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2 **Nutrition Education Effect on Anemia Incidence in Female**  
3 **Adolescents: A Meta-Analysis for Nutrition Awareness Post-**  
4 **COVID-19-Pandemic**

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24 **Abstract**

25 Female adolescents have high-risk anemia because of low iron intake and absorption,  
26 blood loss during menstruation, and an increased need for iron to help rapid growth.

27 This study aimed to see if nutrition education affected the incidence of anemia in  
28 female adolescents. A systematic review and meta-analysis were used to perform this  
29 study. Google Scholar, JAMA Network, PubMed, Science Direct, The New England  
30 Journal of Medicine, Lancet, and ProQuest papers published between 2010 and 2021

31 were used as data sources. The keywords used were "nutrition education" and  
32 "adolescent anemia female." The Preferred Reporting Items for Systematic Reviews  
33 and Meta-Analyses guideline was used to select and organize publications for this  
34 study. Review Manager 5.3 Software was used to choose full-text articles for a meta-  
35 analysis. Seven of the 257 article titles obtained met the meta-analysis requirements.

36 Female adolescents who did not get nutrition education were 2.10 times the risk for  
37 the incidence of anemia (aOR= 2.10; 95% CI= 1.60 to 2.76; p-value <0.001).

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

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2. Need additional sentences to present inconsistent findings  
3. Explanation needed in Table 1 as it consists of adult (not just adolescent)  
4. Range of study until 5897 not 5000  
5. Consistency of using teenagers girls or adolescent girls or teens girl terminology.  
6. Please be more specific who/which institution can carry out these activities  
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## Introduction

Anemia is a sign of poor health in terms of nutrition.<sup>1</sup> In other words, anemia is a condition with a decrease in hemoglobin levels below the normal value caused by iron deficiency. The main cause is due to a lack of iron intake.<sup>2,3,4</sup> Anemia and malnutrition remain global health issues that account for 1.6 billion people or 25% of the world's population, especially among women in developing countries, including Indonesia.<sup>5,6,7</sup> The World Health Organization (WHO) defines adolescents as aged 10-19 years.<sup>8,9,10</sup> Female adolescents 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.<sup>11</sup>

In developing countries, anemia affects a huge wide variety of people.<sup>12</sup> An observation conducted in 34 African countries discovered that the estimated prevalence of anemia in teenagers and younger women ranged from 15% to more than 50%.<sup>13</sup> The North Wollo of Amhara Region is a part of Ethiopia that is often tormented by drought; as tormented by El Nino in 2015/2016, the meal costs had drastically extended in Woldia city due to reduced crop production in the surrounding district.<sup>14</sup>

In India, the problem of malnutrition and micronutrient deficiencies is a huge spread.<sup>15</sup> Micronutrient deficiencies during early childhood can frequently change in teenagers with long-term effects on health, cognition, education, and productivity.<sup>15</sup> Several studies have been performed to prevent anemia, which commonly targets toddlers, younger kids, and pregnant and lactating women; however, no longer teenagers.

In addition, the cause of the current increase in anemia rates is the coronavirus disease 2019 (COVID-19) pandemic accompanying it. This condition has led to significant social transformations affecting overall health status, including anemia, and the feasibility of implementing health programs in a sustainable manner. The spread of COVID-19 has a negative impact on individuals due to loss of income, including job loss, unemployment, or termination of employment, which in turn impacts the household economy.

This pandemic increases the risk of anemia among female adolescents and pregnant women, mainly due to irregular consumption of blood-boosting tablets and weakened economic conditions, which can reduce nutritional intake.<sup>16</sup> Female

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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.<sup>16</sup>

Other studies showed nutrition education can increase adolescent knowledge so that it can change thinking and increase adolescent knowledge to prevent anemia through effective knowledge of nutritional education that has been given. Education is an important part of human resources and the most important part of human life because it can affect human resources quality.<sup>17,18</sup> In today's education era, technological development further 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 learning medium used.<sup>19,20</sup>

Although many similar primary studies have been conducted, some inconsistent research results remain. Therefore a comprehensive analysis is needed to obtain a result that can be interpreted as a whole.<sup>21</sup> Thus, this study aimed to analyze the effect of nutrient education on anemia, especially in female adolescents, to attain convincing and concerning results. [...]

## Method

Four writers did a systematic literature review of one primary author and three co-authors from March to early May 2021. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines are the acronym for systematic review and meta-analysis standards.<sup>8</sup> 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 chosen because they are well-known health databases with bibliometrics that provide free and easy access to verify other people's work.

The first step was to get to the website of the database. Then, to identify relevant articles, 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, tick the text availability article (full text and free full text), article type (journal), with the publication of the last eleven years (2010–2021). For Science Direct, after going to the website, tick all categories for the publication title, as well as all subject areas, by defining the article type or research paper.

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**Commented [K12]:** Please briefly provide a significant novelty of your study and what your study can contribute to the world.

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Following the PRISMA guideline was the next step. 1) Identifying: the authors utilized quote marks or apostrophes to designate relevant journal article titles in the search box on [the two website URLs](#). The authors used the boolean symbol "AND" between keywords with two or more of them. The keywords used to find 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 "adolescent girl" OR "adolescent" OR "young children" AND aOR. Articles that surfaced many times during keyword searches were not reused;

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2) Screening: the authors chose an article title corresponding to the theme while screening journal article [names](#). The inclusion criteria (full-text, open-access articles, teenagers, 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. Articles with abstracts that did not match the requirements were discarded;

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3) Eligibility: full-text versions of selected publications that match the inclusion criteria were downloaded. Both open-access and closed-access journals must meet the criteria. To find a link between nutrition education and anemia, all journals are reviewed and selected. No articles will be utilized if no associations can be detected. 4) [Included](#): all journal articles that meet the inclusion criteria were sorted by publication year, study location, study design, study duration, sample size, number of respondents, and adjusted Odd Ratio (aOR) values. This data was required to compute a meta-analysis using Review Manager 5.3 Software, an open-source software named "Review Manager 5 Software" ([can be downloaded from https://-training.cochrane.org/online-learning/core-software-cochrane-reviews/revman/revman-5 download](https://training.cochrane.org/online-learning/core-software-cochrane-reviews/revman/revman-5-download)). Articles that were not discovered had their OR values removed.

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The meta-analysis was calculated in the final stage by displaying the three components: 1) figure of heterogeneity (I-squared (I<sup>2</sup>)), aimed to determine whether the data in the selected journals were homogeneous or heterogeneous; 2) examining the publication bias figure (Funnel Plot) to find no publication bias; and 3) examining the effect size figure (Forest Plot) to find an effect in getting nutrition education with anemia in female adolescents.<sup>8,9</sup>

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## Results

The procedure of identifying suitable papers for a 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, the authors found 257 articles. However, only 7 articles 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.<sup>22,23</sup> All studies used a cross-sectional design. The study's inclusion time frame included one paper from the publication year. Data from 2010 and 2021 were used in the study.

Table 1 reveals that nutrition education is a predictor of anemia in female adolescents in all of 7 articles. The sample sizes in all of the articles were large. The lowest number of respondents was 340, while the highest was 5,897. For participant secondary data, the age groups were divided into 10-19 years and 15-49 years. Table 2 lists all of the articles that are eligible. All studies showed that a lack of nutrition education might lead to anemia in female adolescents.

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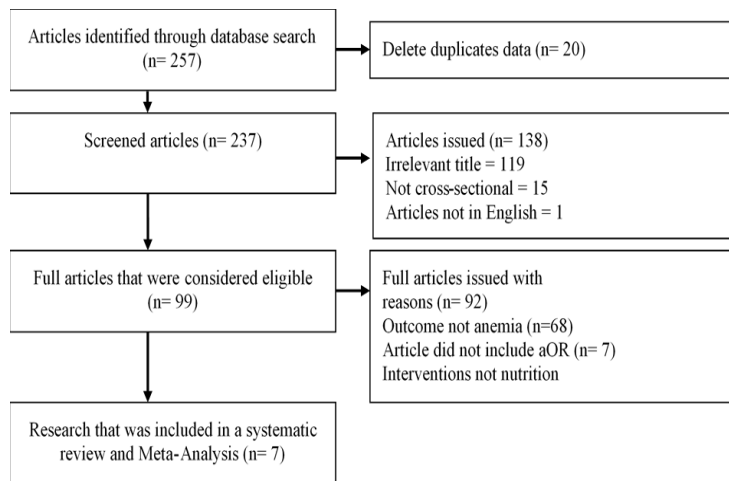


Figure 1. PRISMA Guidelines Flowchart

Table 1. Eligible Articles Characteristics

Author	Year	Country	Study Design	Period	Sample Size	Respondent	Age
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Agustina <i>et al.</i> <sup>22</sup>	2020	Indonesia	Cross-sectional	2016	340	Female adolescents	12-19
Alemu <i>et al.</i> <sup>23</sup>	2019	Ethiopia	Cross-sectional	2011	406	Female adolescents	10-19
Bansal <i>et al.</i>	2020	India	Cross-sectional	2015-2018	5,897	Female adolescents	10-19
Endalifer <i>et al.</i>	2021	Northeast Ethiopia	Cross-sectional	2016	411	Female adolescents	11-12
Gebreyesus <i>et al.</i>	2019	Ethiopia	Cross-sectional	2015	1,323	Female adolescents	10-14
Handiso <i>et al.</i>	2020	Southern Ethiopia	Cross-sectional	2019	843	Female adolescents	10-19
Shemelise <i>et al.</i>	2016	Ethiopia	Cross-sectional	2008-2009	5,500	Participants Secondary Data	15-49

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**Table 2. Type of Intervention and Anemia in the Eligible Article**

Author	Study Design	Setting	Participant	Intervention	Outcomes	aOR
Agustina <i>et al.</i> <sup>22</sup>	Cross-Sectional	Female adolescents, students aged 12-19 years	340	Frequency of reading newspaper or listening radio	Blood hemoglobin concentration	1.44
Alemu <i>et al.</i> <sup>23</sup>	Cross-Sectional	Community based cross-sectional study	406	Knowledge score	Blood hemoglobin concentration	1.15
Bansal <i>et al.</i>	Cross-Sectional	UDAYA longitudinal study	5,897	Media exposure of adolescent	Minimum dietary diversity (MDD-W) for women and blood hemoglobin concentration	2.10
Endalifer <i>et al.</i>	Cross-Sectional	Institution-based cross-sectional	411	Knowledge about nutrition	Dietary Diversity Score (DDS) and Hb Level	4.56
Gebreyesus <i>et al.</i>	Cross-Sectional	Female adolescents, students	1,323	Knowing the term "anemia"	Hemoglobin Level	1.58
Handiso <i>et al.</i>	Cross-Sectional	Community based cross-	843	Taking nutrition	24-h dietary recall (24 HR) and Hb	2.20

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	al	sectional	education	Level
Shemelise <i>et al.</i>	Cross- Sectional	Secondary data of Gilgel Gibe Field Research Center	5,500 Illiterate	Hemoglobin Level 2.69



**Figure 2. Study Location**

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Table 2 shows that all articles used cross-sectional study design. The research settings were female adolescents, students, community-based, and institution-based, and two articles used secondary data (UDAYA longitudinal study and Gilgel Gibe Field Research Center). The interventions were frequency of reading a newspaper or listening radio, knowledge score, media exposure of adolescents, nutrition knowledge, knowing the term "anemia," taking nutrition education and illiterate condition. The outcomes of the study were anemia conditions (showed from blood hemoglobin concentration, hemoglobin level, hemoglobin level with 24-h dietary recall (24 HR), and hemoglobin level with minimum dietary diversity (MDD-W) for women. All of the articles produced aOR ranged from 1.15 to 2.69. Nor did all of the articles present the total cases of respondents with anemia problems as presented in Table 2.

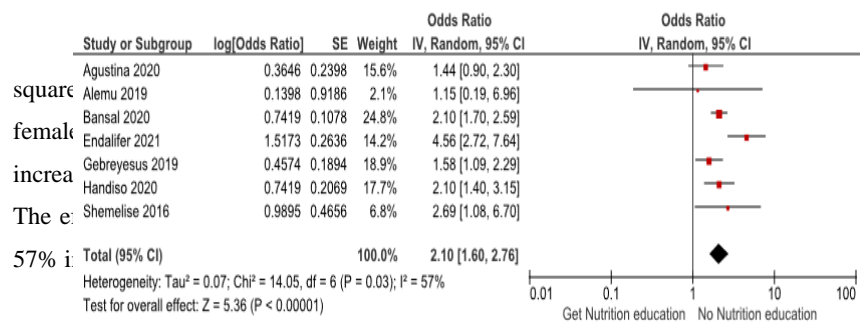
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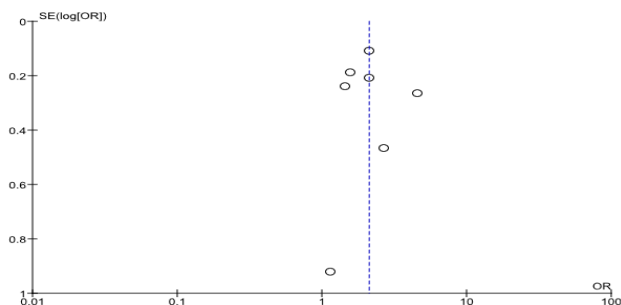
The aOR values of the 7 selected articles are shown in Figure 3. The meta-analysis conducted with RevMan 5.3 Software stated that the random effect model's heterogeneity analysis results showed the estimated amount of total heterogeneity using I Squared (I<sup>2</sup>) with a p-value <0.001. Furthermore, the calculation of the I-

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





**Figure 4. Funnel Plot Between Nutrition Education on the Incidence of Anemia in Female Adolescents**

Figure 4 demonstrates a symmetrical shape in the graph, with 2 plots on the right and 3 plots on the left, and 2 plot on line indicating a publication bias. The standard error on the left plot was 0.8 to 0.2, while the standard error on the right plot was 0.5 to 0.3. The disproportionate distance between studies in both the right and left plots, where the study on the right was farther away from the one on the left and caused bias.

### Discussion

Nutritional status was determined by anthropometric measurements and biochemical assessments with particular reference to their socioeconomic status.<sup>3</sup> Anemia in female adolescents is one indicator of nutritional status. The ordinary Hb range in female adolescents is 11 mgHb/100 mL to 13 mgHb/100 mL. Anemia is the state of the number of erythrocytes or Hb levels in blood is less than normal (12 g/dl). This causes a decrease in the ability Hb and erythrocytes carry oxygen throughout body, so that the body becomes tired quickly and weak. The cause of anemia in female adolescents includes menstruation, bleeding severe, nutritional deficiencies (iron, folate, protein), leukemia, and chronic disease.<sup>2</sup> In addition, COVID-19 is also a cause of anemia because this virus can attack the respiratory system so that hemoglobin and red blood cells which carry oxygen throughout the body decrease.<sup>16</sup>

The anemia signs include weakness, fatigue, lethargy, lack of enthusiasm in daily activities and tightness.<sup>21</sup> Children and pregnant women are especially vulnerable, with an increased maternal and child mortality risk. The prevalence of anemia remains high globally, particularly in low-income settings, where a significant

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proportion of young children and women of childbearing age can be assumed to be anaemic. Iron deficiency anemia has also been shown to affect cognitive and physical development in children and reduce productivity in adults.<sup>24</sup>

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Female adolescents from families whose moms had no formal schooling had been 3.2 instances much more likely to attain low on food variety. Meanwhile, those from families whose fathers only finished grades 1 to 4 were 2.6 times much more likely to attain low on food variety than those whose fathers finished college. Awareness and knowledge can decorate food preference and eating behavior. Similarly, this knowledgeable own family has a better economic status that might result in a excessive quality food plan. Comparable findings were reported by studies performed in Iran, Nigeria, Northern Ethiopia, and Gurage-Ethiopia.<sup>25-29</sup>

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No longer taking nutrients education was significantly related to low nutritional range scores of teenagers' girls in Southern Ethiopia. Female adolescents who did not attend nutrient education were 2.1 times more likely to have a low food variety score in assessment than those who did. Decision making strength for nutrition services was statistically associated with the dietary variety scores of observe individuals. Female adolescents with single fathers and mothers became 2.2 and 2.0 times more likely to have low dietary variety scores than those with both fathers and mothers. Elevating the level of awareness of nutrition increased the food variety score. These findings were in line with studies conducted in Africa and Ethiopia.<sup>30-32</sup>

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Other studies showed that teenagers with bad dietary knowledge were genuinely related to inadequate nutrient variety. Manjeet et al. (2011) showed the results of the study nutrition education is the right thing, effective and sustainable way to prevent iron deficiency anemia. Other research that stated that nutrition education is needed to prevention of anemia is a research that conducted by Nabarun et al. (2014) who conducted a study on 176 adolescents in West Bengal, which states that there are significant increase in knowledge about anemia participating in the program nutrition education (df = 20.241 (175)), with p-value <0.001. Cesilia et al. (2011) stated that significant nutrition education intervention increased knowledge score of 28.6 and a similar study conducted by Darmayanti et al. (2018) stated that there were differences in the level of knowledge after an anemia nutrition education intervention was carried out in both groups, where the intervention group had a higher increase in knowledge with an average of knowledge increased 2.88 compared to the control group.

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This study's results were supported by studies performed in Luxembourg and Jimma by using the developing knowledge of female adolescents approximately diseases, the proof showed adolescents fed on greater diverse foods.<sup>33,34</sup> In addition, evidence from Greek studies revealed that having crucial knowledge approximately meals was important for retaining properly health. Future researchers are expected to expand the search for articles by adding indexing databases that had no longer been used and seeking out articles with a different publication year range and more than two languages (English and Indonesian).

### **Conclusion**

This meta-analysis study shows that nutrition education affects the risk of anemia in female adolescents. As a result, the government as a policymaker, in collaboration with female adolescents, should pay close attention to the importance of nutrition education for young women in order to raise nutrition knowledge and avoid anemia.

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### **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 2010-2021. 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.

### Acknowledgment

The authors would like to thank to the electronic database providers Google Scholar, JAMA Network, PubMed, Science Direct, The New England of Medicine, Lancet, and ProQuest.

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### Author response to Editors' Comment

No.	Editors' / reviewers' comment	Response to comment	Lines
1	Please paraphrase the title to avoid redundancy in the word "nutrition."	Title has been paraphrased to avoid redundancy in the word "nutrition" and has been changed to A Meta-Analysis for Future Health Post-COVID-19-Pandemic	2
2	Since this article will be published in 2023, please use the articles published in 2013-2021 only.	All articles used are fixed from 2013-2021.	28
3	Please end this section with a brief conclusion.	Conclusions have been made in the abstract "This meta-analysis study shows that nutrition education affects the risk of anemia in female adolescents".	35 – 36
4	What is the purpose of this source? It is incoherence with the previous sentence. Please paraphrase/elaborate.	It has been explained the purpose of this resource	52 – 55
5	State the source at the end of the sentence.	Have included the source at the end of the sentence.	62
6	What do you mean by this phrase?	This phrase is several studies have been conducted to prevent anemia not only in young women but also to prevent it from affecting toddlers, small children, as well as pregnant and lactating women	63 – 65
7	Source?	Sources have been made at the end of each sentence	71
8	Please state the reference.	The reference has already been written.	86
9	Please briefly provide a significant novelty of your study and what your study can contribute to the world.	We have briefly listed the significant novelties of this study. "This study is being conducted as a follow-up to obtain a conclusive conclusion about the impact of nutrition education on the incidence of anemia, particularly in adolescent girls all over the world, in	96 – 100

		order to determine whether health programs that provide counseling and education can reduce the incidence of anemia in adolescent girls”.	
10	A review study should be conducted with odd number of authors. In the authors contribution you stated 6 authors. Which one is correct?	Already wrote in the author's contribution indeed 6 authors.	102
11	Please ensure that you <b>follow the PRISMA checklist</b> to provide a systematic review, especially Results and Discussion.	Yes, I have followed the PRISMA checklist.	104
12	Is this refer to the title or the journal name?	It refers to the title	127
13	What are you trying to say here?	all journal articles that meet the inclusion criteria were sorted by publication year, study location, study design, study duration, sample size, number of respondents, and adjusted Odd Ratio (aOR) values.	137 – 139
14	Please add this into the reference list.	It's been added to the reference list.	141
15	What do you mean by this phrase?	What I mean by this sentence is the age groups were divided into 10-19 years and 15-49 years. Table 2 lists all of the eligible articles. All studies showed that a lack of nutrition education might lead to anemia in adolescent girls.	159 -162
16	Please note that the maximum tables and figures in this Special Issue is only 4. You need to delete 2, or you can merge Table 1 and 2, and delete only 1 figure.	I have merged tables 1 and 2 and removed 1 figure	Page 6
17	These studies are not on the reference list. All of the articles reviewed <b>MUST</b> be on the reference list.		
18	Please put the source	Have included the source	Page 8 and 9

	number at the end of each sentence.	number at the end of each sentence.	
19	Please complete this paragraph into 3-5 sentences.	This paragraph has been completed into 5 sentences.	Page 9
20	If you add more references, moreover sources that you refer in the introduction-discussion section, please note that the <b>maximum reference is 40 sources</b> . Please follow the format of writing the reference: - Write only three authors (you can write et al. for the rest) - Write the DOI and provide the URL	References has fulfilled no more than 40 sources and has followed the writing format in the bibliography.	Page 11 – 14



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