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Factors Associated with Anemia in Adolescents and Its Prevention Strategies: Systematic Review

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Abstract
Anemia is a global health issue affecting various age groups, including teenagers. This systematic review aims to identify the causes and treatments of anemia in adolescents. Using the Systematic Literature Review method, data were sourced from four databases: PubMed, Science Direct, Google Scholar, and SCOPUS. The literature search employed the keywords "Risk factor" AND "Anemia" AND "Adolescence," conducted comprehensively via the Publish or Perish (POP) search engine. Articles were selected based on inclusion criteria, covering publications from the last three years (2021-2023). Eligibility was assessed using the PICOS framework, and duplications were filtered using the Covidence application. Articles unrelated to the research problem were excluded after screening titles and abstracts. The VOSviewer application was utilized for thematic mapping. The study selection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Based on 18 selected articles, data was obtained on factors influencing anemia among adolescents such as inadequacy of nutrient intake (N=5 studies) such as protein, iron, and Vitamin A Nutritional status (N=3 studies), dietary patterns (N=2 studies), menstruation (N=2 studies), and hemoglobinopathies (N=1 study) are translated into English. Indirect risk factors associated with anemia among adolescents are found to be: Adolescent females (N=10 studies), Knowledge (N=6 studies), low socioeconomic status (N=3 studies), Education (N=2 studies), Demographics (2 studies), Shared toilet usage (1 study). The study concludes that young women are more susceptible to anemia than young men, with nutritional intake, knowledge, nutritional status, and diet being the primary risk factors. Addressing direct and indirect causes is crucial for effectively managing adolescent anemia.

Keywords: Anemia, Adolescence, Prevention, Risk Factor.

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1. INTRODUCTION

Adolescence is a critical period that experiences growth and maturation of reproductive organs and developmental transitions that require increased nutritional intake, making teenagers more vulnerable to malnutrition. Anemia is a global health problem that affects various age groups, including teenagers. Nearly 90% of adolescents living in low- and middle-income countries (LMICs) experience malnutrition, including anemia and micronutrient deficiencies (Hidayanti et al., 2022; Munira and Viwattanakulvanid, 2024; Zhu et al., 2021). Regional estimates of the World Health Organization (WHO) reveal that preschool-aged children and women in Africa (47.5–67.6%) show the proportion of individuals affected by anemia, The largest number affected by anemia is in Southeast Asia, with an estimated 315 million people (95% CI: 291–340 million) (Krishnan et al., 2021). In 2018, 48.9% of teenagers in Indonesia experienced anemia (Munira and Viwattanakulvanid, 2024). Anemia in adolescents is an important issue to understand and treat seriously because it can have significant impact on their health and quality of life such as cognitive and academic performance, physical health and development, mental and emotional well-being, immune function, and reproductive health. Strategies to prevent or treat anemia must be adapted to local conditions, taking into account the specific etiology and prevalence of anemia in a particular location and population group (Aidah, Bachri, and Palupi, 2023; Eiduson et al., 2022; Sari et al., 2022; Zhu et al., 2021).

Anemia in adolescents can hurt various aspects of their lives, including school performance, physical activity, and cognitive development. Therefore, an in-depth understanding of the causes, symptoms, and strategies for preventing and treating anemia in adolescents is very important to ensure their health and well-being (Mathad, Badiger, and Manjunath, 2023; Sari et al., 2022; Sigit et al., 2023; Yusufu et al., 2023; Zhu et al., 2021). Several risk factors that can cause anemia in adolescents involve nutritional aspects, such as deficiencies in iron, vitamin B12, and folic acid (Cliffer et al., 2023; Khani Jeihooni et al., 2021). In addition, unhealthy lifestyles, unbalanced diets, and certain health problems can also contribute to the high prevalence of anemia in this age group (Mathad et al., 2023; Zhu et al., 2021). Knowledge and education factors greatly determine how a person acts to strive for their health because they determine a healthy lifestyle and eating patterns, changes in modern lifestyles, such as the tendency to consume fast food that is less nutritious and lack of physical activity can increase the risk of anemia in teenagers (Aidah et al., 2023; Munira and Viwattanakulvanid, 2024; Utami et al., 2022). Apart from that, socio-economics also plays a role in the prevalence of anemia in adolescents because it causes limited access to food (Aidah et al., 2023; Yusufu et al., 2023; Zhu et al., 2021). This systematic review aims to identify the causes and treatments of anemia in adolescents.

2. RESEARCH METHOD

This study uses the systematic Literature Review (SLR) as the research design. used to identify problems in research to be corrected in further study and can evaluate theories about how or why phenomena occur (Page et al., 2021; Shamseer et al., 2015). Steps taken in the systematic Literature review are identifying research questions, identifying research articles, selecting articles according to inclusion and exclusion criteria, charting data, extracting data by analyzing research articles, reporting the findings, and conducting discussions (Page et al. 2021).

Search strategy

We have used various databases searched including PubMed, Scopus, Science Direct, and Google Scholar databases. The criteria for selecting studies include those that have undergone peer review and have been published, studies involving factors that caused anemia in adolescents. Excluded from the criteria were reviews, and non-original research articles.

Data is searched using keywords in English, namely "Risk factor" "Anemia" AND "Adolescence" using the Publish or Perish (POP) application.

Eligibility criteria

The review questions, search strategy, and inclusion criteria were derived from the PICO framework, Population (P): Adolescents typically aged 10-19 years, Intervention (I): Identification and implementation of prevention strategies for anemia, such as dietary improvements (iron-rich foods, vitamin C for better iron absorption), iron supplementation, education on nutrition, deworming programs, and public health campaigns, Comparison (C): Adolescents who do not receive these prevention strategies or receive only basic health education, Outcome (O): Reduction in the prevalence and incidence of anemia, improved hemoglobin levels, better overall health and development, and enhanced cognitive and physical performance. The evaluation focused on anemia in adolescents and its Prevention Strategies. For this inquiry, we conducted a search specifically targeting qualitative and Quantitative studies published from 2021 to 2023 and from the official database open access, articles in English and Indonesian that are appropriate to the research topic.

Data collection

Articles that include duplication criteria are excluded via the Covidence application, and for mapping based on themes using the VOS viewer application. Study selection was reported using Preferred Reporting Items for Systematic Reviews or Meta-Analysis (PRISMA). Articles that include duplication criteria are excluded via the Covidence application, and for mapping based on themes using the application VOSviewer.
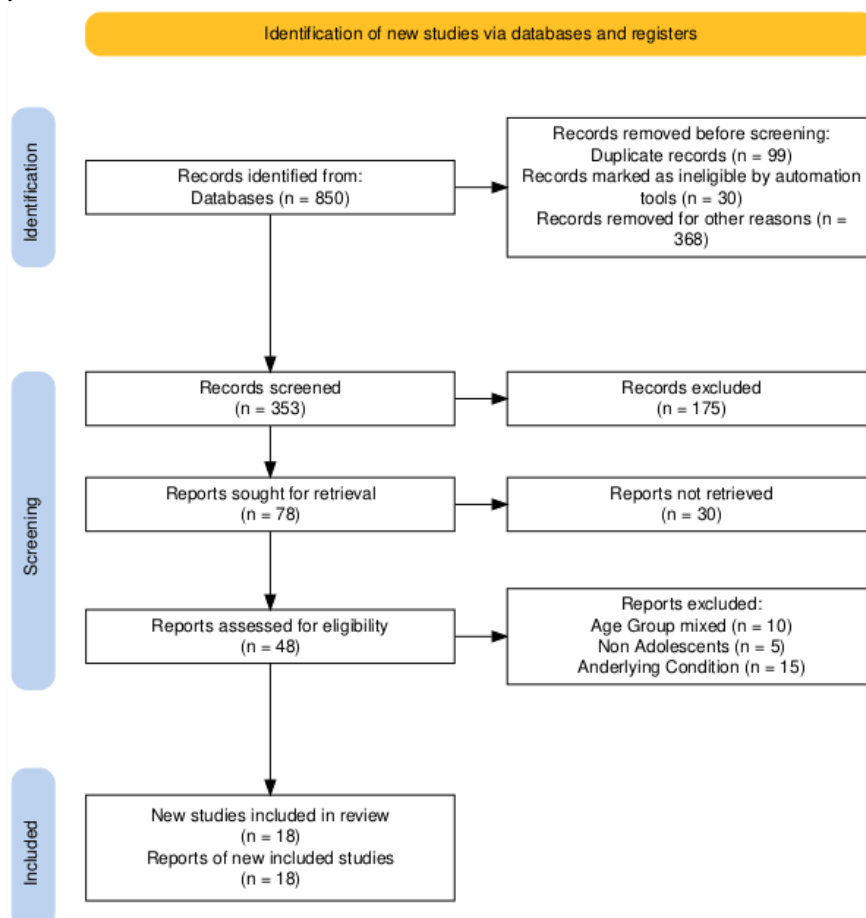

Figure 1. Prisma Flowchart

Data extraction

Data were extracted from all included studies in an extraction table. We categorized themes based on our specific research question and conducted a thematic analysis following the six-step approach proposed by Braun and Clarke (Byrne 2022). Their deductive method involves hierarchically identifying themes. Initially, the writers familiarized themselves with the research by thoroughly reading and reviewing the study data. In phase two, the primary author performed a systematic, manual analysis of characteristics, leading to the generation of preliminary codes. The third phase entailed exploring thematic elements, and the fourth step involved identifying subthemes and examining the interconnections between the themes and codes. After identifying themes in phase five, the findings were evaluated for their pertinence to the research question. The authors convened several times to deliberate on the analysis procedure and agree on the labeling (Byrne 2022).

Table 1. Article Data Extraction Table Used

No	Title, Author, Year, Country	Aim	Method	Result
1	Title: Factors associated with anemia among school-going adolescents aged 10–17 years in Zanzibar, Tanzania: a cross-sectional study Author: Innocent Yusufu, Ilana R. Clifer, Mashavu H. Yussuf, Cecilia Anthony, Frank Mapendo, Seif Abdulla, Mary Masanja, Amani Tinkasimile1, Ali Salim Ali, Mary Mwanyika-Sando and Wafaie Fawzi Year: 2023 Country: Tanzania	To overcome the problem of adolescent anemia, understand the factors associated with anemia in adolescents	Metode: cross-sectional	The results stated that while women had a higher chance of developing anemia than men (adjusted OR = 1.47; 95% CI: 1.24, 1.74), adolescents with high socioeconomic backgrounds had a lower chance of developing anemia than their male counterparts. those with low socio-economic background (Adjusted OR=0.7; CI: 0.54, 0.91), adolescents who experience stunting have a higher chance of developing anemia than students who are not stunted (Adjusted OR=1.38; 95% CI: 1.06,1.81),
2	Title: Anemia and associated factors among adolescent girls and boys at 10–14 years in rural western China Author: Zhonghai Zhu, Christopher R. Sudfeld, Yue Cheng, Qi Qi, Shaoru Li, Mohamed Elhoumed, Wenfang	To determine the prevalence of anemia and related factors among adolescent girls and boys in rural western China	Logistic regression was used to examine factors associated with anemia.	The overall prevalence of anemia was 11.7% (178/1517). Female adolescents were 1.73 (95% CI 1.21, 2.48) times more likely to experience anemia than male adolescents. Adolescents whose mothers graduated from high school were 0.35 (95% CI 0.13, 0.93) times less likely to experience anemia

	Yang, Suying Chang, Michael J. Dibley, Lingxia Zeng, and Wafaie W. Fawzi. Year: 2021 Country: China			compared to adolescents who had <3 years of formal education. Household wealth is also inversely related to anemia.
3	Title: Prevalence of Anemia and Correlation with Knowledge, Nutritional Status, Dietary Habits among Adolescent Girls at Islamic Boarding School Author: Aras Utami, Ani Margawati, Dodik Pramono, Diah Rahayu Wulandari Year: 2023 Negara: Indonesia	To assess the prevalence of anemia and analyze the relationship between knowledge, nutritional status, and eating habits and anemia in adolescent girls	cross-sectional	The prevalence of anemia was found to be 17.3%. In bivariate analysis, being overweight was more likely to have anemia (p=0.044). There is no relationship between the father's education and, the mother's education, knowledge, frequency of staple foods, breakfast habits, consumption of animal side dishes, consumption of vegetable side dishes, consumption of sweet tea, and anemia.
4	Title: Iron Deficiency Anemia and Associated Factors Among Adolescent Girls and Women in a Rural Area of Jatinangor, Indonesia Author: Puspa Sari, Raden Tina Dewi Judistiani, Dewi Marhaeni Diah Herawati, Meita Dhamayanti, Dany Hilmanto Year: 2022 Country: Indonesia	This study explores iron deficiency anemia and associated factors in adolescent girls and women in the rural area of Jatinangor, Indonesia.	cross-sectional	The prevalence of iron deficiency anemia in girls is 21.1% and in women 9.4%, with an average hemoglobin level in adolescents of 10.75 g/dL ($\pm$ 0.79) and in adults 11.20 g/dL ($\pm$ 0.61), while the MCV was 74.49 $\pm$ 8.22 fL in adolescents and 7.61 $\pm$ 8.62 fL in adults. The majority of our sample did not experience growth restriction and were also within the normal weight range. Multivariate logistic regression analysis showed that protein intake (OR=0.25; 95% CI 0.11–0.58) was a factor positively associated with anemia.
5	Title: Prevalence and Predictors of Iron Deficiency in Adolescent and Young Adult Outpatients: Implications for Screening	We examined sex-specific factors associated with ID and IDA as well as the ability of universal and risk factor-based screening using	Qualitative	Among women (n = 350), 34.6% had ID and 6.3% had IDA. Nearly 1 in 3 women with ID have no risk factors. Among men, 12.6% had ID; none had IDAs. More than 1 in 3 men with ID have no risk factors. Current

	Author: Rose Eiduson, MPH, Matthew M. Heeney, MD, Pei-Chi Kao, MPH, Wendy B. London, PhD, Mark D. Fleming, MD, DPhil, and Lydia A. Shrier, MD, MPH Year: 2022 Country: USA	hemoglobin and hemoglobin plus ferritin to detect ID and IDA.		screening approaches cannot detect ID in 47% to 82% of women and 95% to 100% of men. ID is common in male and female adolescent outpatients and young adults. New approaches to ID screening are needed to accurately evaluate iron status in this population
6	Title: Knowledge, attitude, and practice towards anemia prevention among female students in Indonesia: a mixed method study Author: Lafi Munira, Pramon Viwattanakulvanid Year: 2024 Country: Indonesia	This study aims to examine the influence of knowledge and attitudes on anemia prevention practices and to identify reasons for not implementing anemia prevention among female high school students in Banjarmasin City, Indonesia.	Mix Method	The results showed that 254 (72.6%) female students had bad practices, 147 (42.0%) had bad attitudes, and 169 (48.3%) had poor knowledge regarding the prevention of iron deficiency anemia (IDA). Female students in the older age group (17-18 years) (adjusted odds ratio/AOR 1.88, 95% CI 1.12, 3.16), attending vocational school (AOR 1.85, 95% CI 1.05, 3.27), good knowledge (AOR 2.52, 95% CI 1.49, 4.26) was a significant predictor of prevention of iron deficiency anemia (IDA).
7	Title: Anaemia in Indians aged 10–19 years: Prevalence, burden and associated factors at national and regional levels Author: Samuel Scott, Anwesha Lahiri, Vani Sethi, Arjan de Wagt, Purnima Menon, Kapil Yadav, Mini Varghese, William Joe, Sheila C. Vir, Phuong Hong Nguyen Year: 2022 Country: India	The objectives of this study were to (1) describe the national and subnational prevalence, severity, and burden of anemia among Indian adolescents; (2) examine the factors associated with anemia at the level of national dan regional	Logistic regression	Anemia occurs in 40% of girls and 18% of boys, equivalent to 72 million adolescents in 2018, and varies by region (girls 29%–46%; boys 11%–28%) and state (girls 7%–62%). ; men 4%–32%). Iron deficiency (ferritin <15 μg/L) was the strongest predictor of anemia (odds ratio [OR]: 4.68, 95% confidence interval [CI]: [3.21,6.83]), followed by hemoglobinopathy (HbA2 > 3.5% or whatever). HbS) (OR: 2.81, 95% CI: [1.66,4.74]), vitamin A deficiency (serum retinol

				<70 µg/L) (OR: 1.32, 95% CI: [1.02,1.72])
8	Title: School-based supplementation with iron-folic acid or multiple micronutrient tablets to address anemia among adolescents in Burkina Faso: a cluster-randomized trial Author: Ilana R. Cliffer, Ourohire Millogo, Yllassa Barry, Idrissa Kouanda, Guillaume Compaore, Dongqing Wang, Ali Sie, Wafaie Fawzi Year: 2023 Country: Burkina Faso	This study aimed to evaluate the effectiveness of school-based supplementation with folic acid (IFA) or multiple micronutrient supplementation (MMS) in treating anemia among adolescents in Burkina Faso	Quasi Experiment	The prevalence of baseline anemia was similar across study groups, with 32.7% in IFA, 31.2% in MMS, and 29.5% in the control group. Over the full study period, adolescents given IFA had higher hemoglobin levels than the control group (adjusted β: 0.32; 95% CI: 0.02, 0.62). No significant associations were observed with MMS or anemia outcomes; however, the direction and magnitude of the relationship were not significant indicating a potential protective effect of IFA and MMS against anemia
9	Title: Anemia Prevalence and Socioeconomic Status among Adolescent Girls in Rural Western India: A Cross-Sectional Study Author: Manisha Nitin Gore, Madeline Elizabeth Drozd, Reshma Sudhir Patil Year: 2024 Country: India	This study aims to evaluate the prevalence of anemia, as well as socioeconomic and nutritional status among adolescent girls attending rural government schools in Pune, India.	Cross-sectional	The findings show that the overall prevalence of anemia is (42.75%), consisting of severe (2.5%), moderate (21%) and mild (20.25%) cases. Additionally, the majority (74.6%) of girls were classified as underweight. Socioeconomic analysis shows that 64.25% of families belong to the lower middle class, and 27% belong to the upper and lower classes.
10	Title: The longitudinal relationship between nutritional status and anemia among Malaysian adolescents Author: Vanitha Krishnan, Rafdzah Ahmad Zaki, Azmi Mohamed Nahar, Muhammad Yazid	This study aims to show trends in the prevalence of anemia and to determine its longitudinal relationship with nutritional status and lifestyle among Malaysian adolescents	Cohort	The trend of anemia prevalence increased significantly in age groups (7.9%; 95% CI: 2.3-11.1, 13.9%; 95% CI: 10.8-15.7 and 15.8%; 95% CI: 3.8-23.1) at ages 13, 15 and 15 years. 17 years each, especially among women. The trend in the prevalence of anemia in women also increased significantly in age groups (11.1%; 95% CI:

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	Jalaludin, Hazreen Abdul Majid, Year: 2021 Country: Malaysian			6.7-17.8, 15.7%; 95% CI: 11.4-21.3, 23.1%; 95% CI: 16.8-31.0).
11	Title: Impact of nutritional education on knowledge, attitude, and practice regarding anemia among school children in Belgaum, India Author: Adhikari Poudel Sasmitaa, Angolkar Mubashir, Naik Vijaya Year: 2022 Country: India	This research seeks to study the impact of nutrition education on knowledge, attitudes, and practices regarding anemia in school children.	Quasi Experiment	There was a significant increase in the average value of knowledge and attitudes of school children in the post-test evaluation. An overall increase of 51.2% in the mean knowledge score and an overall increase of 20.7% in the mean attitude score was found (P < 0.05). Increased frequency of consumption patterns of iron-rich foods especially Ragi, jaggery, green leafy vegetables, and whole grains was reported.
12	Title: Assessment of anemia and malnutrition among Adolescents in the Kalyan Karnataka region of Karnataka Author: Vijayshree Mathad, Shobha Badiger, Nitin Manjunath Year: 2023 Country: Karnataka	Therefore, this study focused on assessing the prevalence of malnutrition and the degree of anemia among adolescents in the Kalyan region of Karnataka.	Quasi Experiment	The prevalence of anemia among adolescents in our study was 37.7%, and underweight was 36.1%. Adolescent girls have a higher prevalence of anemia (44.5%). The average age of teenagers is 14 years. Underweight is more common in men than women.
13	Title: Factors influencing the prevalence of anemia in female adolescents: A population-based study of the rural setting in Karanganyar, Indonesia Author: Fathimah Sulistyowati Sigit, Fiyan Bahrul Ilmi, Prisilla Desfiandi, Dewantari Saputri, Nur Dwi Fajarini, Ana Susianti d, Latifah Agustina	This study investigated the prevalence of anemia and its relationship with anthropometric indices, eating habits, and menstrual status in adolescent girls in Karanganyar, a rural subdistrict in Indonesia.	Cross-sectional	Around 49% of young women in Karanganyar suffer from anemia. BMI and Mid-Upper Arm Circumference showed an inverse association with anemia [AOR(95%CI): 0.87(0.79–0.95) and 0.89 (0.81–0.99)]. Compared with individuals with a BMI-for-age-Z-Score (BAZ) > -2 SD, those with a BAZ < -2 SD had more than double the odds of anemia [2.43 (0.94–6.29)]. Consumption of fruits [0.32(0.10-0.98)] and vegetable table [0.30(0.11-0.78)] was negatively

	Lestari, Asaduddien Farasf Year: 2024 Country:Indonesia			associated with anemia. No association was observed between menstrual status (length, duration, pads/day) and anemia.
14	Title: Changes in Attitudes Toward Anemia Prevention Through Counseling Based on Health Belief Model Theory in Early Adolescent Children at Junior High School Nurul Islam Jember Author: Hasna Aidah, Syaiful Bachri, Jenie Palupi Year: 2023 Country: Indonesia	The aim of this research is to analyze changes in attitudes towards preventing anemia through counseling based on the HBM (Health Belief Model) theory in adolescents.	Quasi Experiment	With the Mc Nemar test, an α value <0.05 was obtained, namely 0.000, so it can be concluded that there was a change in attitude before and after being given counseling about preventing anemia in early adolescents at Nurul Islam Middle School, Jember.
15	Title: Conditional selection of multifactor evidence for the levels of anemia among women of reproductive age group Author: Pavan Kumar S.T, Biswajit Lahiri Year: 2023 Country: India	This study aims to ascertain the conditional selection of the main indicators that influence the levels of severe, moderate, mild, and no anemia in women of childbearing age in India.	Cross-Sectional	Results: Secondary and higher education had a negative influence on the degree of severe, moderate, and mild anemia. The poorest wealth index layers have higher and more significant levels of severe anemia, and households with two adults of different genders have a significant negative effect ($\beta = -0.116$, $OR = 0.89$, $p < 0.001$) on the level of severe anemia and have a significant positive influence.
16	Title: The Health Belief Model Combined with Education on Healthy Food Preparation to Improve Dietary Iron Intake Among Adolescent Girls Author: Lilik hidayanti, M. Zen Rahfilludin, S.A. Nugraheni, and Retno Murwani Year: 2022	Therefore, this study aims to measure the effect of HBM-based nutrition education combined with healthy food preparation training on increasing iron intake in young women in Islamic boarding schools.	Quasi Experiment	The results showed that there were differences in energy, protein, and iron intake between the two groups at follow-up 1 and 2 ($p<0.05$).

	Country: Malaysia			
17	Title: Animated educational video using health belief model on the knowledge of anemia prevention among female adolescents: An intervention study Author: Siti Aisah, Suhartini Ismail, Ani Margawati Tahun: 2022 Negara: Malaysia	This study tested the effect of educational animated videos on knowledge of anemia prevention in young women using the Health Belief Model (HBM).	Quasi experiment	An animated educational video played three times significantly increased the knowledge of the intervention group (mean scores: pre-test, 94; post-test one, 99; post-test two, 102). Anemia screening barrier score (P=0.001), anemia susceptibility (P=0.001), anemia severity (P=0.001), benefits of preventing anemia (P=0.001), benefits of anemia screening (P=0.001), self-efficacy for obtaining tablets iron (P=0.001), self-recognition of signs and symptoms of anemia (P=0.001), signs of anemia prevention (P=0.001) and health motivation (P=0.001) experienced significant changes.
18	Title: The effect of Nutrition education based on the PRECEDE Model on iron deficiency anemia among female Students Author: Ali Khani Jeihooni, Sanaz Hoshyar, Pooyan Afzali Harsini, and Tayebeh Rakhshani Year: 2021 Country: India	This study aims to evaluate the effectiveness of the PRECEDE model nutrition education on iron deficiency anemia in female students in Fasa City, Fars Province, Iran.	Quasi Experiment	In the experimental group, the average age of students was 13.85+1.72 years and in the control group, it was 13.60+1.81 years. In addition, there were no significant differences in PRECEDE constructs, and nutritional behaviors preventing iron deficiency anemia before intervention in the two study groups.

3. RESULTS AND DISCUSSION

Based on search results using keywords in the PubMed, Scopus, Science Direct, and Google Scholar databases using the Publish or Perish search engine, 850 articles were found. All articles were included in the Covident application, several references were removed (n = 497), consisting of duplicates identified manually (n=4), duplicates identified through Covidence (n = 95), several articles marked as ineligible by automation tools (n = 30), Other reasons (n = 368), Next 78 articles were screened according to title and abstract based on inclusion and exclusion criteria and 30 articles were excluded because they did not meet the requirements. Of the 48 articles, after being read as a whole, 30 articles were excluded because

the subject characteristics were mixed age and did not include the criteria for teenagers and only 18 articles met the requirements.
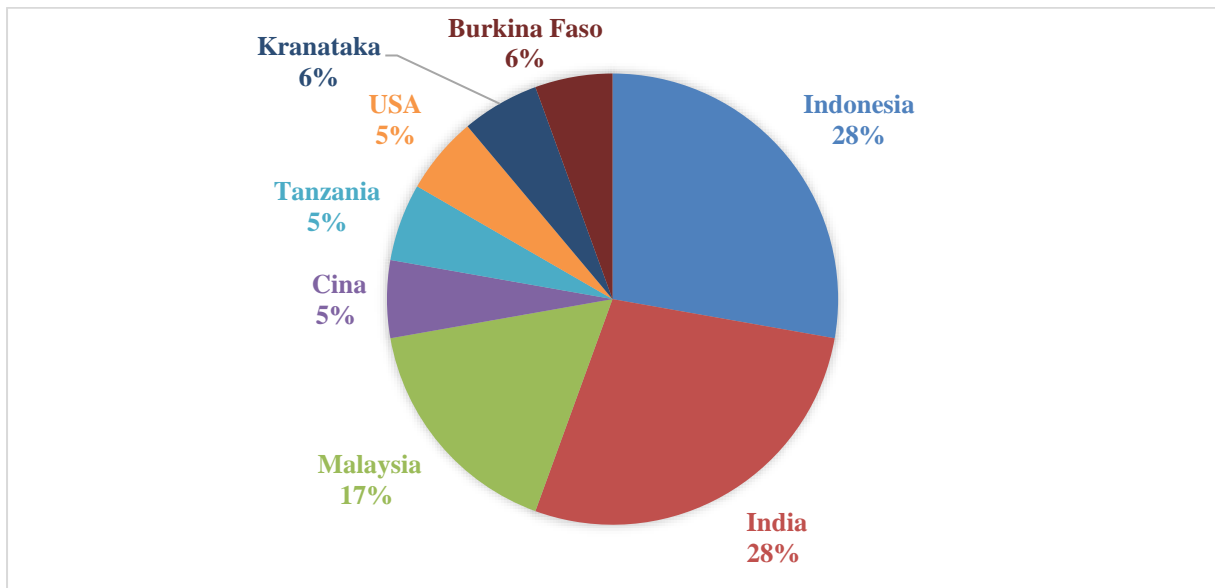
Figure 2. Characteristics by country

Of the 18 articles, five articles were conducted in Indonesia (Aidah et al., 2023; Munira and Viwattanakulvanid, 2024; Sari et al., 2022; Sigit et al., 2023; Utami et al., 2022), five articles were conducted in India (Gore, Drozd, and Patil, 2024; Khani Jeihooni et al., 2021; Kumar and Lahiri, 2023; Sasmita, Mubashir, and Vijaya, 2022; Scott et al., 2022), 1 article conducted in China (Utami et al., 2022; Zhu et al., 2021), 3 articles are done in Malaysia (Aisah, Ismail, and Margawati, 2022; Hidayanti et al., 2022; Krishnan et al., 2021), 1artikel di lakukan di Tanzania (Yusufu et al., 2023), 1 article conducted in Tanzania (Eiduson et al., 2022), 1 article conducted in the USA (Mathad et al., 2023), 1 article in Kranataka, and 1 article on Burkina Faso (Cliffer et al. 2023).
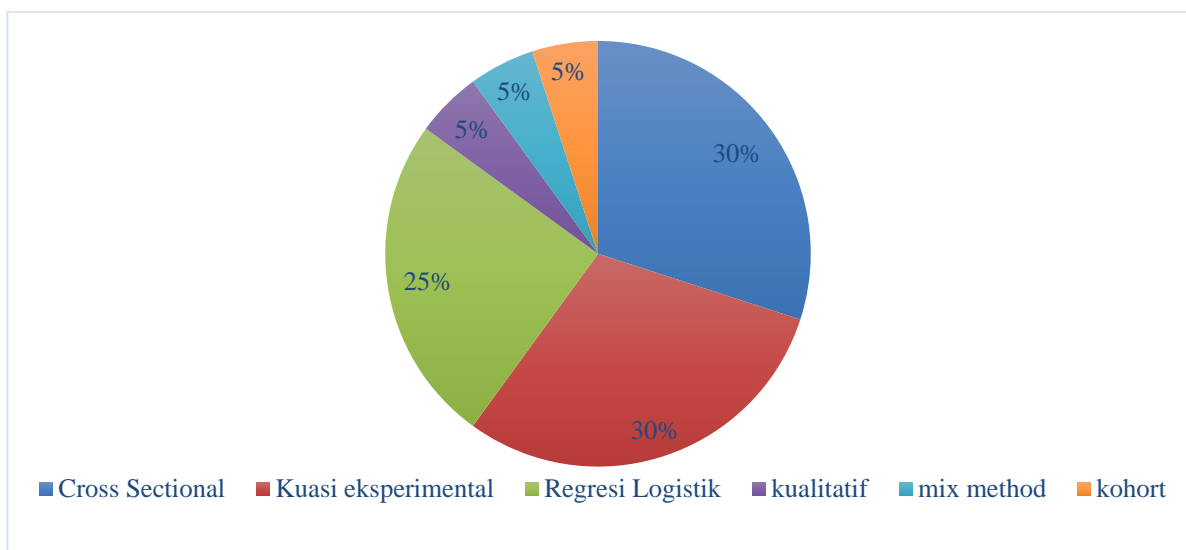
**Figure 3.** Characteristics based on research design

Based on the characteristics of the research design, results were obtained from 18 articles. There is 1 article with a qualitative research design, there is 1 article with a research design *mix method* and there are 17 articles with a quantitative research design, consisting of 6 articles with

a cross-sectional design, 4 articles were assessed using logistic regression, and there are 6 articles with pre-experiment as well as 1 article with a cohort.

Table 2. Analysis and Mapping According to Themes

No	Theme	Under Theme	Article
1	Factor Cause Anemia in Teenagers	Gender	1,2,4,5,6,7,9 ,11,12,13
		Knowledge	3,6,11,14,17, 18
		Nutritional Intake	3,4, 7,10,16
		Economic status	1,2,12
		Nutritional status:	1,3, 13
		Education	2,15
		Dietary habit	2,11
		Menstruation	9,12
		demographics	9,15
		Shared toilet use	1
		hemoglobinopathies	7
2	Strategy Deterrent	Health promotion	1, 16
		Giving tablets to increase blood	1, 2
		Approach interpersonal	17
		Collaboration	6
		Giving Micronutrients	2,8

Based on the article theme analysis carried out after data analysis through data extraction and assessment of the quality of research articles, the selected research article theme was identified namely factors causing anemia in adolescents and prevention strategies which are summarized in Table 2.
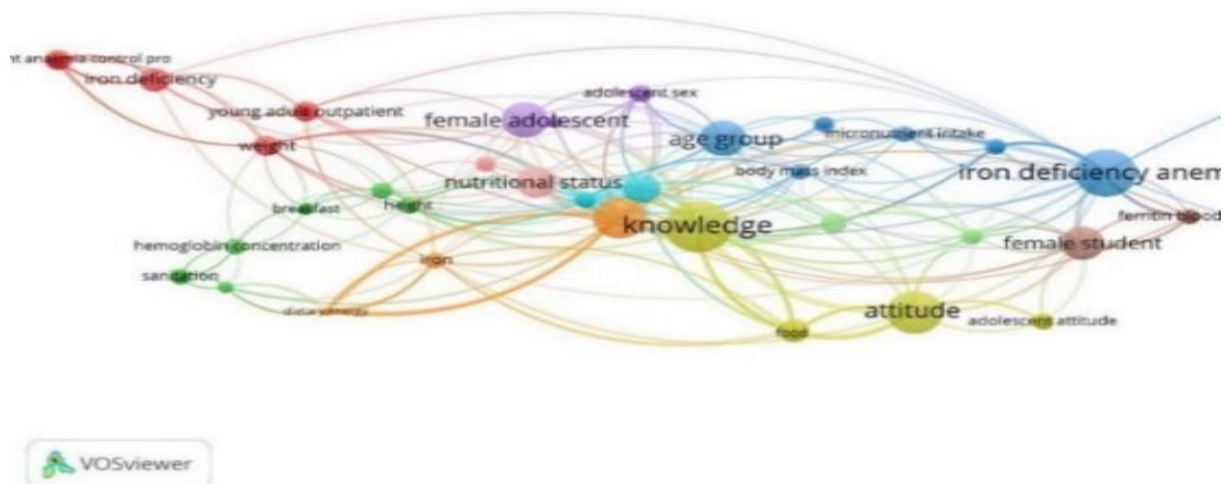
Figure 3. Overview of factors that influence anemia

Research on factors the causes of anemia in teenagers can involve various aspects, which are divided into direct risk factors that contribute to anemia among adolescents: lack of nutritional intake (N= 5 studies) such as protein, Iron, dan Vit A, Nutritional Status (N= 3 studies), Diet (N= 2 studi), menstruation (N= 2 studies), and hemoglobinopathies (N= 1 study). Indirect risk factors found to be associated with anemia among adolescents are: Adolescent

girls (N=10 studies), Knowledge (N=6 studies)), low socioeconomic status (N= 3 studies), Education (N=2 studies), Demographics (2 studies), and Shared toilet use (1 study).

Teenage Girls

Ten studies reported an association between adolescent girls and anemia. These studies show that the chances of adolescent girls experiencing anemia are significant and higher (OR= 1.47; 95% CI: 1.24, 1.74). Teenagers and women tend to be more susceptible to infection anemia due to various related factors with growth and development, especially in the context of changes in physical and biological events that occur over time.

Knowledge

Knowledge is the second biggest factor, after gender, that causes anemia in adolescents. Six studies link knowledge with the incidence of anemia in this age group. Knowledge deficiency could be a causal factor in anemia due to lack of knowledge influences daily behavior and decisions, including decisions related to eating patterns and lifestyle (AOR 2.52, 95% CI 1.49, 4.26), (OR=3.652; 95%CI=1.221-10.922; p=0.020).

Socioeconomic Status

Three studies assessed the association between socioeconomic status and anemia. The results showed that low socioeconomic status increased the likelihood of anemia. The research found that adolescents with low socioeconomic backgrounds were more likely to experience anemia, with results: OR=0.7; CI: 0.54, 0.91)(Yusufu et al. 2023), (Adjusted OR=0.7; CI: 0.54, 0.91).

Nutritional Intake

The nutritional intake study consisted of two articles about protein, two about iron, and one about vitamin A. Lack of nutrients such as iron, vitamin A, and protein can cause anemia because these nutrients have an important role in cell formation and the function of red blood, which is vital in the transportation of oxygen throughout the body (OR=0,25; 95% CI 0,11–0,58).

Educational status

There are only two studies that report educational status as a risk factor for anemia, the risk of anemia increased significantly with decreasing education level (AOR 1.85, 95% CI 1.05, 3.27). Adolescents with education up to junior high school level or lower were found to have a greater chance of developing anemia.

Dietary habit

Two studies assessed the association between anemia and dietary intake practices among adolescents. This research shows that the frequency of eating and the type of food consumed greatly influences the incidence of anemia. This research documents that low dietary diversity significantly increases the risk of anemia in adolescents. Consumption of meat (OR 0.58, 95% CI 0.38, 0.89), eggs (OR 0.60, 95% CI 0.38, 0.93), and frequency of eating three or more times per day (OR 0.68, 95% CI 0.48, 0.96). In addition, low iron intake significantly increases anemia.

Nutritional status

Three articles that reported the relationship between nutritional status were assessed by measuring (BMI, Upper Arm Circumference Stunting status, and obesity and obtained the results of 3 articles that examined the relationship between nutritional status and the incidence of anemia. Poor nutritional status or nutritional deficiencies may be a factor that causes anemia

due to inadequate nutrition sufficient to affect the production and function of red blood cells Several reasons why poor nutritional status can cause anemia to involve several important nutrients, including iron, vitamin B12, folate, and protein.

Menstruation

Two studies reported a relationship between menstruation and the incidence of anemia, this study assessed that excessive bleeding during menstruation significantly increases the likelihood, that adolescent girls who experience bleeding for more than 5 days have an increased risk of experiencing anemia.

Demographics

Two studies reported an association between demographics and the incidence of anemia. Research shows that teenagers living in rural areas have an increased risk of anemia. According to (Yang et al., 2020) as many as 8.4% of participants were identified as suffering from anemia; and the prevalence is higher in rural girls and children, whereas according to (Kumar and Lahiri, 2023) rural households are negatively and significantly associated with moderate and mild anemia.

Shared Toilet Use

Only one study reported a relationship between the use of shared toilets and the incidence of anemia. According to the article, those who use shared toilets have a higher chance of experiencing moderate or severe anemia than those who have access to private toilets (OR=1.68; CI: 1.07, 2.64).

Anemia Prevention Strategy

Here are some strategies summarized from several articles: Promotion of Health that can be done with various methods such as health *Belief Models* or other theories aimed at increasing knowledge about anemia and supporting better behavior change, giving blood supplement tablets to teenagers carried out through schools, Interpersonal approach to giving Health counseling for teenagers, collaboration with teachers and various parties to mobilize teenagers in caring for Their health, and administration of micronutrients in the form of protein, folic acid, iron, vitamin D, and Vitamin A.

Figure 4. Overview of factors that influence anemia

Several articles reported the relationship between adolescent girls and anemia. These

studies show that the chances of teenage girls experiencing anemia are significant and higher (Eiduson et al., 2022; Yusufu et al., 2023). Teenage girls tend to be more vulnerable to anemia due to various factors related to growth and development, especially in the context of physical and biological change that occurs during puberty. Efforts to prevent anemia in adolescents namely by increasing knowledge of teenagers about anemia and healthy lifestyles. (Aidah et al., 2023; Narsih et al., 2020). Teenagers who understand the relationships between patterns of healthy eating, exercise, and anemia prevention will be more likely to adopt a lifestyle that supports health (Romandani, & Rahmawati, 2020). In research Wiafe, assessed knowledge and practices of iron intake and anemia in early adolescents in a rural district in Ghana. The findings of this study indicate that most adolescents are unaware of iron deficiency anemia and have insufficient knowledge about its causes, impact on children's health, and prevention (Wiafe, Apprey, and Annan, 2021).

Lack of nutrients such as iron, acid Folate, Vitamin A, and protein can cause anemia due to nutrients it has an important role in the formation and function of red blood cells, which are vital in the transport of oxygen throughout the body. Foods sources of iron, foods rich in iron, and foods that aid or reduce iron absorption (Hidayanti et al., 2022; Sari et al., 2022). Sources of iron are found in the intake of chicken meat, fresh fish, and dried fish, although there is a statistically significant and inverse relationship with beef (Wiafe et al., 2021).

4. CONCLUSION

Factors that influence the incidence of anemia in adolescents include nutritional intake, nutritional status, diet, menstruation, and hemoglobinopathy, teenage girls, Knowledge, low socio-economic status, Education, demographics, and Use of shared toilets. Adolescent girls are a group that is more susceptible to anemia than adolescent boys. Nutritional intake, knowledge, nutritional status, and diet are the main risk factors for anemia. Various strategies for preventing anemia in adolescents, including increasing nutritional intake, iron supplementation, health education, and other interventions, have been implemented in various countries and through schools. School formal education is carried out on an ongoing basis (Cliffer et al. 2023; Fitria et al. 2021).

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