclusion and exclusion criteria. After obtaining relevant and appropriate articles, a critical review is then carried out by assessing the quality of the study using STROBE, which is a way to scientifically criticize scientific writing for handling articles on analytical epidemiological study designs, namely cohort, case-control and cross-sectional studies, which aim to provide guidance. On how to report good observational research, STROBE consists of 22 items. All articles meet the minimum criteria and have good quality enough.

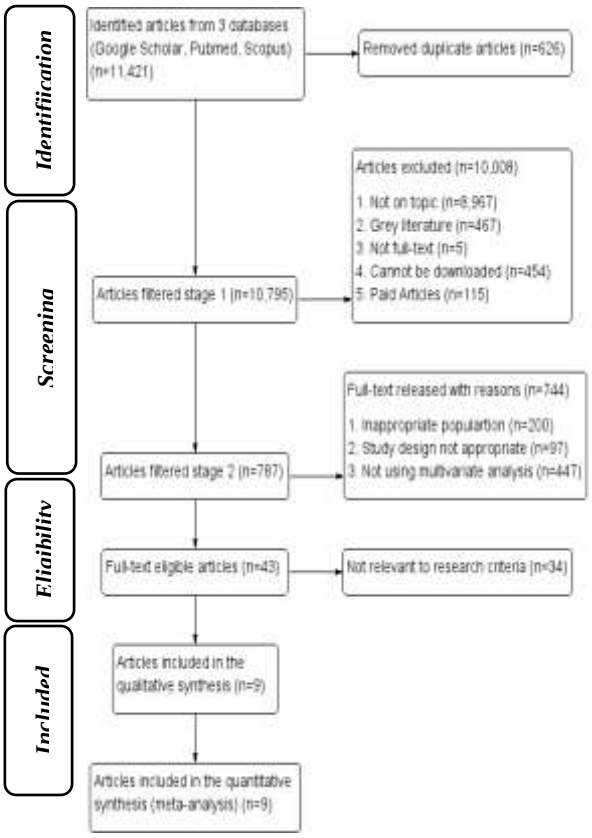

Figure 1. Flowchart-PRISMA flowchart for selection of articles

RESULTS

Overview of Research Area

Research related to the prevalence of anemia and the influence of food diversity and tea or coffee consumption in adolescent girls consists of nine articles originating from the African and Asian continents. Six studies were from the African continent, specifically Ethiopia, and three studies were from the Asian continent, specifically Indonesia. Risk factors of food diversity were found in four articles from Ethiopia, and tea or coffee consumption was found in five articles from two countries (Table 1).

Prevalence of Anemia in Adolescent Girls

The highest prevalence of anemia was in research conducted by Febianingsih et al (18) in Indonesia at 71.30%, and the lowest prevalence was in research by Teni et al (19) in Ethiopia at 12.00% (Figure 2). The average prevalence of anemia in adolescent girls was 30.83% (95% CI: 15.71 to 45.95), with a mean value of 26.70% and a variability of 19.67%. Prevalence variation was between 12.00% and 71.30% (Table 2).

Table 1
Description of Primary Studies Included in The Meta-Analysis

No	Authors	Year	Title	Location	Sample
1	Mohammed Teni, *et al.*(19)	2017	Anemia and Its Relationship with Academic Performance among Adolescent School Girls in Kebena District, Southwest Ethiopia	Ethiopia	442
2	Wahyu Setianingsih, *et al.* (20)	2017	Several Risk Factors for Anemia in Adolescent Girls	Indonesia	172
3	Febianingsih, *et al.*(18)	2019	Prevalence and Risk Factors of Anemia in Adolescent Girls at Sman I Abiansemal Badung	Indonesia	254
4	Seifu Hagos Gebreyesus, *et al.*(21)	2019	Anaemia among adolescent girls in three districts in Ethiopia	Ethiopia	1,323
5	Sileshi Demelash, *et al.*(22)	2019	Prevalence of Anemia and its Associated Factors among School Adolescent Girls Addis Ababa, 2015	Ethiopia	594
6	Kadek Agus Dwija Putra, *et al.*(23)	2020	The relationship between body image and tea drinking habits with anemia among adolescent girls in Badung District, Bali, Indonesia	Indonesia	106
7	Kelemu Fentie, *et al.*(15)	2020	Prevalence of Anemia and Associated Factors among Secondary School Adolescent Girls in Jimma Town, Oromia Regional State, Southwest Ethiopia	Ethiopia	528
8	Meseret Robi Tura, *et al.*(16)	2020	Prevalence of anemia and its associated factors among female adolescents in Ambo Town, West Shewa, Ethiopia	Ethiopia	523
9	Tsegaye Alemu, *et al.*(11)	2020	Prevalence and Predictors of Anaemia Among Adolescent Girls in Rural Hadero Tunto District, Southern Ethiopia: Community-Based Study	Ethiopia	406

Table 2
Description of The Prevalence of Anemia in 9 Primary Studies

Min	Max	Mean	95% CI		Median	SD
			Lower	Upper		
12.00	71.30	30.83	15.71	45.95	26.70	19.67

The prevalence of anemia in adolescent girls from each primary study varies greatly, marked with a red box in each study that is not adjacent. This can be caused by various factors, such as variations in the study population and variations in sample size. The average prevalence of anemia in adolescent girls was 30.83%, marked with a diamond sign (24). There was a width confidence interval in the primary study conducted by Febianingsih (18). Meanwhile, a short confidence interval was found in the primary study (19). The shorter the confidence interval, the more precise the precision of population parameters resulting from the sample (Figure 3).

Food Diversity

A meta-analysis of four articles originating from Ethiopia showed a heterogeneity value of I^2=82%, so a random effect analysis model was used. The study's results found that adolescent girls who have low dietary diversity were 1.87 times more likely to have anemia than adolescent girls who have high dietary diversity, but this has not been proven to be significant, with a value of SMD=1.87; 95% CI=0.88 to 3.97; p-value=0.10

(Figure 4). The funnel plot shows that the distribution of effect estimates from the primary studies of this meta-analysis to the left and right of the vertical line of mean estimates is similar. There are also no striking patterns or asymmetries that could provide clues that there is no publication bias (Figure 5).

Tea or Coffee Consumption

The study found that five articles originating from Ethiopia and Indonesia show a heterogeneity value of I^2=80%, so the random effect model is used. This study found that adolescent girls who consumed tea and coffee had a 2.46 times risk of developing anemia compared to adolescent girls who did not consume tea and coffee, and this was proven to be significant with an SMD value = 2.46; 95% CI=1.15 to 5.27; P-value=0.02 (Figure 6).

The funnel plot shows that the distribution of effect estimates from the primary studies of this meta-analysis lies more to the right of the vertical line of mean estimates than to the left, indicating no publication bias (Figure 7).

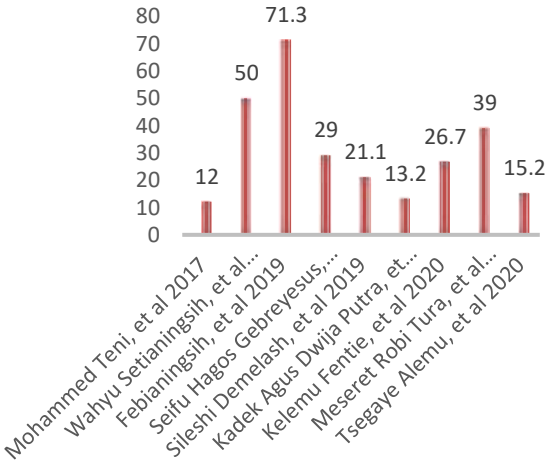

Figure 2. Graph of Anemia Prevalence in Adolescent Girls

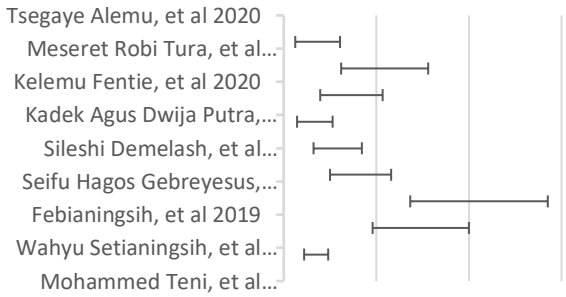

Figure 3. Forest Plot of Anemia Prevalence in Adolescent Girls

DISCUSSION

The results of this study found that the prevalence of anemia in adolescent girls from primary study results is still in the fairly high average range with very high variations between regions. The results are in line with the findings of Habtegiorgis et al (25) and Berhe et al (26), who found that the prevalence rate was high, but there is high variation. There is high variation because the sample size and population are different in each primary study. Several factors also cause significant variations in the incidence of anemia from primary studies, namely economic conditions, socio-cultural conditions and diet.

The prevalence range of anemia in Indonesia is 13.2%-71.3%, and the range of anemia in Ethiopia is 12.0%-39.0%. The average prevalence of anemia in Indonesia is 45.0%, while in Ethiopia, the average is 20.5%, meaning the average prevalence in Indonesia is twice that of Ethiopia. Judging from the sample in Indonesia, the largest sample is 254 teenage girls, while in Ethiopia, the sample of teenage girls is at least 406 people.

Anemia can be a severe health problem in Ethiopia and in Indonesia, including among adolescent girls. Several factors can contribute to the high prevalence of anemia, including nutritional problems, iron deficiency, parasitic infections, sanitation, access to health services, and social and economic factors. Efforts continue to be made to overcome anemia, both through improving access to good nutrition, improving the quality of health services, and nutrition education in the community. Although these problems still exist, there are ongoing efforts to improve the health and well-being of Ethiopia's population. Governments and international health organizations have attempted to address the problem of anemia by increasing access to good nutrition, and nutritional education and improving sanitation conditions. These programs aim to improve public health, especially among vulnerable groups such as adolescent girls (7).

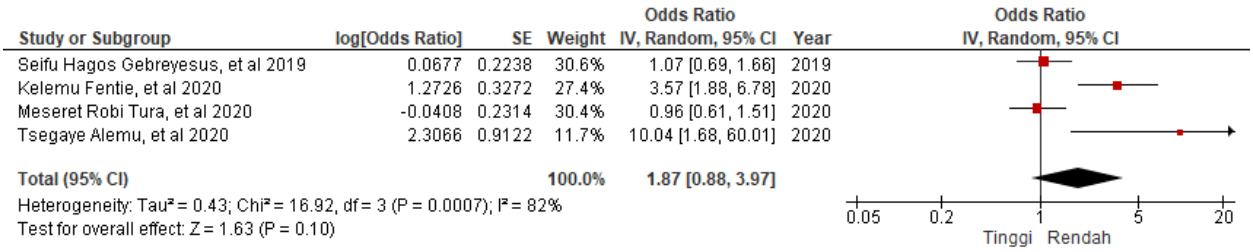

Figure 4. Forest Plot of Food Diversity and the Incidence of Anemia in Adolescent Girls

This study cannot prove a statistically significant relationship between food diversity and the occurrence of anemia. However, there was a tendency for low dietary diversity to increase the risk of anemia in adolescent girls. This research is not in line with meta-analysis research conducted by Habtegiorgis et al (25), which found that household food diversity was found to be a significant factor associated with anemia in adolescent girls. Households with a low food diversity score were 47% more likely to experience anemia in adolescent girls compared to households with high or adequate food diversity. A meta-analysis study conducted by Endale et al (27) also found that adolescent girls with low food diversity were 1.56 times at risk of experiencing anemia compared to adolescent girls who had high food diversity, and this was proven to be significant (p= 0.03). Another study conducted by Berhe et al (26) also stated that adolescent girls who had low or insufficient food diversity had a 2.81 times risk of experiencing anemia compared to adolescent girls with high or adequate food diversity and this was proven to be significant (aOR=2.82; 95% CI=1.33 to 5.9; P-value=0.00).

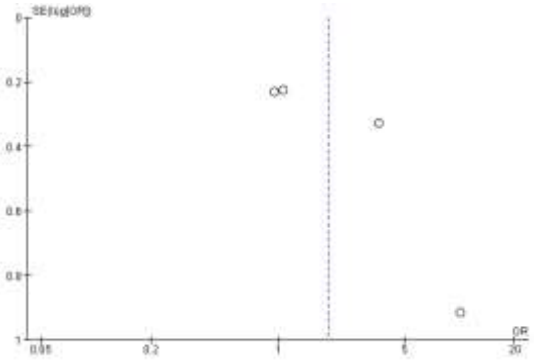

Figure 5. Funnel Plot of Food Diversity and the Incidence of Anemia in Adolescent Girls

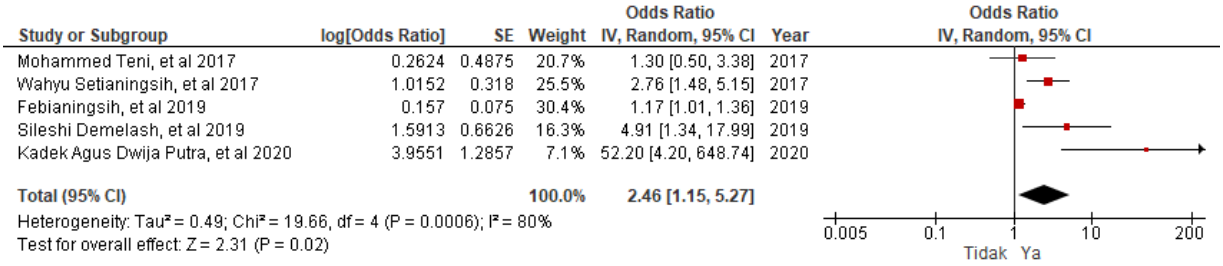

Figure 6. Forest Plot of Tea or Coffee Consumption with the Incidence of Anemia in Adolescent Girls

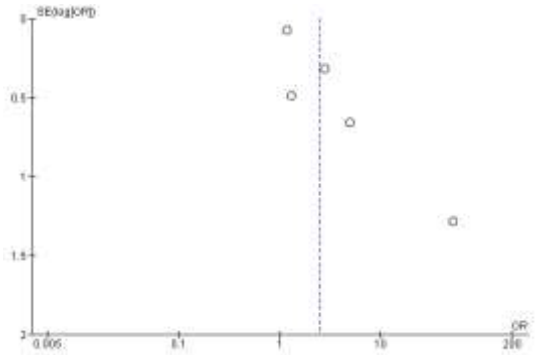

Figure 7. Funnel Plot of Tea or Coffee Consumption with the Incidence of Anemia in Adolescent Girls

Food diversity is in accordance with the general guidelines for balanced nutrition in Indonesia, and it is essential to consume various types of food to meet the nutritional needs of the body, including carbohydrates, protein, vegetables and fruit, fat, dairy products and water. Besides that, there were principles of good nutrition which have been compiled in the slogan "Isi Piringku" (fill my plate) by the Indonesian Ministry of Health. The contents of Isi Piringku include several aspects, including the diversity of food that must be consumed every day, consisting of side dishes, fruit, vegetables and staple foods. Apart from consuming a variety of

foods, it is also recommended to drink eight glasses of water a day, do 30 minutes of physical activity per day, and wash your hands with soap (28). Adolescent girls tend not to consume a variety of foods according to balanced nutrition guidelines. However, adolescent girls tend to consume junk food, which is more about one type of protein (29).

Some sources of iron found in food are sources of heme iron (meat, chicken, fish), sources of non-heme iron (nuts, seeds, dried fruit), sources of fortified iron (cereals, protein powder), and sources of vitamin C (fruits, vegetables and tomatoes). Adolescent girls who lack access to a sufficient variety of foods will experience anemia due to the low content of iron, vitamin B12, or folate, which is used for hematopoiesis (making blood cells), especially erythropoiesis (synthesis of erythrocytes), making them susceptible to anemia. Many adolescent girls follow unhealthy diets to maintain their posture by reducing their consumption of foods that are nutritious and contain iron. Adolescent girls should consume lots of foods rich in iron, but due to a lack of knowledge regarding types of food, adolescent girls follow the wrong diet. Adolescent girls need to know what types of healthy food contain iron-rich ingredients so that adolescent girls do not lack iron and experience anemia (30).

CONCLUSION

The average prevalence of anemia in the entire study was 30.80%, the average of the overall study where the range of anemia was between 12.0%-71.3%. Low food diversity increases the risk of anemia in adolescent girls. However, it is not proven to be statistically significant that consuming tea or coffee influences the incidence of anemia in adolescent girls and is statistically significant. The influence of tea and coffee consumption is more remarkable than food diversity. It is recommended that tea or coffee is not consumed while eating or 30 minutes after eating to prevent anemia in adolescent girls and to implement balanced nutrition guidelines.

CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

AUTHOR CONTRIBUTIONS

YD: Conceptualization, methodology, software, formal analysis, data curation, writing-original draft, writing and editing. UK: Conceptualization, methodology, validation, analysis, data curation, writing, editing, validation and review. GUS: Conceptualization, methodology, validation and project administration. DN: Visualization and project administration.

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