Association of Body Mass Index and Dietary Diversity with Anemia among Adolescent Girls: A Meta Analysis

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Abstract

Anemia among adolescent girls remains a major public health problem with long-term implications for growth, cognitive development, and reproductive health. Nutritional status, particularly body mass index (BMI) and dietary diversity score (DDS), has been identified as an important determinant of anemia; however, findings from primary studies are inconsistent. This study aimed to estimate the pooled association between BMI, dietary diversity, and anemia among adolescent girls through a systematic review and meta-analysis following the PRISMA guidelines. A meta-analysis was conducted using the PICO framework with adolescent girls as the population. Underweight BMI and low DDS were defined as exposures, while normal BMI and adequate DDS served as comparators. Anemia was the outcome of interest. Articles published between 2015 and 2025 were retrieved from PubMed, ScienceDirect, and Google Scholar. Eligible studies were cross-sectional, reported adjusted odds ratios (aOR), and were analyzed using RevMan 5.3. Fifteen studies involving 9,654 adolescent girls from six countries were included. Underweight adolescents had a significantly higher risk of anemia compared with those with normal BMI (aOR = 1.91; 95% CI = 1.63–2.25; $p < 0.001$). Low dietary diversity was also significantly associated with anemia (aOR = 1.71; 95% CI = 1.18–2.50; $p = 0.005$). Underweight BMI and low dietary diversity significantly increase the risk of anemia among adolescent girls.

Keywords: anemia; adolescent girls; body mass index; dietary diversity; meta-analysis

Introduction

Anemia is a condition characterized by a reduced number of red blood cells or a lower-than-normal hemoglobin concentration. Hemoglobin is essential for transporting oxygen throughout the body, and when red blood cells are insufficient, abnormal, or have reduced hemoglobin content, the blood's oxygen-carrying capacity is diminished. This leads to impaired oxygen delivery to tissues, resulting in fatigue, decreased productivity, poor cognitive function, and long-term health consequences (World Health Organization, 2021).

Anemia is a major global public health concern that disproportionately affects vulnerable populations, including young children, adolescent girls, pregnant women, and postpartum women. According to the World Health Organization (WHO), in 2023 an estimated 30.7% of non-pregnant women, 35.5% of pregnant women, and 30.7% of women aged 15–49 years worldwide were anemic. Similarly, in 2019, about 39.8% of children aged 6–59 months were affected by anemia (World Health Organization, 2023).

Recognizing its global significance, anemia has been identified as one of the six Global Nutrition Targets set by the World Health Assembly, as well as a key objective of the United Nations 2030 Agenda for Sustainable Development. WHO has strengthened its commitment to reducing anemia by developing a comprehensive framework

for prevention, diagnosis, and management through a multi-sector approach. This commitment was reaffirmed at the 2021 Nutrition for Growth Summit, where WHO and UNICEF launched the Anemia Action Alliance to coordinate stakeholders and accelerate the implementation of effective national strategies. These initiatives highlight the critical role of anemia reduction in achieving broader health and development goal (World Health Organization, 2021).

Globally, there are currently 1.3 billion adolescents, representing 16% of the population. Individuals aged 10 to 19 years undergo a crucial period of rapid growth and development (UNICEF, 2023b). However, under-nutrition, micro-nutrient deficiencies, and anemia remain persistent challenges, particularly among adolescent girls in low- and middle-income countries, in the context of ongoing food and nutrition insecurity (UNICEF, 2023a). Several studies have identified factors associated with anemia in adolescent girls, including maternal employment, irregular meal patterns, under-nutrition, low household wealth, living apart from parents, poor dietary diversity, and prolonged menstruation lasting more than five days (Fentie et al., 2020; Rahman et al., 2024).

Previous studies have identified nutritional status as a major determinant of anemia in adolescent girls, with low BMI-for-age significantly increasing the likelihood of anemia (aOR = 3.2; 95% CI: 1.43 to 7.05), as demonstrated by Mengistu et al. (2019). Similarly, inadequate dietary diversity has emerged as a strong predictor (aOR = 2.5; 95% CI: 1.1 to 9.2), with Ghimire et al. (2024) reporting that adolescent girls consuming a limited variety of foods were at substantially higher risk of developing anemia compared to those with adequate dietary diversity.

Despite numerous studies examining the relationship between nutritional status and anemia among adolescent girls, inconsistencies remain regarding the magnitude and direction of these associations across different settings. Therefore, this study aims to systematically synthesize available evidence and quantify the pooled association between body mass index, dietary diversity, and anemia among adolescent girls through a meta-analysis.

Methods

1. Study Design

This study employed a systematic review and meta-analysis of observational studies and was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review protocol was developed prior to the study and followed standard methodological procedures.

2. Search Strategy

Articles were retrieved from three databases, namely: PubMed, Google Scholar and Science Direct using the keywords: “Anemia” AND “Body Mass Index” OR “BMI” AND “Underweight” AND “Dietary Diversity” AND “Adolescent girl” AND “Cross Sectional”. The publication period from 2015 to 2025 was selected to ensure the inclusion of the most recent and relevant evidence reflecting current nutritional and epidemiological conditions among adolescent girls.

3. Steps of Meta-Analysis

The meta-analysis was carried out in five steps as follows: formulate research questions in the PICO format (population, intervention, comparison, outcome); search for primary study articles from various electronic databases including Google Scholar, PudMed, and Science Direct; conduct screening and critical appraisal (Critical Appraisal) of primary research articles; perform data extraction and synthesize effect

estimates into RevMan 5.3; interpret and conclude the result.

4. **Inclusion Criteria**

Inclusion criteria in this study included articles with cross-sectional study design, full text available articles, results of analysis used adjusted odds ratio (aOR), year of article used range 2015-2025 and study outcome was adolescent girls who have anemia.

5. **Exclusion Criteria**

Exclusion criteria in this study included not clearly explaining the results; different interventions and populations; reviews, case reports, or intervention studies; paid or locked articles; and analysis results not using an adjusted odds ratio (aOR).

6. **Operational Definition of Variables**

Article search was carried out by considering the eligibility criteria determined using the PICO model. The population of this study was adolescent girls aged 10-19 years, the intervention used were underweight body mass index (BMI) and low dietary diversity score (DDS), the comparison in this study were normal body mass index (BMI) and adequate dietary diversity score (DDS) and the outcome was anemia measured by hemoglobin concentration.

Body mass index (BMI) for age was calculated by using height and weight measurement with anthro-plus software and found BAZ (body mass index for age in z score). It was categorized into underweight (<18.5 kg/m2 or BAZ < -2 SD), normal (18-24.9 kg/m2 BAZ ≥ -2 SD to ≤ +1 SD), and overweight (≥ 25 kg/m2 or BAZ > +1 SD).

Dietary diversity was assessed in adolescent girls consuming different food groups over the past 24 hour period. If the adolescent girls were consumed below five defined groups were low dietary diversity and if the adolescent girls were consumed five and above defined groups were adequate dietary diversity.

Anemia is a condition in which the body lacks hemoglobin concentration less than 12 gr/dL.

7. **Instrument**

The instrument in this study was an article on the association of body mass index and dietary diversity with anemia among adolescent girls. Article screening, data extraction, and quality assessment were independently conducted by two reviewers. Discrepancies were resolved through discussion. Study quality was assessed using checklist for critical assessment from a cross-sectional study (survey) sourced from Critical Appraisal Skills Programme (CASP) (2024).

8. **Data Analysis**

Research that has been collected is selected with predetermined criteria and then the results of the research will be analyzed based on variations between studies with the fixed effect model and random effect model using RevMan 5.3 software. RevMan software functions to calculate the overall adjusted odds ratios (aOR) value by describing the 95% Confidence Interval (CI) using the effects model as well as data heterogeneity.

Results

Search for articles in this study through databases that include PubMed, Google Scholar, and Science Direct in the period 2015-2025. The process of screening articles according to the research criteria can be seen in the PRISMA flow diagram in Figure 1. The initial search process obtained 6,803 articles, then a selection of eligible articles was conducted so that 15 articles were included in the meta-analysis study.

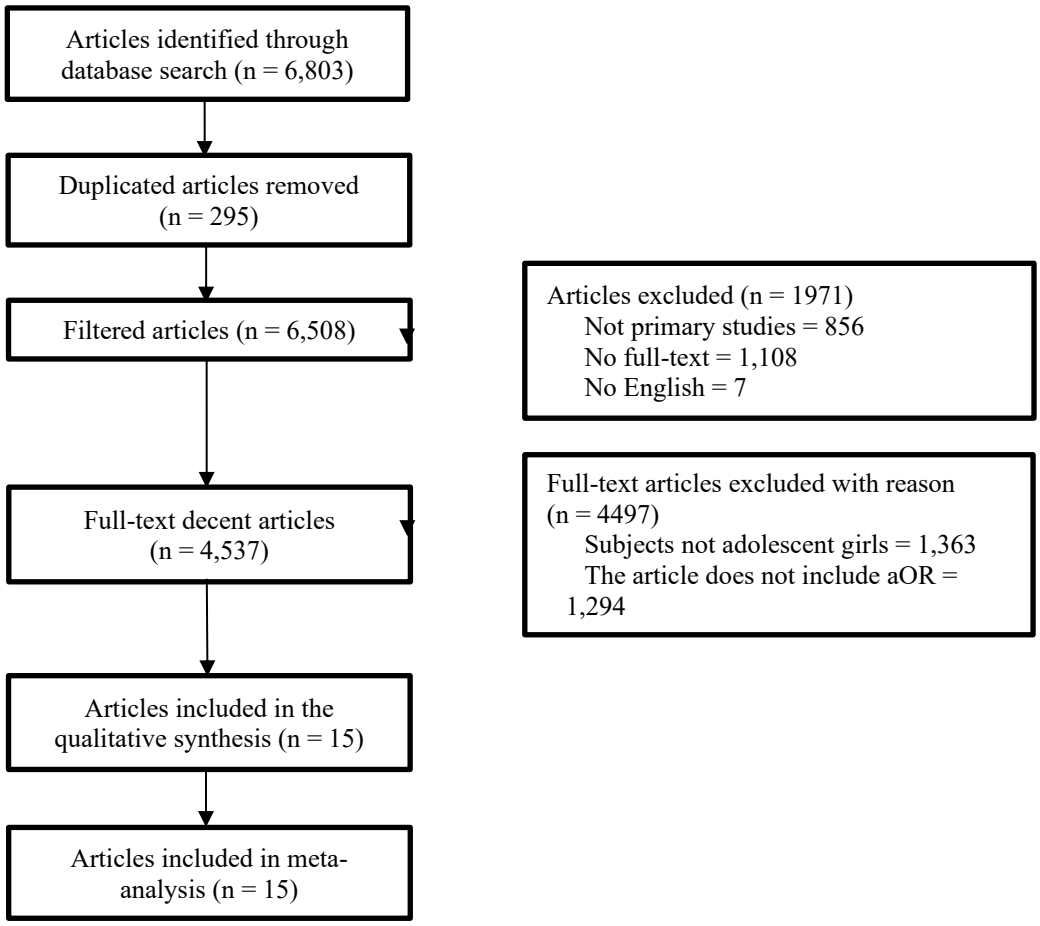

Figure 1. Results of PRISMA flowchart diagrams

The fifteen articles that have been obtained from several databases need to be assessed to determine the quality of the articles before being used as material for meta-analysis. Researchers conducted an assessment of the study quality using a checklist for critical assessment from a cross-sectional study based on Critical Appraisal Skills Programme, (2024) (CASP). The results of the study quality assessment based on CASP can be seen in Table 1.

Table 1. Critical appraisal checklist for cross-sectional studies in meta-analysis

Primary Study	Criteria											Total
	1	2	3	4	5	6	7	8	9	10	11	
Rahman et al., 2024	2	2	2	2	2	2	2	2	2	1	2	21
Mangistu et al., 2019	2	2	2	2	2	2	2	2	2	1	2	21
Tan, et al., 2020	2	2	2	2	2	2	2	2	2	2	2	22
Gonete et al., 2018	2	2	2	2	2	2	2	2	2	2	2	22
Fentie et al., 2020	2	2	2	2	2	2	2	2	2	2	2	22
Ghimire et al., 2024	2	2	2	2	2	2	2	2	2	2	2	22
Ahmed and Mohammed., 2022	2	2	2	2	2	2	2	2	2	2	2	22
Tura et al., 2020	2	2	2	2	2	2	2	2	2	2	2	22
Gebreyesus et al., 2019	2	2	2	2	2	2	2	2	2	2	2	22
Mistry et al., 2017	2	2	2	2	2	2	2	2	2	2	2	22

Dhurde et al., 2024	2	2	2	2	2	2	2	2	2	2	2	22
Demalash and Murutse., 2019	2	2	2	2	2	2	2	2	2	2	2	22
Alemu and Gebremedhin., 2020	2	2	2	2	2	2	2	2	2	2	2	22
Handiso,Y. H., 2022	2	2	2	2	2	2	2	2	2	1	2	21
Agusina et al., 2020	2	2	2	1	2	2	2	2	2	1	2	20

(Primary data, 2025)

Description of the question criteria:

1 = Did the study address a clearly focused issue?
2 = Did the authors use an appropriate method to answer their question?
3 = Were the subjects recruited in an acceptable way?
4 = Were the measures accurately measured to reduce bias?
5 = Were the data collected in a way that addressed the research issue?
6 = Did the study have enough participants to minimize the play of chance?
7 = How are the results presented and what is the main result?
8 = Was the data analysis sufficiently rigorous?
9 = Is there a clear statement of findings?
10 = Can the results be applied to the local population?
11 = How valuable is the research?

Description of the answer score:

0 = No
1 = Hesitant
2 = Yes

Table 2 describes a summary of primary research of the association of body mass index on anemia with cross-sectional design, a meta analysis was carried out on 9 articles originating from the country of Bangladesh, Ethiopia, Vietnam, and India with a sample size of 6,348. The largest research population was found in a study conducted by Tan et al. (2024) namely 1,471 adolescent girls aged 10-18 years, and the study with the smallest population, namely the study conducted by Dhurde et al. (2024) as many as 221 adolescent girls aged 14-19 years.

Table 2. Description of the primary studies of the association of body mass index on anemia in adolescent girls

Author (year)	Country	Sample	Population	Intervention	Comparison	Outcome
Rahman et al. (2024)	Bangladesh	422	Adolescent girls 10-19 years	Underweight	BMI Z score Normal	Anemia
Mengistu et al. (2019)	Ethiopia	423	Adolescent girls 10-19 years	Thin	BMI for age Normal	Anemia
Tan et al. (2024)	Vietnam	1471	Adolescent girls 10-18 years	Thinness	Normal weight	Anemia
Fentie et al. (2020)	Ethiopia	528	Adolescent girls 14-19 years	Thinness	Normal weight	Anemia
Tura et al. (2020)	Ethiopia	532	Adolescent girls 10-19 years	Thin	Not wasted	Anemia
Mistry et al. (2017)	Bangladesh	1314	Adolescent girls 10-19 years	Malnourished	Well nourished	Anemia
Dhurde et al. (2024)	India	221	Adolescent girls 14-19 years	BAZ < -2 $_{SD}$	BAZ normal	Anemia
Demalash and Murutse (2019)	Ethiopia	594	Adolescent girls 15-19 years	Underweight	Normal weight	Anemia
Handiso,Y. H.	Ethiopia	843	Adolescent girls	Thin	Not Thin	Anemia

(2022)	10-19 years	

(Primary Data, 2025)

Table 3 shows the amount of aOR from the primary studies used in the meta-analysis about the association of body mass index with anemia. The largest adjusted odds ratio (aOR) conducted by Mengistu et al. (2019) is 3.20 and the lowest aOR conducted by Rahman et al. (2024) is 1.01.

Table 3. aOR and 95% CI data of the association of body mass index on anemia in adolescent girls

Author (year)	aOR	95% CI	
		Lower Limit	Upper Limit
Rahman et al. (2024)	1.01	0.29	3.42
Mengistu et al. (2019)	3.2	1.43	7.05
Tan et al. (2024)	1.71	0.97	2.99
Fentie et al. (2020)	2.31	0.91	5.45
Tura et al. (2020)	1.67	1.11	2.52
Mistry et al. (2017)	1.42	1.0	2.1
Dhurde et al. (2024)	1.1	0.43	2.9
Demelash & Murutse (2019)	2.72	1.92	5.43
Handiso,Y. H. (2022)	2.09	1.47	2.98

(Primary Data, 2025)

The forest plot in figure 2 shows that adolescent girls with underweight BMI could increase risk of anemia by 1.91 times compared to normal weight BMI, and this result was statistically significant (aOR = 1.91; 95% CI 1.63 to 2.25; $p < 0.001$). The forest plot also showed low heterogeneity of effect estimates across primary studies with $I^2 = 31\%$ ($p = 0.17$). The calculation of average effect estimates was carried out with a fixed effect model approach.

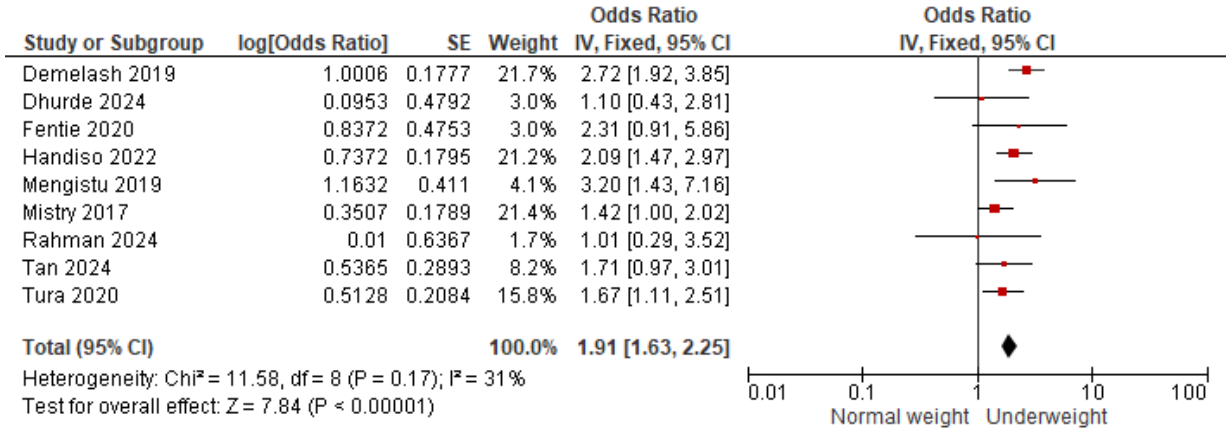

Figure 2. Forest plot of the association of body mass index on anemia in adolescent girls

The funnel plot in Figure 4 shows that the distribution of effect estimates between studies is more symmetrical, that is, the distribution of effect estimates to the right and left of the average vertical line of effect estimates is relatively the same. Thus, this funnel plot indicates that there is no publication bias.

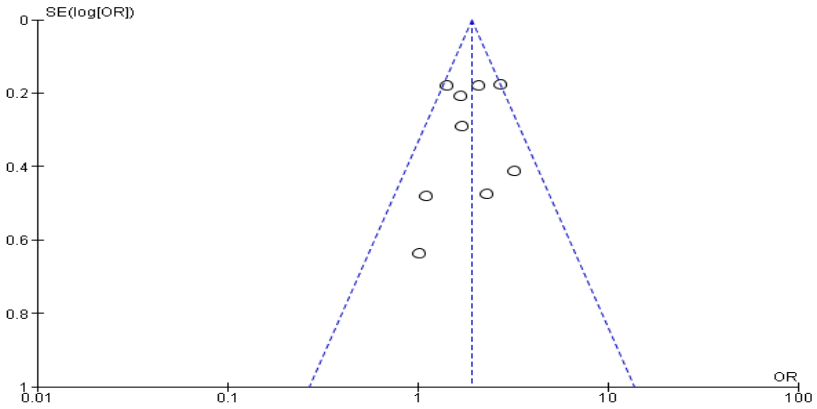

Figure 3. Funnel plot of the association of body mass index on anemia in adolescent girls

Table 4 describes a summary of primary research of the association of dietary diversity on anemia with cross sectional design, a meta analysis was carried out on 9 articles originating from the country of Ethiopia, Nepal, and Indonesia with a sample size of 5,209. The largest research population was found in a study conducted by Gebreyesus et al. (2019) namely 1,323 adolescent girls aged 10-19 years, and the study with the smallest population, namely the study conducted by Agustina et al. (2020) as many as 335 adolescent girls aged 12-19 years.

Table 4. Description of the primary studies of the association of dietary diversity on anemia in adolescent girls

Author (year)	Country	Sample	Population	Intervention	Comparison	Outcome
Gonete et al. (2018)	Ethiopia	462	Adolescent girls 15-19 years	Inadequate dietary diversity	Adequate dietary diversity	Anemia
Fentie et al. (2020)	Ethiopia	528	Adolescent girls 14-19 years	Low dietary diversity score	High dietary diversity score	Anemia
Ghimire et al. (2024)	Nepal	405	Adolescent girls 10-19 years	Absent dietary diversity	Present dietary diversity	Anemia
Ahmed and Mohammed (2022)	Ethiopia	372	Adolescent girls 15-19 years	< 5 Food group dietary diversity	> 5 Food group dietary diversity	Anemia
Tura et al. (2020)	Ethiopia	532	Adolescent girls 10-19 years	Low dietary diversity score	High dietary diversity score	Anemia
Gebreyesus et al. (2019)	Ethiopia	1323	Adolescent girls 10-19 years	Low dietary diversity	High dietary diversity	Anemia
Alemu and Gebremedhin (2020)	Ethiopia	409	Adolescent girls 14-19 years	Low dietary diversity score	High dietary diversity score	Anemia
Handiso,Y. H. (2022)	Ethiopia	843	Adolescent girls 10-19 years	< 5 Food group dietary diversity	≥ 5 Food group dietary diversity	Anemia
Agustina et al. (2020)	Indonesia	335	Adolescent girls 12-19 years	Low dietary diversity score	High dietary diversity score	Anemia

(Primary Data, 2025)

Table 5 shows the amount of aOR from the primary studies used in the meta-analysis about the association

of dietary diversity with anemia. The largest adjusted odds ratio (aOR) conducted by Alemu & Gebremedhin (2020) is 10.04 and the lowest aOR conducted by Handiso (2022) is 0.65.

Table 5. aOR and 95% CI data of the association of dietary diversity on anemia in adolescent girls

Author (year)	aOR	95% CI	
		Lower Limit	Upper Limit
Gonete et al. (2018)	2.1	1.3	3.5
Fentie et al. (2020)	3.57	1.88	6.75
Ghimire et al. (2024)	2.5	1.1	9.2
Ahmed and Mohammed (2022)	1.76	0.5	5.42
Tura et al. (2020)	0.96	0.61	1.53
Gebreyesus et al. (2019)	1.07	0.69	1.65
Alemu and Gebremedhin (2020)	10.04	1.68	60.09
Handiso,Y. H. (2022)	0.65	0.11	2.44
Agustina et al. (2020)	1.44	0.90	2.29

(Primary Data, 2025)

The forest plot in figure 4 shows that adolescent girls with low dietary diversity score could increase risk of anemia by 1.71 times compared to adequate dietary diversity score, and this result was statistically significant (aOR = 1.71; 95% CI 1.18 to 2.50; p = 0.005). The forest plot also showed moderate to high heterogeneity of effect estimates across primary studies with I^2 = 63% (p = 0.006). The calculation of average effect estimates was carried out with a random effect model approach.

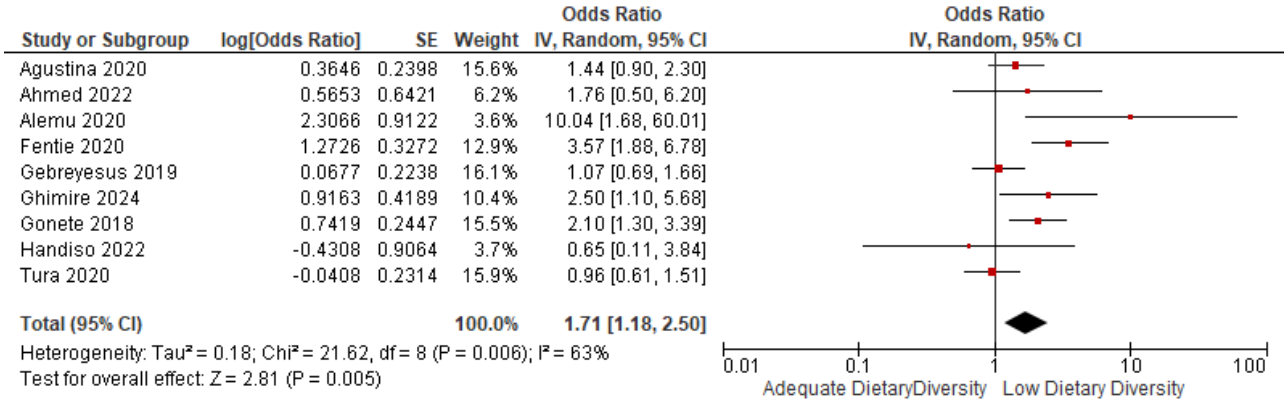

Figure 4. Forest plot of the association of dietary diversity on anemia in adolescent girls

The funnel plot in Figure 5 shows that the distribution of effect estimates between studies is more symmetrical, that is, the distribution of effect estimates to the right and left of the average vertical line of effect estimates is relatively the same. Thus, this funnel plot indicates that there is no publication bias.

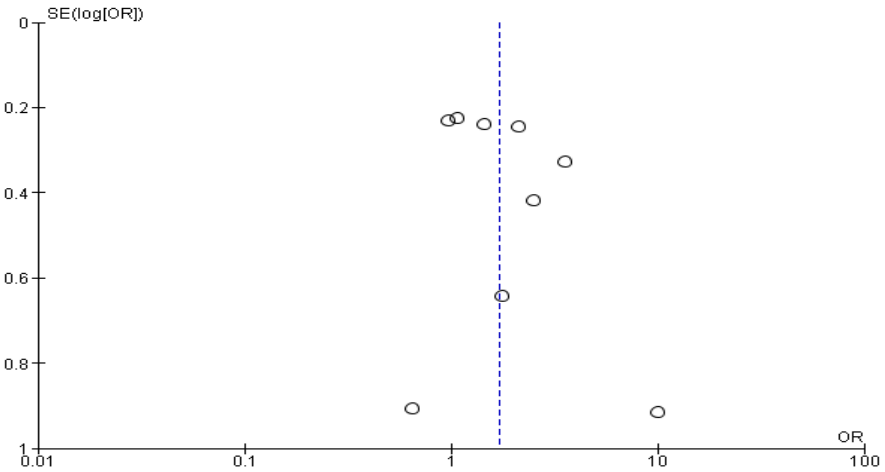

Figure 5. Funnel plot of the association of dietary diversity on anemia in adolescent girls

Although the findings demonstrate consistent associations, the predominance of studies from low- and middle-income countries, particularly Ethiopia and South Asia, may limit the generalizability of the results to other geographic contexts.

Discussion

This meta-analysis study analysed association of body mass index and dietary diversity with anemia among adolescent girls. This study used aOR statistics of multivariate analysis results which aim to get the same final results for the studies to be analyzed.

Association between Body Mass Index and Anemia

This study showed that adolescent girls with underweight BMI increased anemia by 1.91 times compared to normal weight BMI, and this result was statistically significant (aOR= 1.91; 95% CI 1.63 to 2.25; $p < 0.001$). This research is in line with meta-analysis research conducted by Berhe et al. (2022) which found that body mass index to be a significant factor associated with anemia in adolescent girls. Adolescent girls with underweight body mass index, 2.49 times increased the risk of anemia compared to adolescent girls with normal body mass index (aOR= 2.49; 95% CI 1.79 to 3.46; $p <0.001$).

A study in line with this meta analysis research, conducted by Handiso (2022) also reported that adolescent girls with underweight body mass index were 2.09 times more likely to develop anemia compared to adolescent girls who had normal body mass index, and this was proven to be significant (aOR= 2.09; 95% CI 1.47 to 2.98). Another study conducted by Tan et al. (2024) also stated that adolescent girls who had underweight or low body mass index had 1.71 times risk of experiencing anemia compared to adolescent girls with normal body mass index and this was proven to be significant (aOR= 1.71; 95% CI= 0.97 to 2.99).

Adolescent girls who had underweight or a low body mass index are more likely to develop anemia compared to those with a normal body mass index because they probably have micronutrient deficiencies. This condition has important implications not only for academic performance but also for long-term reproductive health. Anemia during adolescence is associated with reduced concentration, impaired learning capacity, and decreased academic achievement. In the long term, if it persists into pregnancy, anemia increases the risk of obstetric complications, including prolonged labor, preterm delivery, low birth weight, and perinatal mortality (Risna'im et al., 2022).

Association between Dietary Diversity and Anemia

In this meta-analysis research identified that adolescent girls with low dietary diversity increased anemia by 1.71 times compared to adequate dietary diversity, and this was proven to be significant (aOR= 1.71; 95% CI 1.18 to 2.50; p= 0.005). A meta-analysis study conducted by Berhe et al. (2022) showed that adolescent girls with inadequate dietary diversity had a higher risk for anemia 2.81 times compared to adequate dietary diversity and this was proven to be significant (aOR= 2.81; 95% CI= 1.33 to 5.9; p= 0.007).

The another study finding was consistent with this study conducted by Fentie et al. (2020) indicated that adolescent girls with low dietary diversity score (DDS) were at higher risk of anemia 3.57 times compared to adolescent with adequate or high dietary diversity score (aOR= 3.57; 95% CI= 1.88 to 6.75). A similar finding was found in studies conducted by Ahmed & Mohammed (2022) also stated that adolescent girls who had low or inadequate dietary diversity score a had 1.76 times risk of experiencing anemia compared to adolescent girls with adequate dietary diversity score and that was statistically significant (aOR= 1.79; 95% CI= 0.5 to 5.42).

Dietary diversity defined as the number of different food groups consumed within the 24 hours preceding data collection. It is widely acknowledged as an essential indicator of diet quality at both the individual and household levels (Fentie et al., 2020). Adolescent girls often do not follow balanced nutrition guidelines and tend to consume a limited variety of foods. Their diets are frequently dominated by junk food, which usually provides only a narrow source of protein. In fact, iron can be obtained from various food sources, including heme iron (meat, poultry, fish), non-heme iron (legumes, seeds, dried fruits), fortified iron (cereals, protein powders), and vitamin C-rich foods (fruits, vegetables, tomatoes) that enhance iron absorption. Therefore, it is important for adolescent girls to understand which healthy foods are rich in iron to prevent iron deficiency and reduce the risk of anemia (Diastanti et al., 2024).

Conclusion

This meta-analysis concludes that underweight body mass index (BMI) and inadequate dietary diversity significantly increase the risk of anemia among adolescent girls. These findings support the need for integrated nutrition interventions, including school-based nutrition programs and dietary diversification strategies. Future longitudinal and intervention studies are recommended to strengthen causal inference and inform public health policy.

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Author Contribution

Pelangi Pagi Kalimasadha is the principal researcher who selects the topic, seeks, collects research data, and analyzed the data. Bhisma Murti reviewed the research documents and data.

References

Agustina, R., Nadiya, K., Andin, E. A., Setianingsih, A. A., Sadariska, A. A., Prafiantini, E., Wirawan, F., Karyadi, E., & Raut, M. K. (2020). Associations of meal patterning, dietary quality and diversity with anemia and

overweight-obesity among Indonesian school-going adolescent girls in West Java. *PLoS ONE*, *15*(4), 1–19. https://doi.org/10.1371/journal.pone.0231519

Ahmed, A., & Mohammed, A. (2022). Anemia and its associated factor among adolescent school girls in Godey and Degehabur council Somali region, eastern Ethiopia. *BMC Nutrition*, *8*(55), 1–6. https://doi.org/10.1186/s40795-022-00548-1

Alemu, T., & Gebremedhin, S. (2020). Prevalence and predictors of anaemia among adolescent girls in rural Hadero Tunto District, Southern Ethiopia: Community based study. *International Journal of Nutrition and Food Sciences*, *9*(1), 16–24. https://doi.org/10.11648/j.ijnfs.20200901.14

Berhe, K., Gebrearegay, F., Gebreegziabhe, H., Weldegerima, L., Kahsay, A., Hadush, H., Gebremariam, B., Fseha, B., Gebremariam, G., Etsay, N., & Hailu, M. (2022). Magnitude and associated factors of anemia among adolescent girls in Ethiopia: A systematic review and meta-analysis. *Archives of Public Health*, *80*(189), 1–15. https://doi.org/10.1186/s13690-022-00942-y

Critical Appraisal Skills Programme. (2024). *CASP cross sectional studies Checklist*.

Demelash, S., & Murutse, M. (2019). Prevalence of anemia and its associated factors among school adolescent girls Addis Ababa, 2015. *EC Nutrition*, *14*(12), 1–11. https://ecronicon.net/assets/ecnu/pdf/ECNU-14-00717.pdf

Dhurde, V. S., Patel, A. B., Locks, L. M., & Hibberd, P. L. (2024). Anaemia prevalence, its determinants and profile of micronutrient status among rural school adolescent girls aged 14–19 years: A cross-sectional study in Nagpur district, Maharashtra, India. *Public Health Nutrition*, *27*(1), 1–10. https://doi.org/10.1017/s1368980024002234

Diastanti, Y., Kalsum, U., Guspianto, & 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://doi.org/10.20473/jbe.V12I32024.280-289

Fentie, K., Wakayo, T., & Gizaw, G. (2020). Prevalence of anemia and associated factors among secondary school adolescent girls in Jimma Town, Oromia Regional State, Southwest Ethiopia. *Anemia*, *2020*(1), 1–11. https://doi.org/10.1155/2020/5043646

Gebreyesus, S. H., Endris, B. S., Beyene, G. T., Farah, A. M., Elias, F., & Bekele, H. N. (2019). Anaemia among adolescent girls in three districts in Ethiopia. *BMC Public Health*, *19*(92), 1–11. https://doi.org/10.1186/s12889-019-6422-0

Ghimire, M., Bhandari, S., & Rajbanshi, M. (2024). Prevalence of anemia and its associated factors among school-going adolescent girls in schools of Dhankuta municipality, Nepal. *PLOS Glob Public Health*, *4*(9), 1–17. https://doi.org/10.1371/journal.pgph.0003684

Gonete, K. A., Tariku, A., Wami, S. D., & Derso, T. (2018). Prevalence and associated factors of anemia among adolescent girls attending high schools in Dembia District, Northwest Ethiopia, 2017. *Archives of Public Health*, *76*(79), 1–9. https://doi.org/10.1186/s13690-018-0324-y

Handiso, Y. H. (2022). Anemia and its determinants among adolescent girls in Southern Ethiopia. *Cogent Public Health*, *9*(1), 1–13. https://doi.org/10.1080/27707571.2022.2082045

Mengistu, G., Azage, M., & Gutema, H. (2019). Iron deficiency anemia among in-school adolescent girls in rural area of Bahir Dar City Administration, North West Ethiopia. *Anemia*, *2019*(1), 1–8. https://doi.org/10.1155/2019/1097547

Mistry, S. K., Jhohura, F. T., Khanam, F., Akter, F., Khan, S., Yunus, F. M., Hossain, M. B., Afsana, K., Haque, M. R., & Rahman, M. (2017). An outline of anemia among adolescent girls in Bangladesh: Findings from a cross sectional study. *BMC Hematology*, *17*(13), 1–8. https://doi.org/10.1186/s12878-017-0084-x

Rahman, M. J., Rahman, M. M., Sarker, M. H. R., Kakehashi, M., Tsunematsu, M., Ali, M., Ahmed, A., Hawlader, M. D. H., & Shimpuku, Y. (2024). Prevalence and influencing factors with knowledge, attitude, and practice toward anemia among school-going adolescent girls in rural Bangladesh. *PLoS ONE*, *19*(11), 1–20. https://doi.org/10.1371/journal.pone.0313071

Risna'im, A. R., Mahtuti, E. Y., Masyhur, M., & Faisal. (2022). Overview of anemia in young women low body mass index (thin category). *Medicra (Journal of Medical Laboratory Science/Technology*, *5*(2), 62–67. https://doi.org/10.21070/medicra.v5i2.1636

Tan, X., Tan, P. Y., Som, S. V., Nguyen, S. D., Tran, D. T., Tran, N. T., Tran, V. K., Moore, J. B., & Gong, Y. Y. (2024). Micronutrient deficiencies and the double burden of malnutrition in Vietnamese female adolescents: A national cross-sectional study in 2020. *The Lancet Regional Health-Western Pacific*, *50*(101164), 1–12. https://doi.org/10.1016/j.lanwpc.2024.101164

Tura, M. R., Egata, G., Fage, S. G., & Roba, K. T. (2020). Prevalence of anemia and its associated factors among female adolescents in Ambo Town, West Shewa, Ethiopia. *Journal of Blood Medicine*, *11*, 279–287. https://doi.org/10.2147/jbm.s263327

UNICEF. (2023a, March). *Undernourished and Overlooked*. https://www.unicef.org/reports/undernourished-overlooked-nutrition-crisis

UNICEF. (2023b, June). *Adolescent Health Dashboards*. https://data.unicef.org/resources/adolescent-health-dashboards-country-profiles/

World Health Organization. (2021). *Anaemia*. https://www.who.int/news-room/fact-sheets/detail/anaemia

World Health Organization. (2023). *Anaemia in Women and Children*. https://www.who.int/data/gho/data/themes/topics/anaemia_in_women_and_children